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DECREASING THE SHRINKAGE AND SWELLING OF LONGITUDINALLY COMPRESSED WOOD

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ABSTRACT

As a result of longitudinal compression of wood (aka. pleating), its radial, tangential and volumetric shrinkage and swelling slightly change, while both longitudinal shrinkage and swelling increase by orders of magnitude, by about 600-900%. This unusually high longitudinal dimension change causes the high deformation ability of pleated wood during the change of its moisture content. The explanation of this great increase in longitudinal shrinkage and swelling may be the wavy cell walls and the distortion of the microfibrils. These phenomena are the result of the treatment and ensures the required property of wood, the pliability. Thus, it is necessary to find a solution to highly improve both anti-shrinkage efficiency and anti-swelling efficiency of pleated wood. Lactic-acid treatment is a good solution. Lactic-acid treatment lowers the dimensional changes of wood through decreasing the moisture uptake of wood. But this impregnation treatment is relatively time consuming, compared for example to heat treatment, which is also an effective method to decrease the moisture uptake of wood by using mostly lower treatment temperatures to prevent the wood from becoming brittle. Microwave treatment has a positive effect on the preparation of the lactic acid. It highly fastens the oligomerization process, which is necessary before the impregnation process, to improve the polymerization ability of lactic acid molecules inside the solid wood.

INTRODUCTION

At the beginning of the 20th century, Max Hanemann patented the method of longitudinal compression of wood, and in the 1920s the technology suitable for mass production was also developed (*Báder and Németh*, 2018b). With this thermo-hydro-mechanical treatment, the wood became more pliable than it would be after only a steaming process, even in cold conditions. The longitudinal compression process and the fixation post-treatment is called "pleating" (*Báder and Németh*, 2018a), due to the buckling of cell walls caused by the treatment.

Pleated wood can be used to make flexible and lightweight furniture (*Anssary*, 2006), to create curved handrails with mechanical fastenings or edge bandings with gluing. It is also well suited for restoration work or to produce vibration-dampened tool handles and custom-shaped tools, arched picture frames, and can be used in the fields of construction, sports equipment, musical instruments and visual arts (*Báder and Németh*, 2018b). It can be processed with negligible wood waste (*Anssary*, 2006), and no excessive manufacturing oversize is required. The structure of the compressed wood remains intact during shaping, because the grain always follows the arch. According to our present knowledge, there are a few places in the world where longitudinally compressed wood is produced today. In Italy, the Candidus Prugger SAS uses a

technology patented in 1927 which was further developed by the company (*Bátori*, 2000). In other places, the manufacturers use the Danish developed equipment of Compwood Machines LTD, for example the Compwood Products KFT (Hungary) and the Pure Timber LLC (USA).

For longitudinal compression, higher density hardwood species are suitable. For example, beech, oak, ash, elm, maple, cherry and walnut are the commonly used species (*Buchter et al.*, 1993). Both pleating and bending of wood require excellent-quality raw material. Straight-growing, knot-free trees with narrow annual rings are the most suitable (*Báder and Németh*, 2017a). The direction of the grain should be parallel to the edges of the workpiece, with a maximum 7° fiber deflection (*Buchter et al.*, 1993). The ratio of sapwood and heartwood, and the disposition of annual rings do not influence the compression quality (*Báder and Németh*, 2017a). According to Buchter et al. (1993), fresh wood with a minimum moisture content (MC) of 16% is required for pleating. If the wood is too dry, during steaming the MC increases and the specimens swell and twist, so it is not suitable for the modification process (*Buchter et al.*, 1993, *Báder and Németh*, 2016).

Wood can be compressed after plasticization (*Anssary*, 2006). As a result of heat and moisture, hemicellulose-cellulose and lignin-cellulose bondings of wood break up. In practice, generally saturated 100 °C steam is used at atmospheric pressure, to avoid desiccation during heating the wood before longitudinal compression (Sandberg and Navi, 2007). The time of plasticization must be sufficient to heat the entire cross-section of the material, which can be calculated as about 2 minutes per mm thickness (*Stevens and Turner*, 1948). A minimum 80 °C temperature of the material is required during the compression process.

During the compression phase, the specimen must be supported on every side to prevent its lateral deflection (*Blankenstein*, 1956). During an ideal compression, there is the same degree of deformation of each section along the length, with less variability for larger compression ratio, and the failure of the wood does not start in the weakest section (*Iványovics*, 2012). The compression ratio is usually 10-30% compared to the original length of the specimen (*Buchter et al.*, 1993). The compressibility ratio of the plasticized wood depends mostly on the wood species and the requirements of the final product (*Thomassen et al.*, 1990).

If the compression forces after longitudinal compression are removed immediately, it results in wet-bendable wood (*Sandberg and Navi*, 2007). After compression, the specimen springs back and the remaining shortening will be 3-5%. Another method for treatment after compression is to keep the compression ratio for a predetermined time. This period is called fixation time. With a day-long fixation time, the specimen is cooled during fixation and the entire shortening will be permanent. This is the dry-bendable wood, which always remains flexible (*Thomassen et al.*, 1990, *Deibl et al.*, 1999). The semi-finished material can be stored with low moisture content. In this state, the biotic organisms do not cause any problems. According to *Bátori* (2000), current technology with a shorter fixation time can be considered as a transitional solution between wet-bendable and dry-bendable compressed wood.

After longitudinal compression and post-treatment, the wood piece can be machined and bent to the desired shape in a cold state. Finally it is end-dried and surface-finished as a straight piece of material (*Sandberg and Navi*, 2007). Bending can be done with simple tools and supporting frames, which are easy to learn to use (*Anssary*, 2006). Compressed wood tolerates higher temperatures during drying than untreated wood without crackings, so the drying time is shorter (*Báder and Németh*, 2017a).

The most important property of longitudinally compressed wood is its modulus of elasticity (*MoE*), which correlates well inversely with the plyability of the material. Thomassen et al. (1990) demonstrated that longitudinal compression reduces the *MoE* of wood. A 20% compression ratio reduces the *MoE* to one third in beech, and from one third to one half in oak (*Kuzsella*, 2011).

As a highly hygroscopic material, wood can both release water into the air and take it up depending on the circumstances (*Frandsen et al.*, 2007). The decrease of bonded moisture content is called desorption because water molecules disconnect from the wood tissue; water uptake is referred to as resorption or adsorption. When the moisture content (*MC*) of wood has reached a constant value at a given ambient temperature and relative humidity (*RH*) of the air, it called hygroscopic equilibrium condition or equilibrium moisture content (*EMC*). Each wood species has only one moisture content at every temperature and relative humidity combination, but they differ in their desorption or adsorption. The curves, depicting the relationship between *EMC* and *RH* at a given temperature, are the sorption isotherms. The *EMC* is generally highest during the initial desorption of green wood (*Skaar*, 1988). Softening of wood is a weakening of its molecular binding forces. Increasing moisture content decreases the softening temperature of lignin and hemicelluloses.

The water content of wood can be divided into two main, physically different parts. Free water is found in the cell lumens, while bound water is in the cell walls (*Niemz and Sonderegger*, 2017). When the *MC* reaches the fibre-saturation point (*FSP*) all intermicellar and interfibrillar cavities (the cell walls) expand and are fully saturated with water, but the cell lumens contain no free water. As a result of increased moisture adsorption, the fibrils move as far apart as is possible given by their relatively strong bonds.

Wood is a highly anisotropic material, which means it swells and shrinks to a different extent in its three anatomical directions: radial (perpendicular to the annual growth rings), tangential (parallel to annual growth rings) and longitudinal (vertical direction) (*Rowell*, 1985). With the change of *MC*, there is considerable variation in strength and elasticity characteristics, density, shrinkage and swelling as anisotropic properties, surface adsorption, optical properties, resistance to insects and fungi, etc., between the absolute dry state and the fibre-saturation point. Dimensional stability is the most important factor. A good index for the changes in the dimensional stability is the anti-shrinkage efficiency (*ASE*). With the increase of *ASE*, wood material will have fewer physical-mechanical problems, such as deformations by its anisotropy or cracks. The easiest way to optimize *ASE* is the reduction of both the ability of wood to uptake moisture or to lose it. This can be done using different chemical- and biological treatments. For longitudinally compressed wood (which is a 100% ecological friendly product), the use of eco-friendly treatments is advisable. These can be heat treatment in different atmospheres, or the impregnation of this material with eco-friendly solutions. Using lactic acid (LA(+)) for this purpose seems to be a good solution.

Polymerization of the L(+)-LA monomer by direct polycondensation without catalysts, solvents and initiators under vacuum was studied by *Achmad et al.* (2009). They reached good results at temperatures below 200 °C; they got lower molecular weight compared to the processes with catalysts, but the polymerization of the L(+)-LA monomers finished. Based on the conclusions of *Noël et al.* (2015), the LA oligomer (OLA) penetrates the wood cell wall due to heating, so this is a bulking modification. With further polymerization, at least 55%

of the OLA fixes into the wood, resulting in a very high *ASE* both in high *RH* and in water, and in a large decrease of modulus of elasticity. Similarly to pleated wood, poly(lactic acid) (PLA) is an eco-friendly product as well. Combining these two materials may result in a highly modified wood material with enhanced properties. PLA can be obtained from a renewable agricultural source, so its production consumes quantities of carbon dioxide. Compared to oil-based products, it provides significant energy savings and at the end-of-use period it is recyclable and compostable.

The aim of this study is to describe the changes both in the water uptake and in the shrinkage-swelling properties of the wood due to longitudinal compression and present the achievable possibilities by using PLA as a modifying agent.

MATERIAL AND METHODS

Two wood species were used in the experiments: beech (*Fagus sylvatica* L.) and sessile oak (*Quercus petraea* (Matt.) Liebl.), altogether 20 specimens per groups. The specimens came from the heartwood section of the same log. Compression samples were sawn in the first step to 20×20×200 mm^3 dimensions (radial × tangential × longitudinal directions), paying attention to the three principle anatomical directions of wood. Three groups were formed for both species. The first group contained the untreated samples, and the second the steamed specimens (100 °C saturated water steam, atmospheric pressure for an hour). The third was the treated group exposed to steaming, 20% compression compared to the original length with a relative compression rate of 15 m/(m·h) and fixation for 1 minute as described by *Báder and Németh* (2018a). After the preparations the *MC* of all samples were over *FSP*. Small specimens for the shrinkage-swelling tests were formed from the original samples with dimensions of 12x12x20 mm^3 using a circular saw, paying attention to avoid drying and each surface was freshly sawn.

Both the dimensions in the three anatomical directions and the weight of each specimens were measured. The specimens were oven-dried with a gradual increase in temperature and final temperature of 103±2 °C to avoid cracks. The dimensions and the weight of each oven-dried specimen was measured again, then they were conditioned at 20 °C and 65% *RH* in a climate chamber. After that, dimension and weight measurement were repeated using the conditioned specimens. Then the specimens were tested through one more cycle of soaking in distilled water until the saturated state and oven drying to 0% *MC*. The next equipment were used:

- Precisa XT 1220M-FR scale (Precisa Instruments AG., Switzerland) which measures grams to 3 decimal places
- Memmert type 100-800 oven (Memmert GmbH., Germany)
- Binder KBF-115 climate chamber (Binder GmbH., Germany).

The *MC* relative to net dry weight, the swelling coefficient in the radial (α_r), tangential (α_t) and longitudinal (α_l) directions, volumetric swelling (α_V), the shrinkage coefficient in the radial (β_r), tangential (β_t) and longitudinal (β_l) directions and the volumetric shrinkage (β_V) were calculated as described in the ISO 13061 standard package.

The anti-swelling efficiency (ASE_α) and the anti-shrinkage efficiency (ASE_β) were calculated separately in the three dimensions and its volume, using the following equations:

$$ASE_\alpha = \frac{\alpha_{ut}-\alpha_t}{\alpha_{ut}} \cdot 100;\ ASE_\beta = \frac{\beta_{ut}-\beta_t}{\beta_{ut}} \cdot 100 \qquad (1)$$

α_{ut}, β_{ut} – swelling coefficient and shrinkage coefficient, respectively, of untreated wood in %
α, β – swelling coefficient and shrinkage coefficient, respectively, of treated wood in %

To be able to use LA for the impregnation of the samples, it is an important step to prepare the monomer solution. The L(+)-LA monomer was a 90% solution in water, purchased from the company Acros Organics b.v.b.a. (Belgium). This solution has to be dehydrated by boiling. Dehydration can be done using a heated magnetic stirrer in high vacuum (*Báder and Németh*, 2017c). The process takes about 90 minutes, followed by the oligomerisation of pure L(+)-LA monomers using also heated magnetic stirrer and vacuum in several steps in more than 4 hours. Thus, this is a slow process with a lot of steps. This whole process can be substituted by using microwaves in one much quicker step. Using a domestic microwave oven equipped with inverter technology, the energy for the process can be precisely set. 500 ml L(+)-LA monomer solution has been treated with 200 W microwave power for 5 minutes in several steps. Between these heating steps the solution was stirred manually, and these steps were repeated until its amount reached 400 ml. In this state the solution contained both monomers and oligomers.

RESULTS AND DISCUSSION

During the first measurement cycle, original green *MC* of the specimens was far above their *FSP*. Neither steaming nor pleating affected the *EMC* of the treated specimens during the measurements. Conditioning at 20 °C and 65% *RH* for 7 days resulted in 9% *EMC* for each group of specimens. The second drying cycle gave slightly lower end-drying weight results than the first drying cycle, which can be explained by weight changes resulting from the loss of wood splinters during drying, soaking and re-drying.

Residual changes of the dimensions happened after the drying and soaking cycles in the longitudinal direction of the pleated wood specimens. These changes seem to be low, below 1%, but may cause significant changes in *ASE*. The shrinkage- and swelling coefficients were calculated, shown in *Table 1*.

Table 1

Shrinkage-swelling Results of Untreated, Steamed and Longitudinally Compressed Beech and Oak Wood Species in Their Volume (V) and in the Three Principle Anatomical Directions (R, T, L).

		First shrinkage cycle				Swelling cycle				Second shrinkage cycle			
		β_{R1}	β_{T1}	β_{L1}	β_{V1}	α_R	α_T	α_L	α_V	β_{R2}	β_{T2}	β_{L2}	β_{V2}
Beech	Untreated	4.2%	9.7%	0.2%	13.6%	4.4%	10.9%	0.2%	15.9%	4.6%	10.6%	0.2%	14.9%
	Steamed	4.8%	10.8%	0.1%	15.3%	5.2%	12.0%	0.2%	18.0%	5.3%	11.5%	0.1%	16.4%
	Pleated	4.7%	10.8%	1.1%	15.9%	4.9%	12.0%	1.4%	19.1%	5.0%	11.4%	1.1%	16.7%
Oak	Untreated	5.6%	12.6%	0.2%	17.7%	6.1%	14.0%	0.2%	21.2%	6.2%	12.2%	0.2%	17.9%
	Steamed	6.4%	10.6%	0.4%	16.6%	5.9%	11.9%	0.3%	18.8%	5.9%	10.8%	0.2%	16.2%
	Pleated	6.3%	11.4%	1.5%	18.3%	6.3%	13.1%	2.0%	22.7%	6.3%	11.6%	1.5%	18.4%

Abbreviations: α – Swelling Coefficient; β – Shrinkage Coefficient

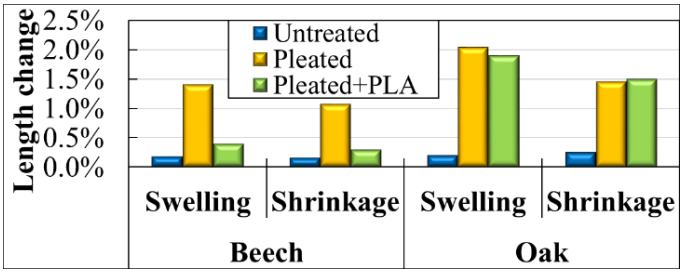
If the differences between the shrinkage and swelling of the three principle anatomical directions are compared, we get a good overview on the high anisotropy of wood. The anisotropy of wood decreases with pleating, because of the change of coefficients in the longitudinal direction increased several fold.

ASE was also calculated using equation (1) from the shrinkage and swelling coefficients, listed in *Table 1*. As a result of pleating, both radial, tangential and volumetric shrinkage coefficient increased 11%, 12% and 17% for beech, and 12% -9% and 4% for oak, respectively. During swelling similar, relatively small increase occurred in radial, tangential and volumetric swelling coefficient of beech wood: 13%, 10% and 20% and of oak wood: 3%, -6% and 7%, respectively. In the longitudinal direction both shrinkage and swelling coefficients increased by orders of magnitude, 580% and 660% for beech and 790% and 900% for oak, respectively. The second shrinkage cycle gave lower results compared to the first shrinkage cycle. The longitudinal shrinkage coefficient increased 570% for beech and 48% for oak. The phenomenon of the very high longitudinal dimension change causes the high deformation ability of pleated wood during the changes of the *MC*. The explanation of this great increase in longitudinal shrinkage and swelling may be because of the distortion of the microfibrils, described by *Báder et al.* (2019). The shrinkage and swelling of the wood decreased only in the tangential direction of oak, so it cannot be said that pleating has anti-shrinkage efficiency or anti-swelling efficiency.

The treatment of wood with OLA and its in-situ polimerisation after the wood samples were impregnated resulted in a great *ASE* for untreated wood. Since the scope of this paper to introduce the effects os LA-treatment on pleated wood, only these results will be described. As a result of the treatment, the maximum dimension changes in the lateral directions of the beech samples became less than half of the original shrinkage and swelling. But the really interesting question is the shrinkage and swelling of pleated wood in its longitudinal direction, because this causes the most problems when using longitudinally compressed wood. Cell walls that are buckled by pleating tend to straighten as they were in their original state due to moisture change, thanks to the memory effect naturally present in the wood. This results in a large change, near an order of a magnitude in the longitudinal swelling and shrinkage values, which results in the unreliability of the pleated wood under changing moisture conditions (*Figure 1*).

Figure 1

Results of Swelling and Shrinkage Tests in the Longitudinal Direction of Beech Wood



Taking into consideration the results of the tests in *Figure 1* it is also evident that both swelling and shrinkage of beech wood highly decreases by the LA treatment. Swelling and shrinkage does not reach the naturally low values of untreated samples, but still highly decrease. Due to the structure of oak, OLA was unable to penetrate in its cellular cavities, so oak could not be impregnated as it was expected. Accordingly, the swelling and shrinkage values of oak remained essentially unchanged.

It was necessary to find an effective and environmentally friendly solution to greatly improve the *ASE* of longitudinally compressed wood, and PLA treatment is a good choice for beech and other similar wood species that can be easily impregnated. The results also showed that the pretreatment of the LA solution with microwaves saves a lot of time during the process. The results of wood treatment using microwave pre-treated LA are very similar to the results of LA pre-treated with conventional heating techniques. It can be concluded that the use of microwaves for the pre-treatment of LA is advantageous and recommended. Of course, the microwave treatment of LA monomers requires additional tests to achieve optimal settings for different purposes.

CONCLUSIONS

Both linear and volumetric swelling and shrinkage increases after the longitudinal compression treatment, but the anisotropy of wood decreases. The further treatment to decrease the dimension changes is necessary so that the pleated wood may be used much several ways. PLA treatment have a very positive effect on the dimensional changes of wood through the decrease of the water uptake and the dehydration.

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SOPRON AND THE LONGITUDINAL WOOD COMPRESSION

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ABSTRACT

The University of Sopron is the only university in Hungary, where forestry and wood technology can be studied. Within the Simonyi Károly Faculty of Engineering, Wood Sciences and Applied Arts, at the Institute of Wood Science the examination of wood anatomy and the modification of different wood species are the main topics, besides the education. One of these studied topics is the technology of longitudinal compression (aka. pleating) of wood, which was first patented in 1917 as an alternative solution to steam bending. The most important advantage of pleating is that the wood becomes more easily bendable and can be better twisted compared to steamed wood. Pleated material can be held in stock until use. This material is used primarily in the furniture industry, interior design and arts. The equilibrium moisture content and fiber saturation point change only slightly with pleating, despite steaming at 100 °C prior to compression at a ratio of 15-23%. Pleated wood dries faster than untreated specimens under the same conditions. The new properties of wood can be explained by cell wall deformations. The technology is based on a heated press, which supports the wood. Thus, it cannot bend and break during the compression process, while at the same time the specimen does not stick to the support.

INTRODUCTION

At the University of Sopron, mainly forestry and wood technology is in focus besides pedagogy and economics. The Simonyi Károly Faculty of Engineering, Wood Sciences and Applied Arts has the opportunity to educate and research in the topic of wood sciences, which is unique at the universities in Hungary. Of course, this faculty has many other directions of education and research, for example informatics, industrial product design, mechatronics , design and graphic design. At the faculty, the Institute of Wood Science deals with two main things: basic wood researches (physical and mechanical properties of wood samples), for example the examination of the mechanical properties of different poplar clones. The other main topic is wood modification. The goal of a modification is to improve one or more properties of wood. It belongs to the truth that if something gets better, necessarily an other thing gets worse. In the last 20 years many modification methods were inspected at the Institute of Wood Science: dry heat treatment of different wood species, heat treatment in linseed oil, acetylation of hornbeam, nano-zinc treatment, compression of wood perpendicular to grain and compression of wood parallel to grain, etc. The aim of this study is to introduce the achievements of the researches related to the longitudinal wood compression at the University of Sopron.

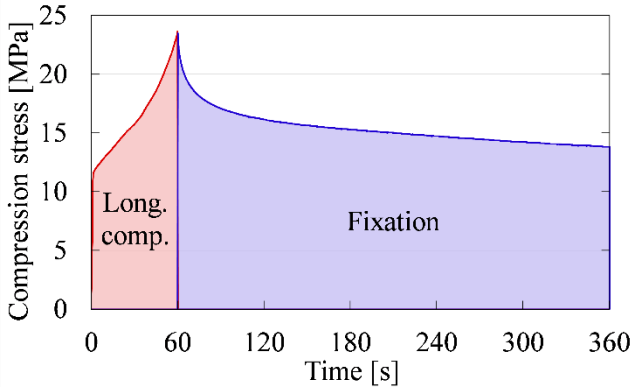
Wood is a natural composite material, built up mainly of cellulose, hemicelluloses and lignin. These three components form the microstructure of cells (*Da Silva and Kyriakides*,

2007). Cellulose chains have a slender shape, 4-5 μm long, and are arranged in bunches, called microfibrils (*Gindl*, 2001). Hemicelluloses and lignin form the matrix of the cell walls, while cells are linked by the highly lignified middle lamella (*Gindl*, 2001).

When the longitudinal compression of wood is combined with a thermo-hydro treatment, wood becomes more pliable. Prior to compression, the high-density and high quality hardwood (*Buchter et al.*, 1993) has to be plasticized. The plasticization process means the softening of the bonds of hemicelluloses and lignin, so the binding force between cells and between microfibrils decreases. According to *Lenth and Kamke* (2001), increasing moisture content (*MC*) decreases the softening temperature of lignin and hemicelluloses. These are the reasons why softening of wood in hot and humid conditions is needed (*Ansell*, 2012). During longitudinal compression, the specimen can be held for a predetermined time constantly at the applied compression level. This period has been called fixation, because the compressed length of the wood is fixated for a predetermined time. In this period, the stresses caused by the longitudinal compression of wood are relaxed and finally – depending on the duration of this period – the longitudinal deformation partially or completely remains after treatment. Fixation increases the effects of the longitudinal compression. Compression stress increases during the compression process and decreases continuously in the fixation phase with gradually decreasing intensity (*Figure 1*). Since the rate of compression is constant in *Figure 1* (*Báder and Németh*, 2018), the shape of the strain-stress curve seems similar to the time-stress curve in the compression phase.

Figure 1:

A Typical Time-Stress Plot of a Longitudinal Wood Compression Followed by a Fixation for 5 Minutes



Source: Based on *Báder and Németh* (2018)

It is most important that the modulus of elasticity (*MoE*) further decreases along with increasing fixation time. The decrease in the *MoE* as a result of longitudinal compression is 59%. Its decrease due to compression followed by fixation for 1 minute is 63%, and if fixation is used for more than 10 hours after compression, the *MoE* decreases by 81%. Each value is with a uniform *MC* of 12% (*Báder and Németh*, 2018). In a previous study by *Báder and Németh*

(2018), a relationship was identified between compressive stress change during fixation, remaining shortening and some mechanical properties. Increasing fixation time increases the remaining shortening of the specimen, so its spring-back will be much weaker (*Báder and Németh*, 2018). The spring-back correlates well with the change of the compression stress during fixation, the *MoE* and the bendability. Fixation for a long-time results in a more effective treatment, but it consumes much time. Thus, it may be used only if extreme wood properties are needed after this modification process. Considering the effective property changes, the productivity and the costs, the ideal fixation time was specified as 1 minute by *Báder and Németh* (2018), but it actually depends on the needs regarding the product properties.

The method of longitudinal compression and fixation was called "pleating" due to the buckling of the cell walls by the treatment. The physical and mechanical properties of pleated wood are most affected by the compression ratio and the time of fixation. After treatment, the specimen is first wet, and it should be dried after adjusting its shape and before its final use. Different minimal moisture contents can be found in the literature as a limit of pliability, ranging from 15% (*Iványovics*, 2005) to 25% (*Buchter et al.*, 1993). Pleated wood with over 15% *MC* has nearly plastic properties. Between 0-5% *MC*, the treated wood is more brittle than untreated wood, so it is no longer pliable (*Vorreiter*, 1949). Unfortunately, after shaping and drying, pleated wood only keeps its shape until it stays dry. If it is re-moistened, its original shape will be partially recovered as it has a high shrinkage-swelling in the longitudinal direction. The easiest way to decrease the swelling of wood is the reduction of its moisture uptake. This might be done using different treatments, for example heat treatment in different atmospheres or impregnation (*Inoue et al.*, 2008).

The described modification method results in a semi-finished wood product, which can be used for many purposes, where pliable wood is needed. Analysing the bending tests of pleated wood showed that the bending force and the *MoE* decrease exceedingly, and ensure a high deformability of the wood, compared to untreated specimens (*Báder and Németh*, 2018). The technology was first patented by Max Hanemann in 1917, but industrial production began only in the second half of the 1920s. The most modern equipment used today has been patented in 1989. Longitudinally compressed wood is currently produced in Italy, in Hungary and in the USA. This is an excellent raw material for the furniture industry, interior design, or areas where sharp corners are not allowed for safety reasons (ship and aircraft furniture) (*Báder*, 2015).

MATERIAL AND METHODS

As mentioned above, hardwoods high-density and high quality hardwood can be compressed in its longitudinal direction without the appearance of wood failures. Thus, beech (*Fagus sylvatica* L.) and oak (*Quercus petraea* (Matt.) Liebl.) specimens are in the scope in our researches, came from the forests near Sopron, Hungary. The logs are processed into boards and the freshly cut boards are cut into specimens with dimensions of 20 × 20 × 200 mm^3 or 20 × 30 × 200 mm^3 (radial × tangential × longitudinal directions), from the same trunk. The specimens are frozen until the time of use. During the treatment, the specimens are first plasticized by saturated steaming at atmospheric pressure, except for the untreated specimens. Steamed specimens are usually also made to observe the possible modifying effect of the steaming process alone. The treated specimens are additionally longitudinally compressed in

a unique laboratory machine, inducing a 20% shortening compared to their original length with a compression rate of 50 mm·min^{-1}. The fixation time is usually 1 minute, or almost a day. The *MC* of the specimens at the time of the compression and fixation treatments is consistently above their fiber saturation point (*FSP*).

As evidenced by *Báder and Németh* (2017), the self-developed laboratory compressing machine produces specimens with equal compression ratio along the length. Unequal compression ratio along the length befalls very rarely and if such a mistake occurs, it is clearly visible (*Báder and Németh*, 2018), so the investigation of the equal compression ratio along the length is not necessary.

RESULTS AND DISCUSSION

In this chapter, we will introduce a selection of the researches and the achieved results carried out with compressed wood at the Institute of Wood Science.

The properties of longitudinally compressed wood are influenced by many factors. One of the most important factors is the time of fixation, which means that how long is the sample held compressed after reaching the specified compression ratio. As a result of this treatment (also known as pleating due to the deformations of the cell walls) wood will be more easily bendable in smaller curves, compared to untreated or freshly steamed wood. Selected physical mechanical properties were investigated (remaining shortening, *MoE*, bending stress and bendability coefficient) using different specimens: untreated, compressed in its longitudinal direction, compressed and fixated for 1 or 3 minutes, compressed and fixated for a long time.

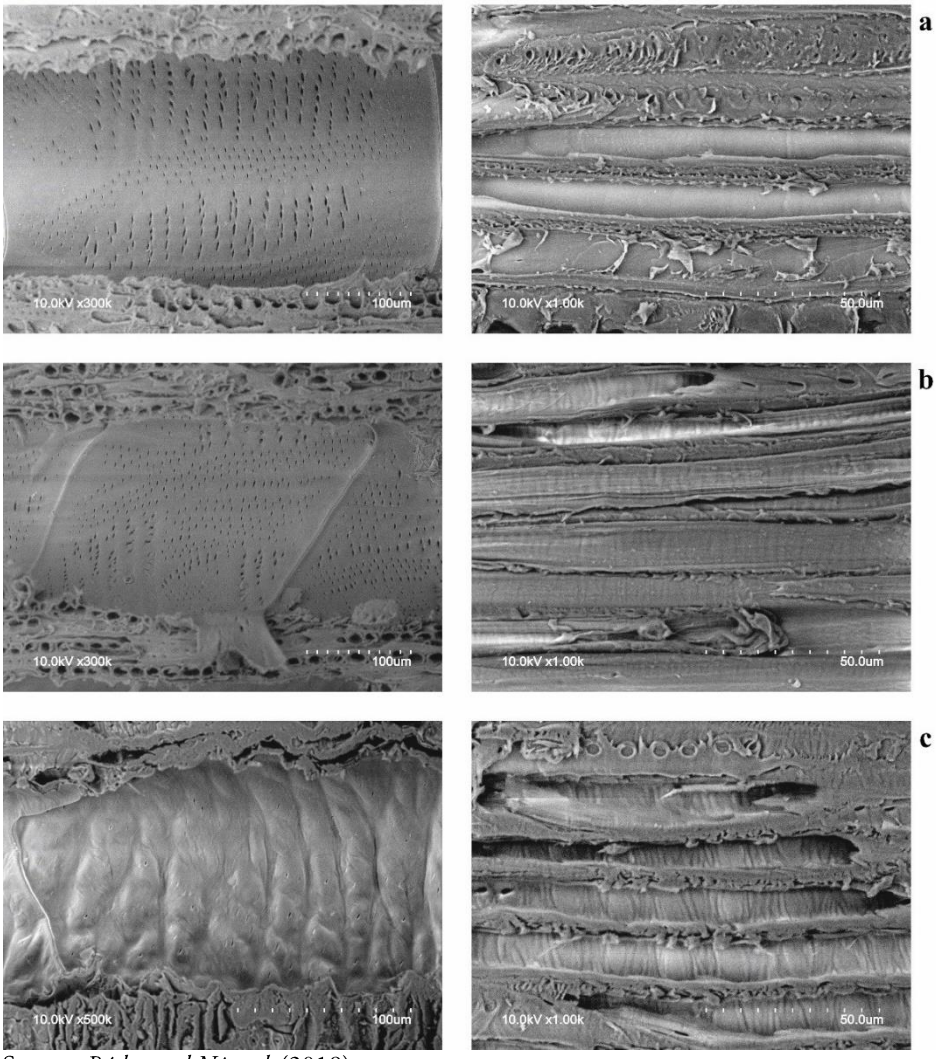
During fixation, the compression stress decreases continuously. After 1 minute of fixation the change of the compression stress as well as the change of material properties slow down, thus, the recommended minimum fixation time is 1 minute as an ideal combination of economic fixation time and increasing of pliability. This results in a maximum deflection during 4-point bending tests of 353%, in a decrease of *MoE* to 37% and in a decrease in bending stress at 5 mm crosshead displacement to the half of untreated specimens. To meet special requirements for the product, both the compression ratio and the time of fixation can be varied. Fixation for a long time results in a wood material with approximately plastic properties. It achieves a more than 6 times higher deflection compared to untreated wood, still without breaking, but slows down the production and increases the costs (*Báder and Németh*, 2018).

With the next research micromechanical characterization of longitudinally compressed wood could be successfully compared to untreated reference materials. The comparison of the various methods of treatments showed that the indentation modulus of the secondary cell wall S2 significantly decreased as a result of the compression and fixation treatments, whereas the hardness of the S2 cell wall was only slightly affected. Total deformation work of cell walls increased when wood was treated. Relative to the total deformation work its viscoelastic share remained unchanged, while elastic behavior was increased at the expense of plastic deformation work. Thus, the treatments resulted in higher flexibility together with higher resilience and reduced ductility on the cell wall level, compared to the untreated wood. Comparing indentation modulus with macromechanical properties the observable degree of change was smaller, which was attributed the difference in stress state of the two methods. As a general trend higher fixation time increased the effects of the longitudinal compression treatment.

In contrast to the S2 the cell wall middle lamella was only subjected to minor changes as a result of the treatments. AFM images showed microfibril disorientation in the S2 cell wall due to mechanical wood modification. Similar observations were also made on the cellular level (*Figure 2*). Therefore, the earlier proposed term "pleating" seems to well describe the treatment (*Báder et al.*, 2019).

Figure 2:

Scanning Electron Microscopy Images of the Trachea (left) and the Fibers (right) of Oak Wood in an Untreated Sample (a), a Longitudinally Compressed Sample Without Fixation (b), and a Longitudinally Compressed Sample with Fixation for a Long-time (c)



Source: *Báder and Németh* (2018)

In this study, comparative bending- and compression tests were carried out with longitudinally compressed beech wood specimens with different *MC*s. The mechanical properties of wood change with the *MC* and the ratio of change differs from the untreated specimens. This study indicates that compressive strength parallel to the grain exhibits the smallest sensitivity to changes in *MC* by an αvalue of 3.2%, followed by 4.2% for its modulus of rupture, 5.0% for its *MoE* and 5.4% for stress at a 4 mm crosshead displacement. With increasing *MC*, the α value of both the bendability coefficient and the highest deflection during a 4-point bending test causes an increase of 4.2% and 7.6%, respectively. As a result of the research, it can be deduced that there is a negligible difference between the change of the modulus of rupture of the untreated and the treated wood due to the change in their *MC*. However, the change of *MoE*, bendability coefficient and compressive strength show a considerably alteration. For the best pliability during bending, the *MC* of pleated wood must be close to its fiber saturation point (*Báder and Németh*, 2019).

CONCLUSIONS

This study shows the production and some properties of longitudinally compressed wood. Wood is commonly bent for thousands of years and always the same problem happens: the wood breakes on its tension side, because it can be barely elonged. So the solution is to make the fibres elongable, by making the fibres buckled. After steaming the wood is pressed from its two ends, while it is supported on 4 sides by steel plates, to avoid the bending and breaking of the specimen. Due to the longitudinal compression, the wood remains highly pliable up to months. Fixation allows the sample to undergo viscoelastic shortening, thus the springback will be smaller and the change of mechanical properties will be greater.

The cell walls of an untreated wood are smooth. Due to compression the cell walls crinkle, and look like a half-closed concertina, or a plisse shade. That's why a descriptive name for the process is pleating. The atomic force microscopy images showed that not only structural changes happened, but also changes in the cell walls. The examination of indentation modulus showed a significant reduction by the compression. The hardness of the cell wall also decreased, but just slightly. The results of the 4-point bending tests shows that modulus of rupture decreases and modulus of elasticity decreases highly, both by the compression and the fixation. It is known for a long time, that with the decrease of modulus of elasticity, the pliability highly increases.

ACKNOWLEDGEMENT

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POSSIBILITIES OF USING NANOTECHNOLOGY IN WOOD COLOUR PROTECTION

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ABSTRACT

Colourfastness characterizes the colour-resistance of a material to fading or running. It is an important factor in the evaluation of wood, but unfortunately the colour of most wood species is not stable under outdoor conditions, it is mainly degraded by UV-radiation. The final result of outdoor weathering on unprotected wood surfaces is the well-known greying effect. To protect the colour of wood material, only surface protection is available nowadays, but in case of surface damages (scratching, cracks, etc.) this protection is not adequate. The impregnation of wood in the whole cross-section with UV-stable nanoparticles can protect the wood long lasting. Most promising results can be found in the literature about the utilization of TiO_2, ZnO, CeO_2 and Fe_3O_2 nanoparticles to protect the wood against UV-radiation. The advantage of using nanoparticles for wood protection against UV irradiation is that this treatment usually remains the initial colour of wood unchanged, or there is only a slight change in colour. This paper is a review of recent results and possibilities about the UV-protection of wood by nanoparticles.

INTRODUCTION

The utilization of nanoparticles to improve the properties of wood is not widely investigated recently. On the other hand, many promising results were achieved with the use of nanoparticles in relation to the mechanical, combustion, hydrophobic and some other properties of different polymers, papers or textiles (*Csóka et al.*, 2007; *Sun et al.*, 2007; *Textor and Mahltig*, 2007). Recently, there is only limited information available about the utilization of nanoparticles to improve the wood properties, but all results are positive. With the use of different nanoparticles it is possible to reduce the moisture uptake, or improve UV-protection, mechanical properties and durability (*Rassam et al.*, 2012; *Mahltig et al.*, 2008). According to the careful examination of the results mentioned above, new ways of utilization in the field of wood science and technology are available. The novelty of the use of nanoparticles for the improvement of wood properties is that its effect is not known until now. Besides surface treatments a full cross-section treatment is possible which can make the service life of wooden products longer. The technical properties of most of the European wood species are in many respects behind some competing materials, which are originating from sources that are disadvantageous in aspect of sustainability (endangered tropical wood species, plastics). An important objective during the utilization of nanoparticles for UV-protection of wood is the expressive improvement of the properties of European wood species.

THE COLOUR OF WOOD

In the first approach, lightness can be used to characterize wood in colour. Colour variations on different effects can also be most clearly demonstrated by the change of lightness. However, colour cannot be specified with a single colour coordinate. The colour of the various wood species is broad enough in the yellow-red range (CIELab colour system), from the almost completely yellow to reddish shades (hab= 0 ~ 85°). Comparing the colour angle data with the lightness values, it can be concluded that there is a closer relationship between the two colour characteristics. The darker colour of the wood always has the shift towards the redder shades. Lighter wood species have yellowish hues. Saturation of the colour of wood embraces a much smaller range than lightness or hue, as it has low saturation. Among the main chemical components of wood, cellulose and hemicelluloses do not absorb visible light.

Natural lignin may contain quinoidal-structured chromophore groups as a result of build-up biochemical processes, but the colour is still pale yellow. The colour of the wood is, therefore, not determined by the main components, but by the extractive materials. Since the quality and quantity of extractive materials is significant to the tree species, the colour of the wood depends largely on the tree species. Substances are very sensitive to environmental impacts, especially light and heat, and therefore the colour of wood is influenced by environmental requisition. The moisture content also influences the colour of the wood. Sorption water changes the colour slightly to the fiber saturation point. Free water, however, results in a significant reduction of lightness. The lightness of green wood can be 10-15% lower than that of dry wood. Wet wood is better penetrated by light, and light absorption is higher. This change in the refractive index of the wood caused by moisture plays the leading role. The wood colour, to a small extent, is influenced by the surface roughness and the illuminating angles; these are the most important physical factors (*Feist*, 1989).

The wood has a complex anatomical structure. From this, visually perceptible segments of the early and late wood, the annual rings, the sapwood and the heartwood. It is possible to distinguish well the places called “false red heartwood" and other areas exposed to damages or disease. All of these play a significant role in the colour of the wood. The lightness of the early wood is greater than the late wood, which is determined by the loose structure and the difference in chemical composition. The standard deviation of the colour characteristics of homogeneous wood species (beech, mahogany) is smaller than that of less homogeneous species (poplar, oak, larch) (*Feist*, 1989). The colour difference can also be determined by objective colour measurement methods for trees that show visually distinction of the sapwood and the heartwood. The lightness of the heartwood is smaller and the colour shifts towards the reddish shades. The colour difference increases with drying. The reason for the colour difference is the polyphenol-type substances present in the heartwood, and the chemical transformation of polyphenols. Colour measurement can be used to determine the extent and the surface of the "false heartwood". The reason for the colour difference is in this case also a higher concentration of oxidized forms of polyphenols (*Feist*, 1989).

EFFECT OF SOLAR IRRADIATION, RAIN AND HEAT ON THE COLOUR OF WOOD

Examining the wood as a combined system, it can be stated that a significant change in colour is applied to sunlight. Decrease of lightness has a significant effect on the colour

shifting, changes in the hue have a smaller effect, and the smallest effect is the saturation. The rate of reduction of lightness in the initial stage of exposure to sunlight is fast and then decreases. After a long time of sunlight radiation, the wood changes colour in the opposite direction, a slow lightening starts. The phenomenon suggests consecutive processes. Photooxidation, the formation of colour compounds, is followed by the degradation of colour compounds by light. The decomposition of coloured compounds is also indicated by a relatively significant decrease in saturation with the slow increase in lightness. The effect can be increased by the leaching of dissolved compounds (*Evans*, 2008). The important role of the wavelength of light is demonstrated by irradiation with light of different wavelengths that the colour of the wood may shift in a very different direction:

- 236 to 346 nm wavelengths change colour to yellowish shades
- 364 to 500 nm wavelengths change colour to reddish shades

Although the colour change is dependent on wavelengths and wood species, sunlight spectrum irradiation results in decisively reddish shades. As a result of the very large number of extractives in the different wood materials, the nature and extent of colour change depend on the wood species. However, a clear explanation for the causes of the changes can only be the light-induced reactions of the compounds present in the wood.

Beside the solar radiation, the impact of water is the greatest in the degradation of wood. In contact with the surface of the wood, water is rapidly absorbed through the wood capillaries and then adsorption into the cell-walls begins. However, this process only takes place on the surface quickly; moisture penetrates much more slowly into the inner layers. As a result of this, the upper layers of the wood will swell while the volume of the inner layers remains unchanged. This results in tensions between the surface and inner layers of the wood. Tensile stresses exert on the surface layers, while compression stresses the inner layers, causing the surface to crack (*Evans*, 2008). Additionally, the role of water through surface leaching is significant during outdoor exposure. Rain primarily enhances external degradation by washing out water-soluble extracts and degradation products of lignin and hemicelluloses from the surface. This results in the colour change of the exposed wood becoming faster and becoming gray. The presence of water also contributes to hydrolytic reactions during photodegradation, which also accelerates degradation of the surface during exposure (*Evans*, 2008). It can also be shown that not only the liquid water (rain) but also the humidity of the air have an effect on the external degradation of wood. Higher humidity results in greater degradation (*Tolvaj et al.*, 2016).

As a result of solar radiation, surface temperatures may increase significantly during outdoor use (50-70 °C), which also promotes degradation. Although this temperature does not approach the glass transition temperature of lignin (130-150 °C) or the heat degradation temperature of the wood components (160-260 °C). Therefore, this temperature alone does not cause degradation of the surface, but it promotes photo oxidation and hydrolytic processes caused by light and water (*Tolvaj et al.*, 2011).

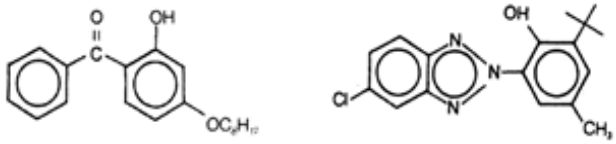
COLOUR PROTECTION OF WOOD

The photoprotection of wood can be realized by absorbing or reflecting the damaging radiation. The possibilities of protection are discussed in this chapter, in more detail on the effects of nanomaterials.

UV absorbers absorb UV radiation, pass through tautomeric conversion and transform the energy of radiation into heat. A large number of UV absorbers are available at present, such as benzophenone, benzotriazole, and triazine (*Figure 1*). The absorption characteristics of UV absorbers are determined by their chromophore group. Volatility and leaching resistance are dependent on molecular weight (*Hayoz et al.*, 2003).

Figure 1:

Chemical Structures of Typical Benzophenone (Left) and Benzotriazole (Right) UV Absorbers Used to Photostabilisation of Wood



Several constituents such as phenolic antioxidants, heavy hydrocarbons and glycols, hindered amine light stabilizers are capable of neutralizing or blocking free radicals and some of them are used to protect wood from photodegradation. Hindered amine light stabilizers are heat and light-proof derivatives of 2,2,6,6-tetramethyl piperidine. These compounds are capable of UV protection when combined with UV absorbers (*Hayoz et al.*, 2003). Hindered amine light stabilizers protect wood from photodegradation by terminatig free radicals involved in photooxidation (*Gugumus*, 1993).

The wood material contains 20-30% of lignin, but it is unevenly distributed within the cell wall, so it can reach over 70% concentration in the middle lamella [28]. Lignin strongly absorbs UV light, creating aromatic free radicals resulting in depolymerization of the wood's polymers by sunlight. Components suitable for lignin modification include: inorganic metal compounds, most notably chromic acid but also copper and cobalt chromates, ferric chloride and nitrate, and various manganese, titanium and zirconium compounds (*Schmalzl and Evans*, 2003). Treating the surface of wood with oxidative manganese compounds such as manganese (III) acetate dihydrate or potassium permanganate is suitable for protecting wood from photodegradation. However, these compounds are less effective than chromium acids and stain the wood. Titanates and zirconates are colourless and are also suitable for wood preservation against photodegradation. Titanates are more effective than zirconates, but the efficacy of both groups is less than that of chromic acid (*Schmalzl and Evans*, 2003).

The most common way of outdoor protection of wood against photodegradation is to use coatings such as paints, varnishes, stains and water repellents. The coatings can be divided into two groups: film-forming or penetrating. Film formers, such as paints, contain pigments that protect the wood from sunlight by blocking them on the surface of the wood. A common problem with film forming coatings is the loss of adhesion to the surface due to the cyclic dimensional changes in wood as a result of moisture changes. Due to the high maintenance requirements of the paints it is recommended to use penetrating coatings (*Feist*, 1989). The penetrating coatings typically contain some hydrophobic, e.g. wax, oil or resin that penetrates into the wood and then cures. Contrary to film-formings, which form a barrier on the surface,

water repellents form a hydrophobic surface to prevent water absorption through the capillaries (*Borgin*, 1961). The penetrating stains are water-repellent preservatives that contain pigments or UV stabilizers to protect the wood. Their failure is accelerated by the cracking of wood and the erosion of pigments from the surface. The deposition of air pollutants can also contribute to discolouration. Stains generally provide protection for 3 to 6 years depending on the wood species, wood surface texture and type and quantity of stain. Paints and stains change the colour of wood. In cases where it is necessary to preserve the original colour of the wood, clear film-forming finishes can also be used. Although they often contain UV stabilizers, they provide only moderate protection against outdoor exposure as they transmit sunlight and partly UV radiation. As a result of this, it is expected that the wood will be protected for a period of one to three years. Possible solution for increasing photostability with transparent coatings is the pre-treatment of wood with UV absorbers, hindered amine light stabilizers or chromic acid.

Due to the tighter environmental standards and a growing social demand, there is an increasing need for the use of environmentally friendly UV stabilizers. The main disadvantages of the compounds listed above are that they are in many cases toxic, carcinogenic. In contrast, the use of pigments and nanoparticles typically does not carry a significant environmental risk, especially compared to traditional solutions (e.g. chromic acid, UV absorbers, etc.). The use of pigments for UV protection has a decade-long history, but the application of nanoparticles has only spread over the past 5 to 10 years, and in most cases we cannot talk about industrial applications. However, based on the available test results, the rapid spread of the method can be expected, which is also indicated by the rapid growth of commercially available nanoparticle based UV protection products.

Basically, the smaller is the wavelength of the light, the greater is the ability to reflect it on small particles (Rayleigh-scattering). Accordingly, below a certain size, the particles are able to filter out the UV radiation, while they only have a small effect on the visible range of the spectra. This feature of small particles makes them suitable for photoprotection of wood. Most commonly, titanium dioxide, iron or zinc oxide particles are used as "transparent" photoprotection for wood. Clear synthetic iron oxides are often used in paints. They differ from the iron oxide pigments because they are smaller in size (0,01-0,15 µm) and let pass the visible spectrum and filter the UV range. They are available as red, orange and yellow crystals. The desired UV filter effect can be achieved using a concentration of 2 g/m2 or 2%. In addition, transparent iron oxide UV filters are able to maintain their protective effect during exposure to photodegradation over a longer period of time, as opposed to organic UV absorbers (e.g. benzotriazole) (*Feist*, 1989). Iron oxides have a disadvantage of their colour, if necessary to preserve the original appearance of the wood.

Another option is to use micronized titanium dioxide or zinc oxide as a UV reflector for photoprotection of wood. Titanium dioxide is a highly effective white pigment for photoprotection that is used in opaque paints. Particles of titanium dioxide with few nanometers in diameter do not reflect visible light, but are able to protect the wood from the degrading effect of UV radiation. This effect can be achieved by titanium dioxide if it is in rutile form (*Borgin*, 1961). Titanium dioxide provides good protection for wood when applied at a concentration of 0,5-1%, possibly combined with iron oxide (*Blackburn et al.*, 1991). However, the concentration can be raised to up to 5% and thus efficiency without

deteriorating the transparency of the surface film layer (*Pacaud et al.*, 1998). The transparency can be preserved optimally if the titanium dioxide particle size is between 2 and 50 nm. Titanium dioxide nanoparticles can be applied also directly on the wood surface by in-situ creating a thin layer on the surface. This allows the surface to withstand the damaging effect of UV radiation and also exhibits hydrophobic character. The hydrophobic nature prevents the surface from being cyclically wetted, thus protecting against surface cracks. It also protects against damaging organisms (e.g. mold) on the surface by reducing water absorption (*Rassam et al.*, 2012). The disadvantage of the use of titanium dioxide nanoparticles is their UV-induced photoactivity which has a degrading effect on wood polymers and optionally on the carrier (paint) polymers (*Broekhuizen and Broekhuizen*, 2009).

In addition, micronized zinc oxide can be used to avoid photodegradation of wood. The advantage of using zinc oxide in spite of titanium dioxide is that the same UV filtering capability is available at lower concentrations and zinc oxide has less whitening effect on the surface. Nano zinc oxide can be applied directly to the wood as an aqueous dispersion, which provides good resistance to leaching to effectively protect the wood against sunlight over a longer period of time. Another advantage of zinc oxide is that it has bactericidal and fungicidal properties, which also contributes to reducing surface discolouration during outdoor exposure.

CONCLUSIONS

Wood materials have a poor resistance to the damaging effect of UV radiation, and for this reason, long-lasting investigations have focused on colour retention procedures. Over time, there have been many solutions to preserving the colour of wood in outdoor use, but most of them do not provide long-term protection or are environmentally responsible for their application. This problem can be solved by nanoparticle based UV protection systems. They can be used as fillers in surface finishes (film forming or penetrating), or even directly as a surface layer formed by an in-situ method on wood. Their further advantage is that they often produce a combined effect, not only against photodegradation, but also have a fungicide / biocidal effect or a water-repellent effect.

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AGROFORESTRY IS THE SOLUTION? PROFITABILITY OF THE AGRICULTURAL FARMS THE HUNGARIAN CASE

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ABSTRACT

Agroforestry and agricultural diversification impacts on farmer incomes and long-term economic benefits are still less explored. The essence of our article is that, when examining the profitability of Hungarian agricultural sector, it is worth focus on specific factors determining the profitability like agroforestry and diversification. On the other hand, we used hierarchical clustering with other main variables (agricultural subsidies, plant size, leverage) of agriculture profitability to find out which kind of the agricultural companies belongs to the profitable category. The clustering process was performed using the Ward method. The study analyzes agricultural enterprises based on the farm database of the Hungarian Farming Information System operated by the Agricultural Research Institute. The analysis was performed statistically closed 2013-2015 data. Based on our resarch, the farmers should invest in agroforestry and agricultural diversification because it is a perspective to secure the income generation and to improve resilience.

INTRODUCTION

The purpose of this publication is to survey farm profits in Hungary and also to evaluate the agroforestry impact for farming. Knowledge of farmers profit and agroforestry as well as their inter linkages is important for potential intervention mechanisms aiming to improve the prevailing farming system. Agroforestry positively impacts on farmer incomes. We used hierarchical clustering (key variables: agricultural subsidies, plant size, leverage) of agriculture profitability to find out which kind of the agricultural companies belongs to the profitable category. The clustering process was performed using the Ward method. The analysis was performed statistically closed 2013-2015 data. Based on our resarch, the farmers should invest in agroforestry and agricultural diversification because it is a good perspective to secure the income generation and to improve resilience.

The effects of agroforestry and agricultural diversification on farmers' incomes and long-term economic benefits are unexplored research area. The essence of our paper is that when examining the profitability of the Hungarian agricultural sector, it is worth focusing on the factors determining profitability, such as agro-forestry and diversification. On the other hand, we used hierarchical clustering with key variables of agricultural profitability (agricultural subsidies, farm sizes, leverage) to determine what type of agricultural enterprise belongs to the profitable category.

The clustering process was performed by Ward method. The study examines agricultural businesses on the basis of the Agricultural Information System database operated by the Institute for Agricultural Research. The analysis was performed with statistically closed data for 2013-2015. According to our research, farmers need to invest in agroforestry and agricultural diversification, because this is a perspective to increase profitability.

LITERATURE REVIEW

Numerous studies have focused on differences in the level of development of the industry when examining profitability (*Hirsch and Schiefer*, 2016; *Chaddad et al.*, 2013; *Goddard et al.*, 2009; *Grant et al.*, 2006). In their view, structural characteristics are the main drivers of profits. *Blazkova et al.* (2018) examined the factors affecting profitability in the Czech food industry from 2003 to 2014. The main variables of the study were the company-specific features, industry characteristics and seasonal variables. Based on their results, industry characteristics and seasonal variables determined the variance of corporate profits only marginally, and the main explanatory factors were company-specific data. Similar results were obtained for the explanatory power of ROA variance, *Hawawini et al.* (2003) *Goddard et al.* (2009), *Claver et al.* (2002, 42.7%) and *Hirsch and Schiefer* (2016).

According to Schumacher and co-authors, 48.7% of ROA was determined by company-specific characteristics (*Schumacher and Boland,* 2005), so industry effects are only partially important for profitability.

Since the 1990s, however, there has been a shift in the field of research whereby business characteristics determine the profitability of agricultural firms. According to this view, there are significant differences in the allocation of the input and output of enterprises compared to the industry average. (*Barney*, 1991). When looking at post-2000 data, company-specific factors were also found to be determinants of profitability and its variance. In addition to company-specific and industry-specific features, Zouaghi and co-workers also examined the location when examining the profitability of Spanish agriculture. Hierarchical linear ANOVA (Analysis of variance) modeling investigated the data of 3273 agricultural companies from 2006 to 2013 in various regions of Spain. In their results, the firm-specific data determined the variance of profitability the most (48.8%) , the industry-specific variables only 0.8-4.2%, the location 0.1-1.8%, and in the year They contributed between 0.1% and 2.5%. (*Zouaghi et al.,* 2017)

Justyna Góral and Michał Soliwoda (2018) explained ROE and ROA indicators on large farms in Poland (with 100 hectares or more agricultural land). A sample of 78 organizations concluded the 2007-2011 period. They found that, subsidies had a negative impact on the profitability of large farms.

Nehring et al. (2015) explored the variables that determine the profitability of American poultry farms. The size of the farm, its diversification, the region, the age of the farmers and the characteristics of the employees were identified as the most important determinants of the business performance in the United States.

Machek & Špička (2015) examined three indicators of profitability, namely ROS, ROA and ROE. Their results show that ROS, ROA and ROE are strongly correlated with economic value added (EVA) variables.

Zakova Kroupova (2016) focused on the dairy and mixed business activity farms with FADN data from 2004 to 2011. Main drivers of the profitability were the following variables: increase in output, change in input-output prices, change in decoupled subsidies, change in technology, farm size, value added and technical efficiency (*Kroupova*, 2016).

Gorton et al. (2003) and *Sipiczki et al.* (2019) examined domestic profitability by cluster analysis using AKI FADN data. Gorton and his co-workers began to examine the profitability of domestic agriculture with a cost-to-income ratio in their article to approximate profitability with the expected rent of land. According to their results, in 2000, 80% of individual farms and 81%

of corporate farms would be profitable with the traditional cost / income ratio without subsidies. In contrast, if we add the opportunity costs, such as land use instead of own land use, to the cost, only 56% of individual farms and 74% of corporate farms are profitable. (*Gorton et al.*, 2003).

Csonka et al. (2018) focused on the spatial pattern of agroforestry CAP measures. They identified areas with unused agroforestry potential in Hungary.

Summarizing previous theoretical and empirical findings, agricultural profitability is determined lesser by industry effects and greater extent by company-specific factors, which is why we focused on these.

Profitability factors were measured using several methods and a number of variables. Based on the results of the literature we examined the most significant factors in more detail. To examined precisely for different farm sizes or production activity, like *Gorton et al.* (2003), we use cluster analysis to determined the most profitable and less profitable groups. Then we examined their characteristics and suggesting ways to improve the sector's profitability.

The essence of our article is that, when examining the profitability of Hungarian agricultural sector, it is worth focus on specific factors determining the profitability like agroforestry and diversification.

MATERIAL AND METHODS

The database is the agricultural database operated by the Agricultural Research Institute (AKI). We worked out the data of the year 2013-2015 data of the agri-business AKI database. The 1965 data record company balance sheet and profit and loss statement represent a representative sample of Hungarian agricultural economy. This number of companies provided data in all three year.

The clustering process included the variables in *Table 1*, which were considered to be relevant by literature. The input variables used were always average values, the arithmetic mean of the three years (2013-2015).

Table 1

Clustering process included the variables

name	description	unit
output	Sales, includes subsidies without repayment	thousand HUF
subs	subsidies without repayment	thousand HUF
land	All areas used by the farm	hectare
totala	All assets	thousand HUF
persubs	Proportion of subsidies from sales	percentage
perrland	Land rented to all areas ratio	percentage
percrop	Arable crop sales from all sales (non-subsidized release)	percentage
hhi	Herfindahl index	-
leverage	Leverage	-
forestou	Forestry output compared to total output	percentage
renou	Land rent and interest divided by output	percentage
rengm	Land rent and interest divided by gross profits	percentage

The study attempted to pick an explanatory variables which we are believed to be of particular interest in profitability changes in the sector. We used the R + and Microsoft Office Excel programs for the research. In cluster analysis, we would like to group observation units in such a way that the members of one group would be close to each other along each variable. (*Székelyi et al.*, 2004). Clustering groups help to organize observation units into relatively homogeneous groups, so-called clusters. For larger samples the hierarchical cluster analysis is much more complicated, so it is advisable to choose the K-median method.

The output variable represents the net sales revenue. Nearly 65% of individual farms had Output below 20,000 thousand HUF and 95% had Output below 100,000 thousand HUF during the study period, as shown in the histogram in *Figure 1*.

A similar distribution can be observed for the subsidies received and the area of the farm.

The "subs" variable shows the average value of non-repayable grants. The distribution of this variable is similar to that of sales (*Figure 2*).

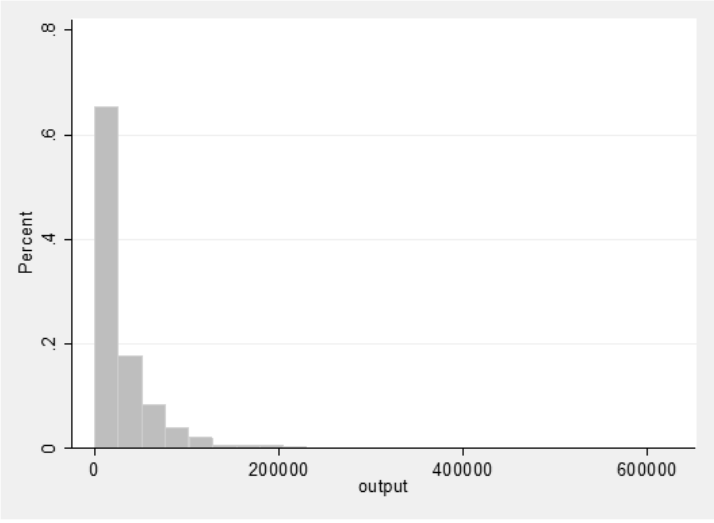
The ratio of the subsidy compared to the revenue is the variable to ("persubs"). The land used by the farm is also an important variable that is intended to show the size of the farm. The distribution histogram is shown in *Figure 3*.

Rented land (rland) also includes land leased for free. (Perrland) shows the percentage of all areas leased.

We focused on specific factors determining the profitability like agroforestry and forestry diversification. This variable is (forestou) which is Forestry output compared to total output. Our database does not contain information about farmers trees and forest location. Because of this our result shows more likely the farmers agroforestry diversification instead of agroforestry plant production method.

Figure 1

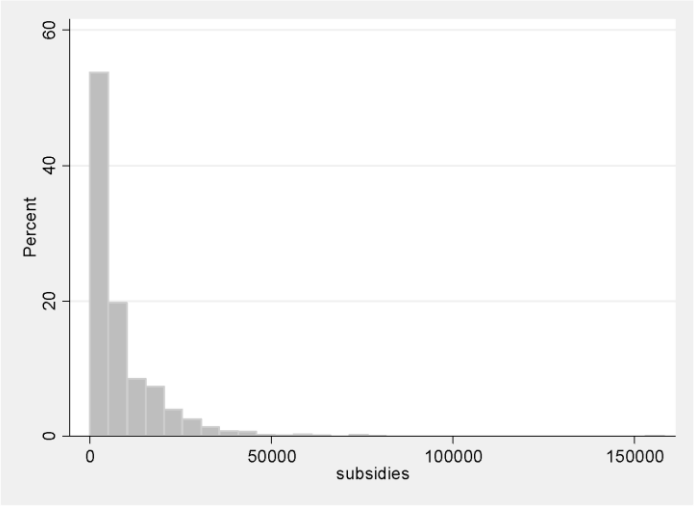
Percentage histogram of Output Variable (output thousand HUF)



Source: Based on AKI data

Figure 2

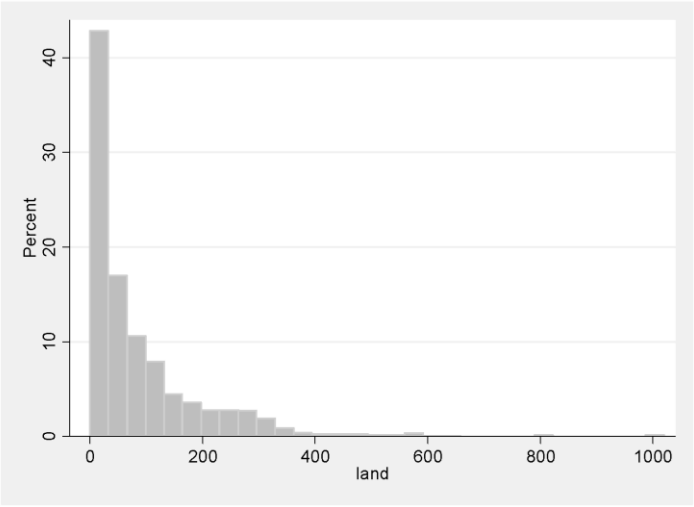
Percentage histogram of Subs Variable



Source: Based on AKI data

Figure 3

Percentage histogram of Land Variable

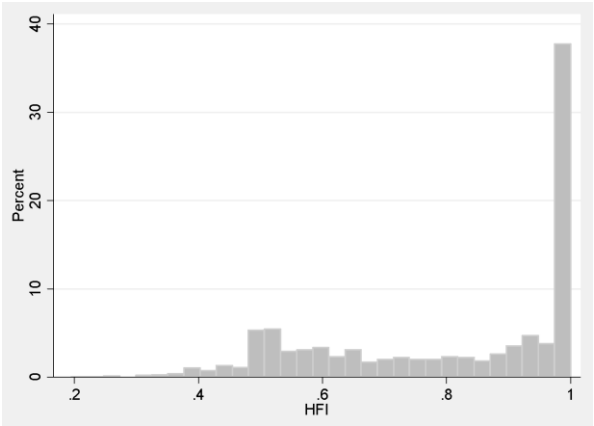


Source: Based on AKI data

Also we used the Herfindahl index (hhi) variable is a proxy for farm diversification (*Figure 4*).

Figure 4

Percentage histogram of HFI (Herfindahl index) variable



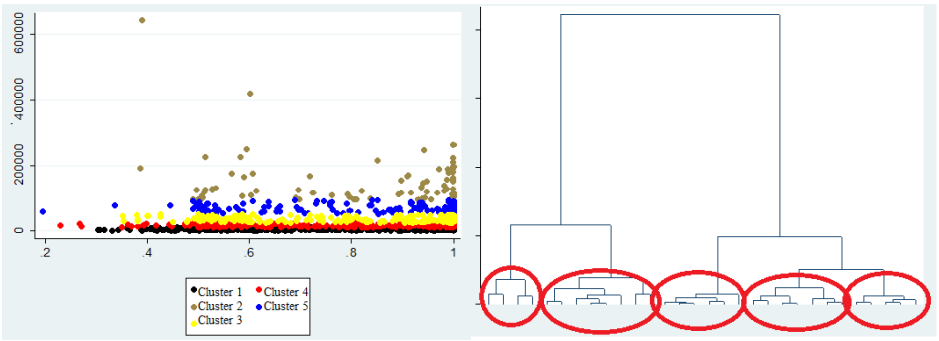
Source: Based on AKI data

The higher value of the indicator, show less diversification direction. According to the Herfidal Index, almost 40% of the individual farms generate their revenue from only one production type.

First, hierarchical clustering was chosen in order to determine the number of clusters. Subsequently, among the non-hierarchical clustering methods, the k-median method was used. The sample size justified non-hierarchical clustering. In our opinion, cluster centers are better characterized by medians than arithmetic means. Data were standardized using the z-score method. In the dendrogram, it can also be seen that, five clusters are optimal. The non-hierarchical clustering procedure classified 3 farms outside the clusters, making the total sample of only 1420 farms. The five cluster were able to form distinct groups (*Figure 5*).

Figure 5

Dendogram and boxplot figure of clustering process. (vertical axis: standard production value, horizontal: Herfindahl index)



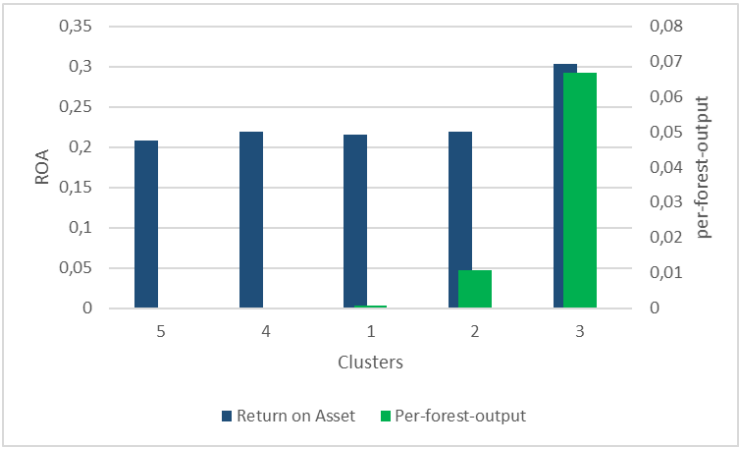
Source: Based on AKI data

RESULTS AND DISCUSSION

In case of open-field vegetable production the highest (30% average ROA) profitability was achieved by cluster 3 farms with the highest agroforestry potential (*Figure 6*).

Figure 6

"Forest output per output" and ROA indicators in the case of open-field vegetable production.



Source: Based on AKI data

In case of vegetable forcing the highest (23,4% average ROA) profitability was achieved by cluster 3 farms also with the highest agroforestry potential (*Figure 7*).

Figure 7

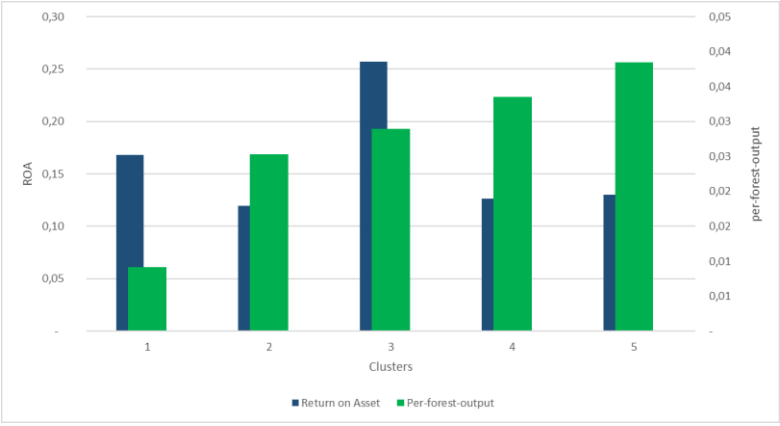
"Forest output per output" and ROA indicators in the case of vegetable forcing production.

Source: Based on AKI data

There is no such clear correlation in the case of Fieldcrops and arable crop production: In the case of the smallest farm size, the profitability was the worst, regardless of forest area and agroforest sales revenue, and in the case of large farm size, profitability was the highest (because of economies of scale) (*Figure 8*).

Figure 8

"Forest output per output" and ROA indicators in the case of Fieldcrops and arable crop production.



Source: Based on AKI data

Asset-based profitability does not show a significant difference depending on forest area and forestry revenue, but the cost-proportionate revenue (CostRev) efficiency indicator shows an improving trend with the growth of forestry potential in case of medium size farms (*Table 2*).

Table 2

Clusters "Forest output per output", ROA and "Costs per Revenue" indicators in the case of Fieldcrops.

Cluster	Mean / Forest output per output	Mean / Return on Asset %	Mean / Costs per Revenue	Mean / Output	
1	0,92%	17%	0,98	39 286	
2	2,53%	12%	0,96	19 479	
3	2,89%	26%	0,79	143 763	Biggest farm size
4	3,35%	13%	1,37	19 364	Smallest farm size
5	3,85%	13%	0,93	25 122	

Source: Based on AKI data

CONCLUSIONS

Based on our resarch, the farmers should invest in agroforestry and agricultural diversification because it is a good perspective to secure the income generation and to improve resilience. That statement especially concern open-field vegetable production and vegetable forcing production, but only partially true in the case of Fieldcrops and arable crop production. Because large farm size profitability was the highest regardless agroforestry diversification (probably because of economies of scale) but the cost-proportionate revenue (CostRev) efficiency indicator shows an improving trend with the growth of forestry potential in case of medium size farms.

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INVESTIGATION OF CHANGING THE LAND COVER IN THE GAME MANAGEMENT LANDSCAPE CENTER OF KAPOSVÁR UNIVERSITY USING A DRONE

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ABSTRACT

Nowadays the use of drones in the civil sphere is spreading. Technology can play a particularly important role in agriculture. The Game Management Landscape Center of Kaposvár University participates in the Agroforest project. Many ruminant species live in the deer farm of Bőszénfa. In the project, a wooded pasture was created for these animals. We show a land cover survey of the created area using a drone.
Keywords: Agroforest, wooded pasture, land cover survey, drone

INTRODUCTION

Wild ruminant species are dominated by red deer and fallow deer, but there is also a flock of mouflon in the Game Management Landscape Center of Kaposvár University. It is well known that the best habitat for these species is a variety of woody shrub-pastures. Their main food is provided by monocotyledons, leguminous plants, shrub shoots and leaves, and fruits of woody plants.

PURPOSE

As part of Agroforest project, efforts have been made to develop an area that is suitable for herbaceous plants in addition to woody plants. The plant communities that have at least 30% of the woody plants are the most able to withstand the increasing summer heat and the periodic rainfall missing. The diverse species composition, microclimate and dynamically changing phenological phases of grove communities provide food and habitat for many species.

MATERIAL AND METHOD

The investigated area unit is in the 23-431 map segment according to the EOV (Unified National Projection) map system segmentation. First, a base „map" for the studied area (HD72/EOV coordinate contour lines, and an orthophoto of 40 cm/px spatial resolution from 2015) was purchased from FÖMI (Department of Geodesy, Remote Sensing and Land Offices, under the Government Office of the Capital City Budapest) (*Figure 1*).
The contour lines map was converted into a raster Digital Elevation Model (DEM) and then a slope map using GIS software (*Figure 2* and *Figure 3*).

Figure 1

The investigation area on the base orthophoto and contour lines

Figure 2

Digital Elevation Model (DEM) of investigated area created from contour lines

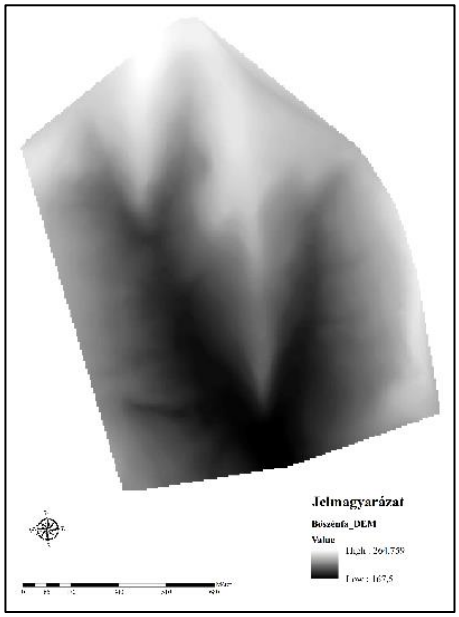
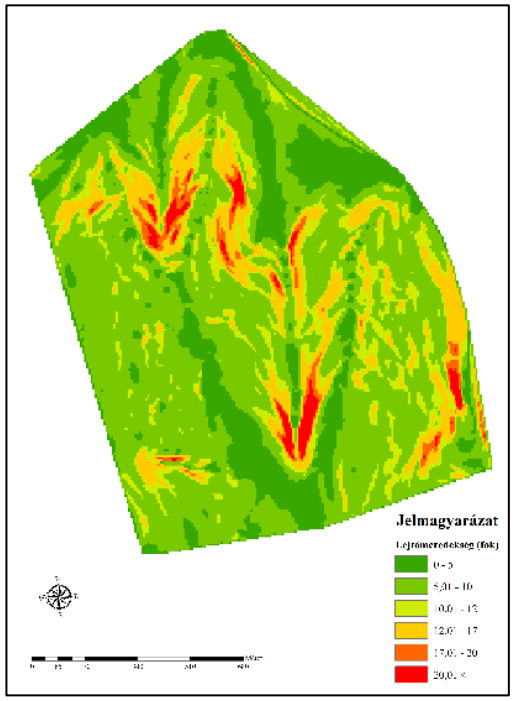


Figure 3

The created slope map from DEM



It was required to discover the geomorphological conditions of this area. Based on the data, the depth difference between the deepest and highest points of the area is 97.5 meters (167.5 and 265 m), the maximum slope is approximately 33 degrees (32.75).

Considering that the land cover survey did not have to be done for the whole area, knowing the geographical features, a narrower sample area was determined.

The designated area of 42.5 hectares is the western boundary of a valley in the north-east, the eastern boundary in a valley in the north-west and the central part of the valley in the north-east (*Figure 4*). The difference between the deepest and highest elevations is 70 meters (170-240 m).

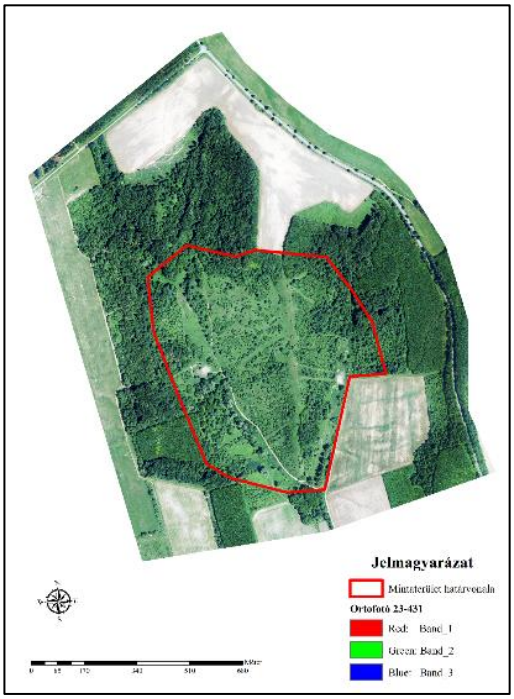
Before the establishment of the wooded grove area, there was only grassland covered around the roads only, and a closed canopy was formed in the bushy wooded area.

The drone's flight plan was then determined in the next step. The flight parameters were set in a free software. Parameters used during flights:

- flight altitude: 130 meters,
- maximum flight speed: 15 m / s,
- direction of flight: between 0 and -15 grade (due to N-W wind direction),
- side overlap: 60%,
- front overlap: 80%.

Figure 4

The suitable area to establish a test area (42.5 hectares)



RESULT

Aerial photos made of the studied area in three drone flights:

- March 15, 2018 - 553 images
- May 1, 2018 - 491 images
- June 17, 2018 - 540 images

From the hundreds of images captured during flights, georeferenced orthomosaics were created with spatial resolution of centimeters using photogrammetric methods (*Figure 5*).

In contrast of the original plans due to cost savings, only 3.84 ha of land coverage has been modified. In this area, some of the vegetation had to be removed using a special forestry mulcher machine (FAE UMM HP 250) (*Figure 6*). Thanks to the three drone surveying, it is possible the compare orthophotos of the area before and after mulching. The time-series orthophotos were examined by classification to see the changes in land cover.

After the orthophotos were created, a classification was made on the basis of three predefined land cover categories using the GIS program. In order to make the classification as accurate as possible, the "supervised image classification" function was used (*Figure 7*).

Figure 5

The orthophotos of the selected test area

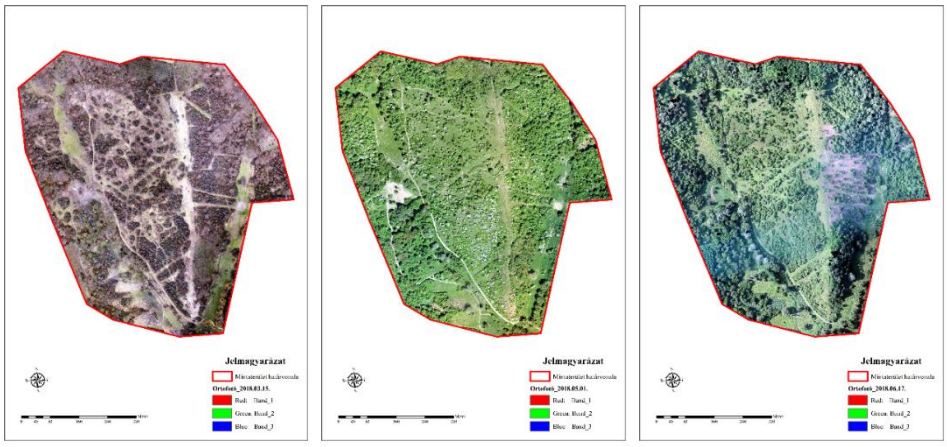


Figure 6

Clipped test area of the third orthophoto (3.84 hectares)

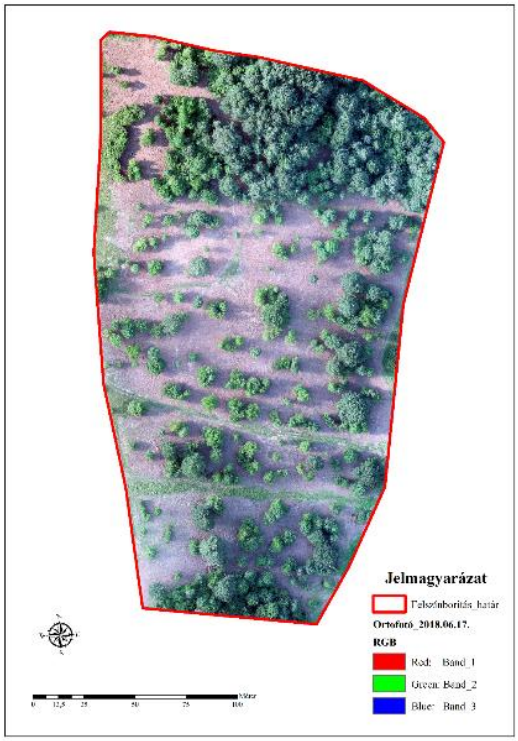
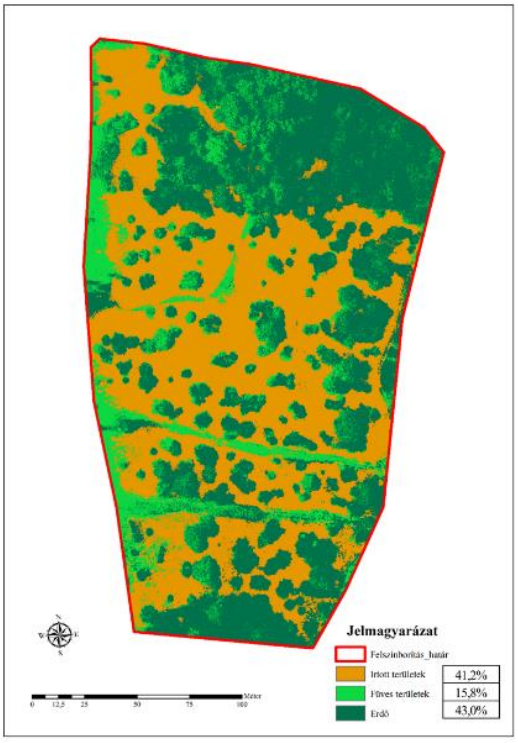


Figure 7

The classified test area



Originally, the grassland area was 15.8% which was supplemented by another 41.2% with the cleaned area, which together is now suitable for the production of sufficient quantities of fodder.

ACKNOWLEDGMENTS

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SPATIAL DRIVERS OF AGROFORESTRY ADOPTION IN HUNGARIAN SETTLEMENTS

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ABSTRACT

Agroforestry systems means land use systems in which trees are grown in combination with agriculture on the same land. The environmental services provided by agroforestry systems can be divided into four categories: (i) carbon sequestration, (ii) biodiversity improvements, (iii) enhanced soil productivity and conservation, (iv) water and air conservation. The main goal of this paper is to provide a starting point to develop local-resource based strategies supporting the spatial spread of agroforestry practices in Hungary. In order to achieve this goal, the results of two different research are combined in our study. The first one is the recent study of Csonka et al, 2019 in which five different spatial clusters of Hungarian settlements were identified, validated and visualised, based on agro-environmental characteristics. The second source of our research is the project AGroFORestry that Will Advance Rural Development (AGFORWARD). AGFORWARD was a four-year research project funded by the European Union and built on agroforestry experiments. After reviewing the case studies of the AGRPROWARD research project, we found opportunities for each cluster that could be adopted as good practice. There are, of course, significant differences between clusters in terms of their suitability for use in agroforestry systems, but it can be stated that they have every right to exist.

INTRODUCTION

"Agroforestry systems means land use systems in which trees are grown in combination with agriculture on the same land. The minimum and maximum number of trees per hectare shall be determined by the Member States taking account of local pedo- climatic and environmental conditions, forestry species and the need to ensure sustainable agricultural use of the land." (*European Parliament*, 2013)

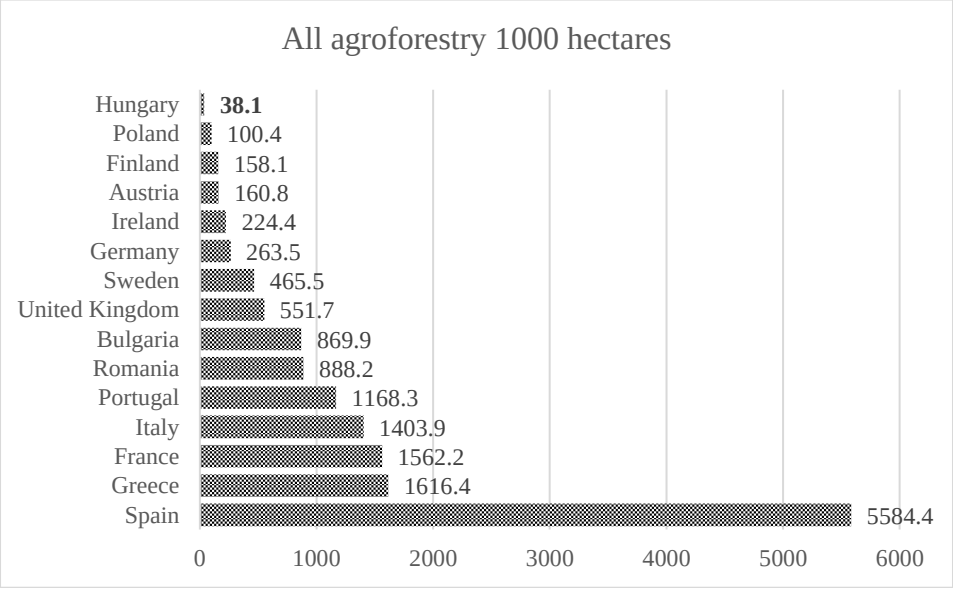
The environmental services provided by agroforestry systems can be divided into four categories: (i) carbon sequestration, (ii) biodiversity improvements, (iii) enhanced soil productivity and conservation, (iv) water and air conservation (*Jose*, 2009). Agroforestry offers compelling synergies between adaptation (e.g., soil and water conservation, improved microclimate conditions, improved soil fertility) and mitigation (carbon sequestration) solutions to climate change (*Lasco et al.*, 2014). Agroforestry systems can also improve livelihoods, enhance food security, and provide clean energy, contributing to sustainable rural development (*Sharma et al.*, 2016). According to *Kachova et al.* (2016), agroforestry is a profitable, environmentally friendly, and sustainable technology for farmers living in less-developed rural areas. It is widely known that the development of rural areas has become a key point of Common Agricultural Policy (CAP) in the European Union (EU). Agroforestry systems are supported by the EU's rural development policies (RDPs) since they play a relevant role in producing positive social, economic, and environmental externalities (*Gaspar et al.*, 2016). Although agroforestry was poorly adopted in the CAP 2007–2013, recent

evidence implies a better success in the CAP 2014–2020 (*Santiago-Freijanes et al.*, 2018a). *Mosquera-Losada et al.* (2016) highlights five existing types of support for agroforestry on farms: (i) measures promoting silvoarable practices on farms, (ii) support for silvopasture farms, (iii) support for farms with high value trees, (iv) support for high nature value farms, and (v) forest farming activities. Despite the growing importance of agroforestry within the CAP, there is limited research evaluating these schemes, except recent papers by Santiago-*Freijanes et al.* (2018b), *Moreno et al.* (2018), *Mosquera-Losada et al.* (2018), and *Pantera et al.* (2018). Although some aspects of the spatial patterns of agroforestry schemes are already highlighted (*den Herder et al.*, 2017; *Santigato-Freijanes et al.*, 2018b), the drivers of agroforestry adoption is still not fully identified.

Agroforestry can be found almost everywhere in Europe, however, it is difficult to determine its actual area. According to *Herder et al.* (2016) 15.4 million hectares of agroforestry are recorded in the EU-27 which is 3.6% of the total area and 8.8% of the agricultural area. These systems are mainly found in southern and south-western Europe, eg. Spain, Portugal, which are typical representatives of livestock agroforestry systems. Italy, Bulgaria and Greece are characterized by agroforestry systems combined with olive and citrus plantations. Of the more than 15 million hectares, Hungary has 38,100 hectares on the basis of land cover. (*Herder et al*, 2016)

Figure 1

The agroforestry areas by country in the EU, 1000 hectares.



Source: Based on *Herder et al*, 2016

As it can be seen in *Figure 1*, the area occupied by agroforestry systems is very low Hungary, especially compared to other EU countries. The main goal of this paper is to provide a starting

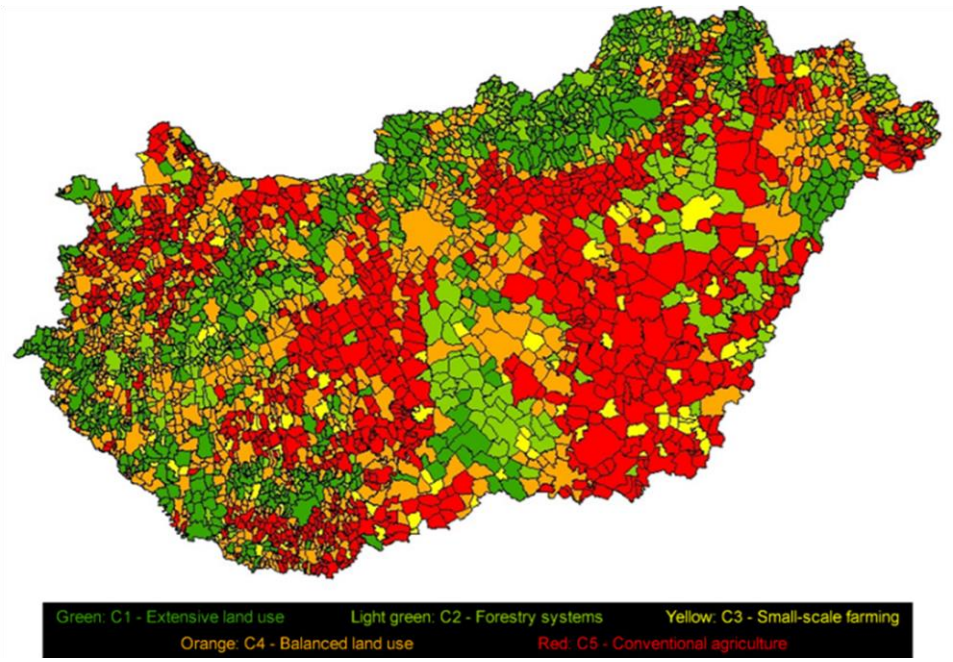
point to develop local-resource based strategies supporting the spatial spread of agroforestry practices in Hungary. In order to achieve this goal, the results of two different research are combined in our study. The first one is the recent study of *Csonka et al.* (2019) in which five different spatial clusters of Hungarian settlements were identified, validated and visualised, based on agro-environmental characteristics. The second source of our research is the project AGroFORestry that Will Advance Rural Development (AGFORWARD). AGFORWARD was a four-year research project funded by the European Union and built on agroforestry experiments. The overall aim of the project was to promote agroforestry practices in Europe.

MATERIAL AND METHODS

In our study, a matching approach is used to find the most suitable agroforestry practices provided by AGFORWARD for each spatial clusters identified by *Csonka et al* (2019). The clusters can be seen in Figure 1. The explanations of different clusters can be found under the cluster map.

Figure 1

Cluster map of Hungarian agroforestry potential at settlement level



Source: *Csonka et al* (2019)

- Cluster 1(Extensive land use group) represents municipalities with a low proportion of small-scale farming and forested areas, where the amount of extensive agricultural areas exceeds the volume of intensive agricultural land use. The tendency to run agroforestry projects is the lowest in this group while activity in the field of other agri-environmental projects is quite high.

- Cluster 2 (Forestry systems group) is clearly dominated by forested areas, whereas the presence of small-scale farming and intensive agriculture is relatively low. The tendency to run agroforestry and other agri-environmental projects is by far the highest in this group.
- Both small-scale farming and intensive agricultural land are dominant in Cluster 3 (Small-scale farming group). The presence of small-scale farms might create an ideal environment for agroforestry adoption. However, the moderately low rate of extensive agriculture limits the tendency to establish agri-environmental and agroforestry projects.
- Cluster 4 (Balanced land use group) is theoretically not suitable for agroforestry adoption. The presence of agricultural land use (both extensive and intensive) is slightly below average, while the small-scale farming ratio and the proportion of forested areas is relatively low. Despite this, the demand for agroforestry projects is high (the second highest) in this group.
- Cluster 5 (Conventional agriculture group) is characterized by the dominance of intensive agriculture. The proportion of extensive agricultural lands and forests are by far the lowest of all clusters. The demand for agroforestry and agri-environmental subsidies is also very low.

A qualitative content analysis of the AGFORWARD innovation and best pracice leaflets (sources: https://www.agforward.eu/index.php/en/Innovation-leaflets.html, https://www.agforward.eu/index.php/en/best-practices-leaflets.html) was applied to find the potentially most suitable agroforestry practices for each clusters. Fourty-six innovation leaflets and ten best practice leaflets were processed in the frame of content analyses. This paper presents a few examples of the results.

RESULTS AND DISCUSSION – THE MOST PROMISING AGROFORESTRY PRACTICES PER CLUSTERS

One of the possible agroforestry solutions for the Cluster 1 is the restoration of abandoned grasslands in extensive areas as they did in Bakony, Hungary.[1] Shrub clearing's labour demand is high but after a time saves feeding costs of the animals. Besides protecting old trees on pastures offers many opportunities including ecological and cultural tourism. Products made around old trees could be branded separately in addition the old trees are forestry genetic resources, as well as having a cultural and educational role, increase soil fertility and help preserve biodiversity.[2] Chestnut trees are difficult to grow profitably for human consumption due to high labor costs. However, premium quality pork is possible if the chestnut is used as feed.[3] An other viable option is to adopt a slightly modified version (suitable to continetal conditions) of the well-

[1] https://agforward.eu/index.php/en/Innovation-leaflets.html?file=files/agforward/documents/leaflets/12_Restoration_of_abandoned_wood_pasture.pdf
[2] https://agforward.eu/index.php/en/Innovation-leaflets.html?file=files/agforward/documents/leaflets/13_Protecting_large_old_trees_in_wood_pastures.pdf
[3] https://agforward.eu/index.php/en/Innovation-leaflets.html?file=files/agforward/documents/leaflets/17_Protecting_trees_in_chestnut_stands_grazed_with_Celtic_pigs.pdf

known mediterranien silvopastoral systems called dehesa and montado. A wide range of innovative practices improving the productivity of this systems are presented by AGFORWARD leaflets, e.g. triticale production on wood pastures, fast rotational intensive grazing, establishing pastures rich in shade tolerant legumes, etc.

It may be worth introducing chestnut trees in wooded areas too (Cluster 2) whose fruit can serve as both human and animal food, but besides this chestnut woodlands are one of the best habitats for the production of edible mushrooms.[4]

Agrisilvicultural systems can work well in Cluster 3 and allow multiple products to be produced at the same time. These systems outside the timber give you extra yield and can be beneficial to grow not an usual plants. Such intermediate plant can be a wild asparagus (Asparagus acutifolius) which is a perennial plant with consumable shoots. It is known as a herb but is also used in flower arrangement too.[5] Another plant in intercroping may be chickpeas (Cicer arietinum L.) which is a high quality food for humans and it is also popular in animal nutrition due to its high protein content. It has low water requirements, requires little management, and can provide the farmer with significant additional income from growing chickpeas among trees. In addition its roots fixing nitrogen reducing the application of nitrogen fertilizer to the soil.[6] The intercropping of trees and leguminous crops for animal feed and cereals for grain production could be a valuable addition to the system. It provides new products such as hay and grain for animals, and offers environmental benefits, such as increased biodiversity and soil conservation.[7] In this group it is worth thinking about pilot projects. Small-scale mosaic wood plowing systems can be a real attraction for small-scale production of multiple products.

In Cluster 4 it is worth thonking about silvopastural systems which could work well. Intensive cultivation of hardwoods (nuts) that provide valuable wood could be tried. Grazing (sheep) can be used next to the trees to protect the inter-tree area from weeds, in addition sowing legumes between rows can help feed the animals and improve soil quality.[8] The proximity of the cities gives the opportunity to process valuable timber and also allows the processing of mutton. Another example to follow in Cluster 4 may be an apple orchard grazed in France. Sheep can promote nutrient retention and by eating fallen leaves and fruits destroys apple scab spores and pests. Its should result in reduced need for pesticide applications. Grass can be used to maintain ewes or fatten lambs, which can increase farm income. Financial and environmental benefits of orchard grazing are the following. Sheep farmers take advantage of the grass produced in the

[4] https://agforward.eu/index.php/en/Innovation-leaflets.html?file=files/agforward/documents/leaflets/18_New_approaches_for_producing_selected_varieties_of_chestnut.pdf

[5] https://agforward.eu/index.php/en/Innovation-leaflets.html?file=files/agforward/documents/leaflets/19_Wild_asparagus_in_olive_orchards.pdf

[6] https://agforward.eu/index.php/en/Innovation-leaflets.html?file=files/agforward/documents/leaflets/19_Wild_asparagus_in_olive_orchards.pdf

[7] https://agforward.eu/index.php/en/Innovation-leaflets.html?file=files/agforward/documents/leaflets/21_Olive_trees_intercropped_with_cereals_and_legumes.pdf

[8] https://agforward.eu/index.php/en/Innovation-leaflets.html?file=files/agforward/documents/leaflets/16_Grazing_sheep_under_walnut_trees.pdf

orchards and enjoy the benefits of the hay produced there. Orchard owners reduce their mowing costs, increase nitrogen supply to their soils, and if they let other farmers' sheep into the orchard, they also receive rental income from sheep farmers. There can also be social benefits in terms of employment and plant biodiversity. Grazing is particularly beneficial for cider apples, as the use of pesticide regime is less permissible in that case.[9]

To forward in Cluster 5 is relatively difficult, as farms of this kind have previously moved towards intensive production and the transition to more extensive production is difficult to change. Additional costs, lack of appropriate expertise and sometimes professional support, are the biggest problems. The need for specialized workforce, more complex work, and additional administrative burden and time do not motivate farms to switch. Of course, there are also benefits of switching, but we can find the basically in the production. Partial shade, of up to 40%, can help reduce the damage to cereal crops caused by spring heat waves affecting not only in Mediterranean countries with increasing frequency. Trees, through their deep root systems, are able to capture some residual nitrogen leached below the root system of annual plants, which reduces the risk of nitrogen leaching. Fine tree roots can be vertically and horizontally modifed by the presence of the crop, thereby developing deeper rooting profles than in pure plantations. This reduces the competition for soil nutrients and water[10].

CONCLUSIONS

In the course of the research, Hungarian micro-regions were grouped on the basis of the opportunities provided by the natural factors and the agricultural production previously characterized for them to the agar-forestry systems. It can be stated that each cluster has the opportunity to use agar-forestry systems with all their advantages and potential disadvantages. After reviewing the case studies of the AGRPROWARD research project, we found opportunities for each cluster that could be adopted as good practice. There are, of course, significant differences between clusters in terms of their suitability for use in agar-forestry systems, but it can be stated that they have every right to exist.

ACKNOWLEDGEMENT

The publication of this paper is supported by the EFOP-3.6.2-16-2017-00018 “Produce together with the nature – agroforestry as a new outbreaking possibility” project.

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[9] https://agforward.eu/index.php/en/Innovation-leaflets.html?file=files/agforward/documents/leaflets/24_Economic_benefits_of_grazed_apple_orchards_in_England.pdf

[10] https://www.agforward.eu/index.php/en/agroforestry-for-arable-farmers-in-western-france.html

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ANALYSIS OF A RIPARIAN ZONE GROUNDWATER SUPPLY IN KASZÓ

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ABSTRACT

Riparian zone forests are very diverse ecosystems and they are a special type of the agro-forestry systems. On the other hand, the biological production of these forests is high; therefore, they are valuable from an economic viewpoint as well. Prolonged drought periods in the changing climate will likely causes reduction of groundwater resources which at last probably degrades these ecosystems. With reasonably designed water supply systems, unfavorable processes can be stopped, and valuable ecosystems can be preserved. The effect of a water supply was analyzed in Kaszó forest (Somogy county, Hungary). 18 experimental plots were selected for eco-hydrological monitoring in different forest ecosystems. Two own developed methods were used for analysis: a spatio-temporal difference and a double mass curve approach. Both methods revealed that the water supply interventions had a positive effect on the riparian zone groundwater. A complex field monitoring was conducted on three representative locations (meteorological, soil, groundwater and phenological measurements). Based on the complex data a 1-D Hydrus model was successfully calibrated for alder and common oak forests.

INTRODUCTION

Riparian zone forests have very important roles. As a buffer zone they protect a stream system against stress factors (both quantitatively and qualitatively). On the other hand, these ecosystems are very diverse, and the biological production of these forests is high; therefore, they are valuable from an economic viewpoint as well. In a changing climate the drought periods can be longer and become more serious (*Szilágyi és Józsa*, 2008; *Bartholy, Pongrácz and Torma*, 2010), so the state of these ecosystems with high water demands is getting worse. Water scarcity for a prolonged period will degrade ecosystems (reduction in the number of species, a decrease in productivity) or eventually result in the disappearance of these riparian forests. With reasonably designed water supply systems, unfavorable processes can be stopped, and valuable ecosystems can be preserved.

A good examples of well documented water supply interventions are from the Fekete-Körös river valley (*Puskás*, 1999) and Bereg plain (*Olajos et al.*, 2009) with a relative long history. In this study the effect of the water supply was analyzed in Kaszó forest (Somogy county, Hungary).

MATHERIAL AND METHODS

Kaszó Forest is located in Somogy county (Hungary). The research area can charadterised as hilly region with sandy soils. The groundwater depth is typically 6-10 m on

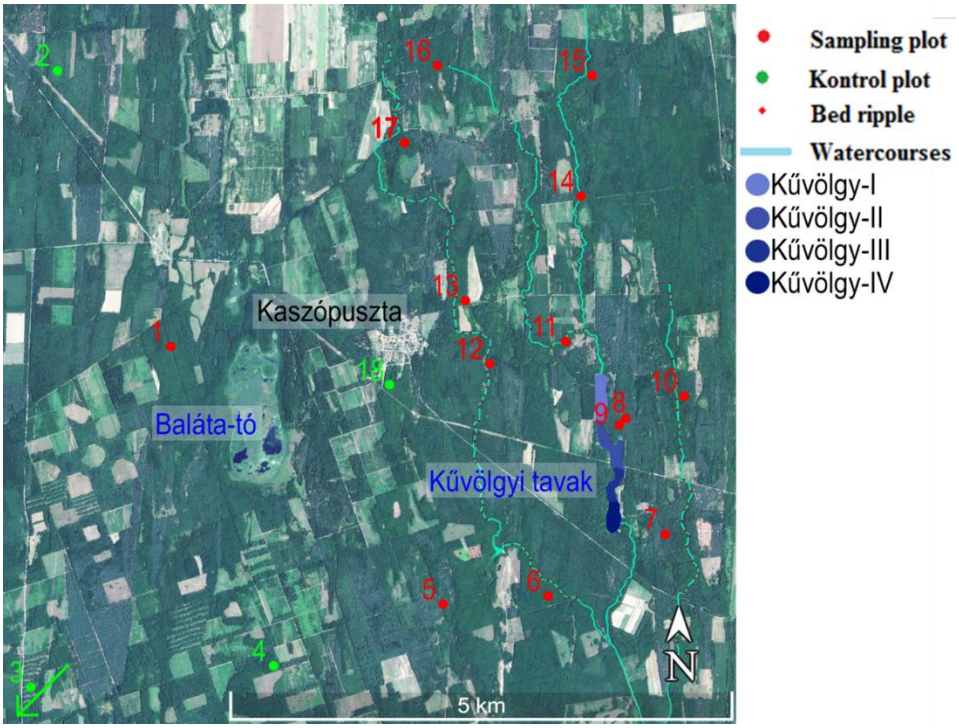
hillsides and close to the surface in valley locations. The area enjoys semi humid climate with 9,8-10,2 Celsius mean temperature and with 750 mm annual precipitation (430-450mm in growing season) (*Dövényi et al.*, 2010).

During the water supply inerventions in Kaszó Forest the following works were completed (*Figure 1*). 123 bottom threshold were implemented along both the perennial and the emhereral parts of the stream system in 2015.

In 2016 the Bükki reservoir were settled and the lake Baláta water system was reconstructed. In 2017 the Kűvölgyi lake system was dredged and a new lake was implemented upstream of the Lake 3. Regarding the settlements of new lakes the open water surface was significantly increased (from 7.13 ha to 15.8 ha). For monitoring of interentions a local meteorological station and 18 groungwater wells on representative locations were settled (*Eötvös and Horváth*, 2018).

Figure 1

Research area



Data of monitoring wells were examined with a treatment-control space and time deviations based approach. According to *Figure 2* firstly spatial and after temporal difference calculated between control and treatment influenced well data to evaluate the effect of interventions.

Figure 2

Groundwater data analysis with treatment-control space and time deviations

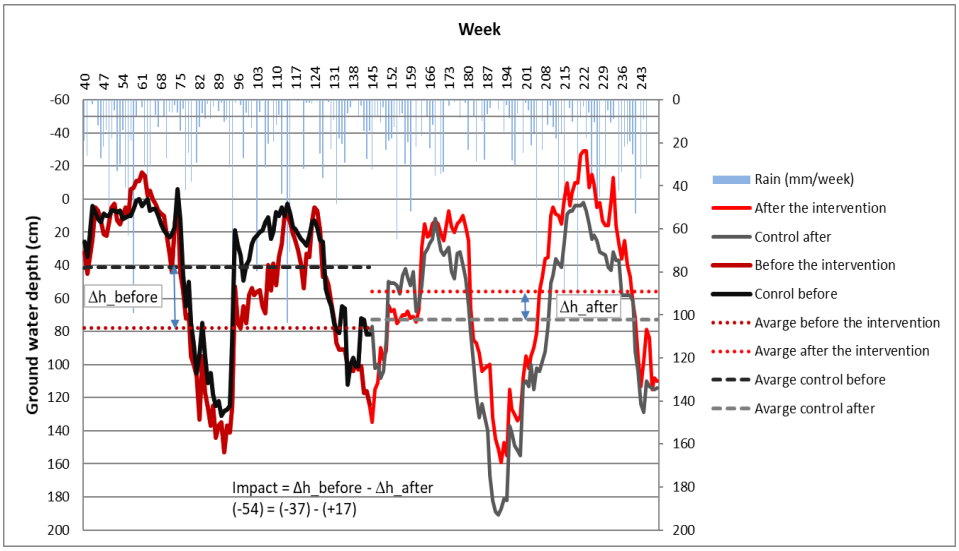


Figure 3

PET calibration using dry period groundwater ET data

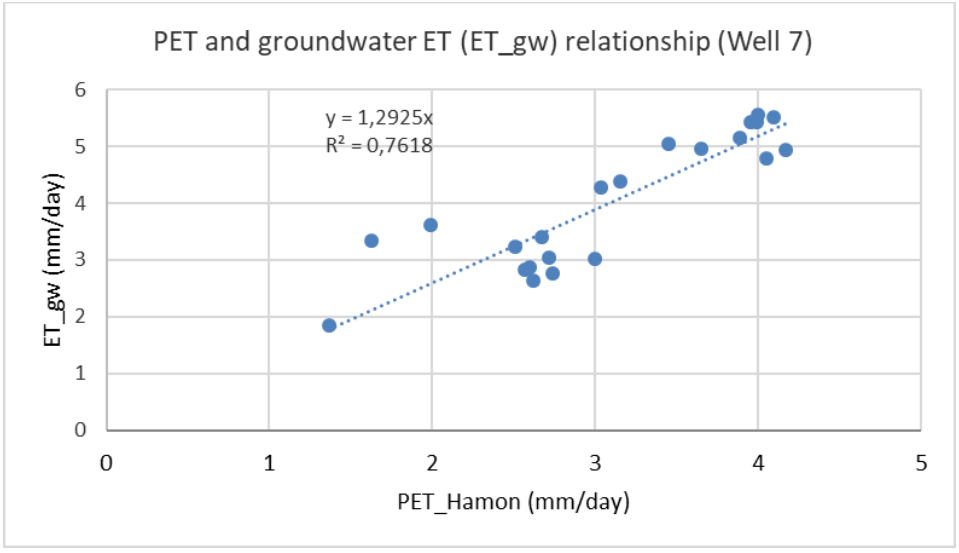
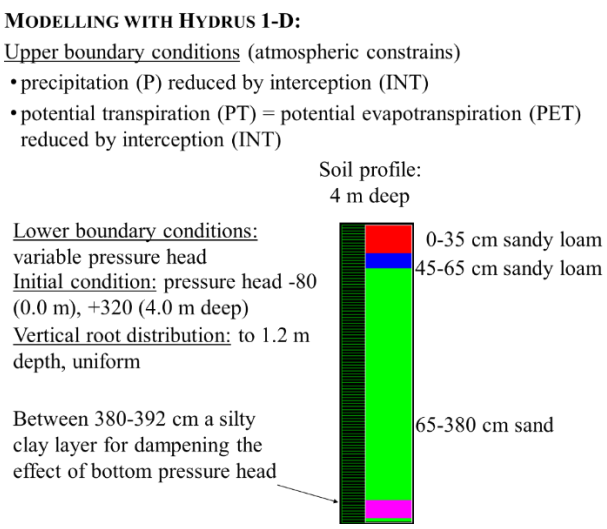


Figure 4

Model setup for 1-D Hydrus modelling

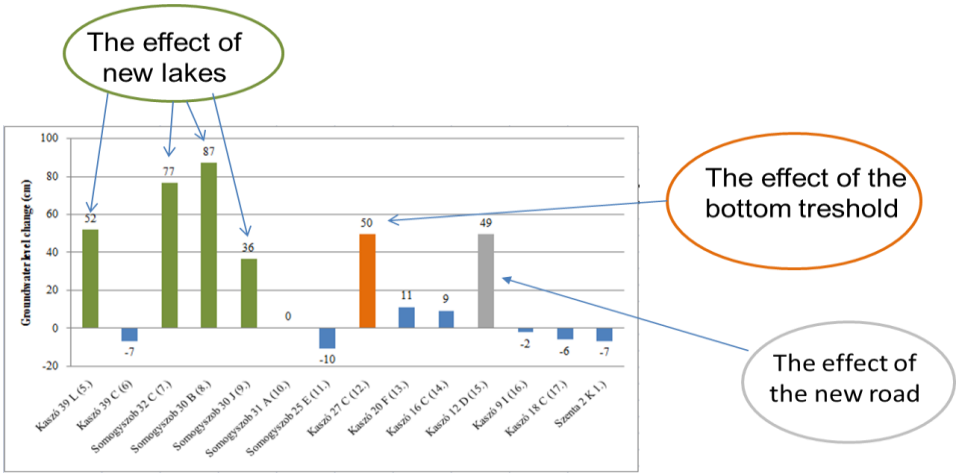


RESULTS AND DISCUSSION

Results of the groundwater level analysis showed that the intervention (water supply) had a general positive effect on the water table (*Figure 5*). 40-50 cm water table rise was caused by the interventions in the neighbourhood of the new lakes, but the effects of the bottom tresholds was not always significant.

Figure 5

Effects of the interventions on water table in case of the monitored locations



Hudrus 1-D modelling results showed that the capillary rise (water uptake from ground water) significantly increased (30%) in the surroundings of the new reservoirs (8 and 9 groundwater wells) regarding water supply interventions.

CONCLUSIONS

Results from both evaluations (groundwater level analysis and Hydrus modelling) showed that the interventions (water supply) had significant, positive effects on the water table and so the status of the riparian forest (azonal forest ecosystems).

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FIELD UTILIZATION OF BIOGAS FERMENTATION RESIDUES COMBINED WITH BACTERIAL FERTILIZERS, IN SUGAR BEET CULTURE

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ABSTRACT

Within the framework of the research, the University of Kaposvár was conducting field experiments for two years in connection with the R&D project on the agricultural application and utilization of biogas sludge and other byproducts of Magyar Cukor Zrt. In this study, we present the yield-enhancing and quality-enhancing effects of biogas sludge in sugar beet culture. Due to the characteristics of the field, 4.6 hectares were treated in the experiment with sugar factory biogas sludge and Phylazonite soil-regenerating bacterial fertilizer (Pseudomonas putida, Pseudomonas fluorescens, Bacillus megaterium, Bacillus subtilis). On 4.6 hectares only sugar mill biogas sludge treatment, on 10 hectares only Phylazonite soil regeneration was applied. The remaining ~ 18 ha was used as a control plot. During the experiment, the sugar factory biogas sludge was applied at a dose of 50 m3/ha and the soil-regenerating bacterial fertilizer Phylazonit was applied at a dose of 20 l/ha. The application rate per hectare is determined on the basis of the soil test report. Based on real crop yields, the highest sugar beet yield of biogas sludge + bacteria treatment was 69.17 t/ha. The biogas sludge treatment yielded 56.05 t / ha, the bacterial treatment 60.31 t/ha, and the control plot yielded 49.83 t/ha. The highest sugar content was registered at the control plot with 18.4%. In summary, the biogas sludge + soil regenerating bacterium combination resulted in almost 20 tons of crop excess compared to the control plot. With higher yields, the sugar content decreased by 1.7%, however, this is not such a reduction that the surplus of sugar beet yield could not compensate. On the basis of yield, the soil regeneration bacterial treatment reached the second highest result, followed by the biogas sludge treatment. No pathological difference between the plots was observed. According to the present results, the biogas sludge is able to supplement the sugar beet's nutrient requirement to a certain extent.
Keywords: sugar beet, biogas sludge, bacterial fertilizer, soil nutrients supply

INTRODUCTION

Sugar beet, as a specific arable crop, by its spread has contributed to the improvement of the standard of agricultural crop production. It occupies a prominent position among plants that can be grown by intensive crop production technologies. The economic efficiency of sugar production is essentially determined by the safety of the production and the quality of the beet. It is therefore in the common interest of processors and producers to maximize their average yields and quality in each harvest. In the case of sugar beet, the quantity and quality of the crop are basically determined by the applied agrotechnology, and in particular by the appropriate nutrient supply (*Ungai*, 2005)

Sugar beet take up significant amounts of nutrients from the soil to form root crops. The amount of fertilizer applied and the time of application should be determined so that at each stage of the beet growing season sufficient nutrients are available in the form to be taken in order to achieve high root yield, and at the same time the nutrient supply should not cause

any deterioration. The right amount and proportion of nutrients increases the beet's crop safety, improves drought tolerance and disease resistance of the plants. The specific nutritional requirements of sugar beet for the production of 1000kg of main and by-products: N: 3.5kg, P2O5: 1.5kg, K2O 5.5kg, CaO: 4.5kg, MgO: 1.5kg (*Füleky-Sárdi*, 2014)

As a general rule, phosphorus and potassium fertilizers should be applied in a single dose in the autumn, before cultivation, and then ploughed into the soil. 30-40% of the nitrogen dose should be applied in the autumn and 60-70% in the spring before sowing. In addition to the planned beet yield, the characteristics of the soil, the pre-crop and the time and amount of organic fertilization shall be taken into account in the autumn-spring division. The nutrient supply of sugar beet is primarily aimed at providing the nutrients needed for crop production during the growing season according to the needs of the beet. However, the nutrients released have a significant effect on the beet quality as well (*Búzás*, 1978).

According to *Winner* (1968), when comparing the different production factors, it is undoubtedly that fertilization has the greatest effect on the quality of sugar beet. Therefore, errors in the field of fertilization have the most serious consequences. The yield and quality of sugar beet - if there is a balanced crop and no damage to the foliage or roots - is determined primarily by plant nutrition (*Ruzsányi et al.*, 2002).

MATERIAL AND METHODS

Following preliminary soil tests, the biogas sludge combined with bacterial fertilizers was applied for on 8/11/2017 by applying for soil protection permits for the biogas sludge application to the 32.26 ha area with block identifier RW63X-6-15 of Kaposvár-Péterpuszta. Due to the characteristics of the field, 4.6 hectares of sugar factory biogas sludge and Phylazonite soil regenerating bacterial fertilizers (Pseudomonas putida, Pseudomonas fluorescens, Bacillus megaterium, Bacillus subtilis, containing 109 db / cm3 germ) were treated in the experiment. 4.6 ha were treated with sugar factory biogas sludge treatment only, 10 ha were treated with Phylazonite soil regeneration treatment only. The remaining ~13 ha was used as a control plot. During the experiment, the sugar factory biogas sludge was applied at a dose of 40 m3 / ha and 20 liters / ha of Phylazonite soil-regenerating bacterial fertilizer. The biogas sludge was applied from the Annaburger tank to a depth of 15 cm with a Garant Kotte injector. During the first treatment, the bacterial preparation and the biogas sludge were homogenized together. During the third treatment, the fertilizer was applied to the soil by spraying, followed by immediate ingestion into the soil.

There was sunflower forecrop on the field. The harvest was followed by disc stubbling followed by injection. The injection was followed by medium deep ploughing. As a basic fertilizer, 400 kg of potassium salt (60%), 150 kg of DAP, 370 kg of MAS were applied in spring. Sugar beet was sown with Gellért variety on April 9, 2018 with 1.2 U/ha. The individual plots were managed together, no further differences were applied in cultivation technology.

RESULTS AND DISCUSSION

During the experiment, a foliage analysis was made on June 7 2018. According to the results, the phosphorus content of the plants of each plot was low, the samples showed less than 0.27%. The supply of boron, manganese and calcium was moderate. The nitrogen

supply was high, the iron supply was very high. In this period, with the exception of the control, window treatment was observed in the other three treatments, from which small and large plants were sampled separately. The only difference between the large and small plants was the iron and manganese supply. The values of small plants were almost double that of large plants *(see Table 1)*. The cause of the window is probably the result of the lack of rainfall or improper soil tillage.

Table 1

Results of foliage analysis

	dry matter	N	P	K	Ca	Mg	Fe	Mn	Cu	Zn	B
	%	%	%	%	%	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
control	21.2	5.43	0.25	3.84	1.35	1.07	544	424.71	15.54	46.82	57.65
biogas sludge large plant	24	4.68	0.25	3.76	1.18	1	549	170.04	14.93	25.61	46.08
biogas sludge small plant	20.7	4.79	0.27	3.99	1.72	1.09	878	369.29	12.42	26.38	73.39
bacteria large plant	19.8	4.70	0.18	4.18	1.14	1.05	647	264.17	11.68	30.61	53.67
bacteria small plant	20	3.94	0.22	4.01	1.57	1.06	973	643.15	11.32	32.41	72.44
biogas sludge + bacteria large plant	19	5.54	0.34	3.67	1.1	1.02	355	111.99	17.2	25.69	43.24
biogas sludge + bacteria small plant	19.3	4.99	0.26	4.14	1.18	0.97	688	193.54	14.14	14.52	42.10
Supply explanation:											

low	
middle	
high	
very high	

Source: Magyar Cukor Zrt.

Beets for internal parameters was sampled 4 times: June 31st, August 29th, October 26th, December 17th 2018. The sampling was performed according to the standard. The values obtained are shown in *Table 2*.

At the first sampling, on June 31, the control treatment was far ahead of the other treatments, reaching 16.42% sugar content. There was no significant difference between the other treatments. Among the other contents, the sodium and the Alpha-amino-N are the highest in the control plot. Potassium content was high in biogas sludge + bacterial treatment.

According to the second sample, the sugar content samples did not differ, there was no significant difference between them based on other quality indicators. The lowest expected

yield is 40.83 t/ha for biogas sludge + bacterial treatment, the highest is measured for bacterial treatment 75.55 t/ha.

Table 2

Quantity and quality parameters during vegetation period

	Sugar content %	K mmol/kg	Na mmol/kg	Alfa-amino-N mmol/kg	Beet weight kg	Beet weight g/pc	Beet yield t/ha	Thick juice purity %
31.07.2018								
sludge + bacteria	12,46	42,70	4,70	20,80	6,00	**300**	**26,12**	**91,55**
sludge	12,02	31,90	5,00	10,20	4,00	**400**	**34,75**	**93,77**
bacteria	12,30	35,70	7,20	11,60	2,30	**230**	**20,44**	**93,04**
control	16,42	34,30	9,20	26,50	5,00	**500**	**36,36**	**93,28**
29.08.2018								
sludge + bacteria	16,2	33,2	5,4	12,8	4,7	**470**	**40,83**	**94,84**
sludge	15,8	31,8	5,3	15,5	**4,1**	**820**	**71,23**	**94,62**
bacteria	16,6	34,7	7,4	14,3	**8,5**	**850**	**75,55**	**94,51**
control	16,8	30,6	8,9	13,4	**6,9**	**690**	**50,18**	**94,86**
26.10.2018								
sludge + bacteria	16,3	29,2	4,1	8,7	**9,8**	**980**	**85,13**	**95,69**
sludge	16,8	27,0	4,6	10,8	7,5	**750**	**65,15**	**95,75**
bacteria	16,1	24,1	6,0	23,8	**8,0**	**800**	**71,11**	**94,59**
control	17,1	23,3	4,2	15,0	**7,3**	**730**	**53,09**	**95,82**
17.12.2018								
sludge + bacteria	16,7	32,5	6,0	12,5			**69,10**	**95,00**
sludge	17,2	26,6	7,7	7,9			**56,00**	**95,86**
bacteria	16,7	26,9	7,7	6,8			**60,30**	**95,82**
control	18,4	24,8	4,2	3,4			**49,80**	**96,85**

Source: *Magyar Cukor Zrt.*

There was no significant difference in the content of the third sample, the potassium content of the bacterial treatment alone was higher than the others. The highest yield is measured 85.13 t/ha from biogas sludge + bacterial treatment and the lowest is 53.09 t / ha from the control plot.

Beet harvest was on 17 Dec 2018. Based on real crop yields, the highest yield of biogas sludge + bacterial treatment was 69.17 t/ha. The biogas sludge treatment yielded 56.05 t/ha, the only bacterial treatment 60.31 t/ha, and the control plot yielded 49.83 t/ha. The highest sugar content was on the control plot with 18.4%.

CONCLUSIONS

In summary, the biogas sludge + soil regenerating bacterium combination resulted in almost 20 tons of crop excess compared to the control plot. With higher yields, the sugar content decreased by 1.7%, however, this is not such a reduction that the surplus of sugar beet yield could not compensate. On the basis of yield, the soil regeneration bacterial treatment reached the second highest result, followed by the biogas sludge treatment. No pathological difference between the plots was observed. According to the present results, the biogas sludge is able to supplement the sugar beet's nutrient requirement to a certain extent.

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QUALITATIVE ANALYSIS OF A SMALL-SCALE AGROFORESTRY SYSTEM IN TOLNA COUNTY

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ABSTRACT

Agroforestry is a land management practice which intentionally integrates woody vegetation with crop and/or animal systems to benefit from the resulting ecological and economic interactions. In the Hungarian agricultural history, systems and technologies known as agroforestry today have centuries-old traditions, traces of this can be also found in the current land use. However, this form of land use has been significantly diminished during the last decades. At the same time, mitigating climate change and adapting to climate change as a double constraint is a great reason for the wider spread of agroforestry systems. The objective of this paper is to provide a best practice example in order to help Hungarian small-scale farms adopting agroforestry practices. A qualitative in-depth analysis was applied in order to explore a best practice case in Tolna County. The examined agroforestry system is located in Döbrököz, a medium-sized village in Southern Transdanubia. The case study presented in this paper provide a solid justification for small-scale agroforestry systems. The system can be adopted in many hilly areas of the Transdanubian Region. With the help of a good designed agroforestry system, it is possible to turn unfavorable geographical conditions into environmental and economic advantages.

INTRODUCTION

Agroforestry is a land management practice which intentionally integrates woody vegetation with crop and/or animal systems to benefit from the resulting ecological and economic interactions (*Burgess et al.*, 2015). The environmental services provided by agroforestry systems can be divided into four categories: (i) carbon sequestration, (ii) biodiversity improvements, (iii) enhanced soil productivity and conservation, (iv) water and air conservation (*Jose*, 2009). Agroforestry offers compelling synergies between adaptation (e.g., soil and water conservation, improved microclimate conditions, improved soil fertility) and mitigation (carbon sequestration) solutions to climate change (*Lasco et al.*, 2014). Agroforestry systems can also improve livelihoods, enhance food security, and provide clean energy, contributing to sustainable rural development (*Sharma et al.*, 2016). According to *Kachova et al.,* (2016), agroforestry is a profitable, environmentally friendly, and sustainable technology for farmers living in less-developed rural areas (*Csonka et al*, 2018).

In the Hungarian agricultural history, systems and technologies known as agroforestry today have centuries-old traditions, traces of this can be also found in the current land use. However, as *Varga and Bölöni* (2009) pointed out, this form of land use has been significantly diminished during the last decades. Wooded pastures have a total domestic area of only 5,500 hectares, most of this silvopasture systems are abandoned. Hungary also has a deep tradition

in the plantation and management of forest srips and forest belts protecting crop fields against erosion and deflation.

Against this historical background, it is particularly worrying that the domestic area of field protection forests has decreased by 15% between 2011 and 2015 (teir.hu). At present, 40% of the approximately 11,400 hectares of land are located in the Great Plain, and another 20% in the Central Transdanubian region. South Transdanubia (884 ha) and Central Hungary (668 ha) have the smallest area of field protection forests.

It can be seen from the above that the use of agroforestry technologies in Hungary has been limited and traditional agroforestry practices have been reduced to the end of the 20th century. At the same time, mitigating climate change and adapting to climate change as a double constraint is a great reason for the wider spread of agroforestry systems. In addition, the country has a high proportion of agro-environmentally sensitive agricultural areas, which justifies the use of systems providing complex ecosystem services (*Vityi and Marosvölgyi*, 2014). From the point of view of technology adaptation, nearly sixty percent of the Hungarian agricultural areas are used by individual farms, which are typically small-scale. The sustainability and rural development functions of agroforestry systems can prevail in such small farms (*Coulibaly et al.*, 2017; *Cole*, 2010).

The objective of this paper is to provide a best practice example in order to help Hungarian small-scale farms adopting agroforestry practices.

THEORETICAL BACKGROUND – THE DRIVERS OF AGROFORESTRY ADOPTION

The distribution of new agricultural technologies is strongly differentiated in space (*Berger*, 2001; *Minten and Barrett*, 2007; *Genius et al.*, 2013). Natural and ecological conditions provide important incentives which can influence the implementation of agroforestry technologies in a given area. *Reisner et al.* (2007) employed broad-resolution spatial data on soil, climate, topography, and land cover to identify potential agroforestry target regions in Europe. Their results show that silvoarable agroforestry has been implemented efficiently throughout the continent. Furthermore, due to their wide variety, agroforestry technologies can be adopted both in tropical and temperate areas of Earth (den *Herder et al.*, 2017). To sum up, the spread of different agroforestry systems is not limited by natural conditions in Europe. Despite this fact, the spatial distribution of agroforestry is unequal across Europe. The highest frequency of agroforestry systems is in the southern countries while there is a very low density of agroforestry in other regions of Europe (den *Herder et al.*, 2017). Since this spatial inequality cannot be explained by the variety of natural conditions, other factors should be explored to explain it.

Neupane et al. (2002) developed a complex framework for exploring agroforestry adoption at the household level. The factors of agroforestry adoption can be divided into four main categories:

- community characteristics (access to market, infrastructure, technology, education, local knowledge, extension and employment opportunities, natural environment);
- household characteristics (socioeconomic factors, resources, extension contracts, membership in farmers' groups, needs);

- activity of local NGOs and farmers' groups (coordination, local level participation, awareness campaigns, meetings, local resource mobilization, moral support);
- activity of external agroforestry organization (design and dissemination of appropriate agroforestry technology, design of farmers' visits, demonstration farms and on-farm trials, provision of material support, training, technical know-how, and extension).

These factors influence the awareness of agroforestry, then the attitude towards agroforestry, and finally the adoption of agroforestry. Note that the natural environment forms only a small part of the model, while the majority of factors are related to social and/or economic dimensions.

Zerihun et al. (2014) provide a similar complex framework for analyzing factors in the adoption of natural resources management, especially in the adoption of agroforestry systems. They point out that the sustainable adoption of agroforestry is affected by

- contemporary global changes and macro policies;
- institutional factors, e.g., operational rules, collective choice rules, and constitutional rules;
- physical and technical attributes of resources;
- external agents (users, resource users, and stakeholders);
- other factors like risk, household preferences, resource endowments, incentives (e.g., subsidies, prices, and expectations), and biophysical factors.

Cooper and Denning (2000) argue that the scaling up of agroforestry innovations is influenced by ten different factors, including learning-by-doing practices, technology options, knowledge sharing and extension approaches, institutional capacity, policy and market options, strategic partnerships, and available germplasms.

Louah et al. (2017) highlight the importance of path dependency and cognitive lock-in as barriers to the development of temperate agroforestry. Usually, farmers accept common old technologies as established and unquestionable, so they react negatively to new technologies. Path dependency and cognitive lock-in effects can be reduced by ecological education and learning within innovation networks. Based on a semi-quantitative questionnaire, *Sereke et al.* (2016) concluded that payments for ecosystem services (e.g., agroforestry systems) cannot change attitude lock-in as long as farmers' expectations and knowledge are not appropriately addressed

Beyond these drivers, there is another factor which may have a positive effect on the diffusion of innovative agricultural technologies, the agglomeration effect or agglomeration externality.

Recent studies highlight the relevance of agglomeration effects in agriculture (*Allaire et al.*, 2015; *Schmidtner et al.*, 2012).

Based on this short review, the driving factors of agroforestry adoption are summarized in *Table 1.*

MATERIAL AND METHODS

A qualitative in-depth analysis was applied in order to explore a best practice case in Tolna County. The qualitative approach consists of four steps:

- introduction of the main characteristics of the study site;
- presentation of the environmental impacts of the agroforestry system examined;
- a comparison of the crop yields of agroforestry systems and control areas;
- driving factor analysis based on the categories of *Table 1.*

Table 1

The main driving factors of agroforestry adoption

Factor categories	Source
Natural resources and ecological factors	*Reisner et al.* (2007), *den Herder et al.* (2017)
Agricultural demography and resources	*Neupane et al.* (2002), *Kant and Lehrer* (2004), *Zerihun et al.* (2014)
Markets, institutions and policies	*Cooper and Denning* (2000), *Neupane et al.* (2002), *Kant and Lehrer* (2004), *Zerihun et al.* (2014)
Networks and partnerships	*Cooper and Denning* (2000), *Neupane et al.* (2002), *Louah et al.* (2017)
Expectations and technological knowledge	*Sereke et al.* (2016)
Path dependency and cognitive lock-in	*Louah et al.* (2017)
Agglomeration effects	*Nyblom et al.* (2003), *Schmidtner et al.* (2012), *Allaire et al.* (2015)

Source: own compilation

RESULTS AND DISCUSSION

The main characteristics of the study site

The examined agroforestry system is located in Döbrököz, a medium-sized village in Southern Transdanubia, more precisely in Völgység microregion, which is a part of Somogy-Tolna Hills and the catchment area of Kapos stream. The total area of the site is 7.06 hectares, of which 1.65 hectares are divided into 4 forest strips, 1.65 hectares are meadows, the remaining includes vineyards, orchards and farm buildings. The dominant soil type is a slightly acidic loess sand. According to the results of recent soil analysis, the humus content of the soil is between 0.7-1.2%, weakly acidic, weakly bound, and poorly supplied with nutrients.

The precursor to the development of the agroforestry system was determined by the nature of the partitioning of enclosed gardens, the aging of the previous parcel owners and the popular and widespread acacia plantations in the area in the 1990s.

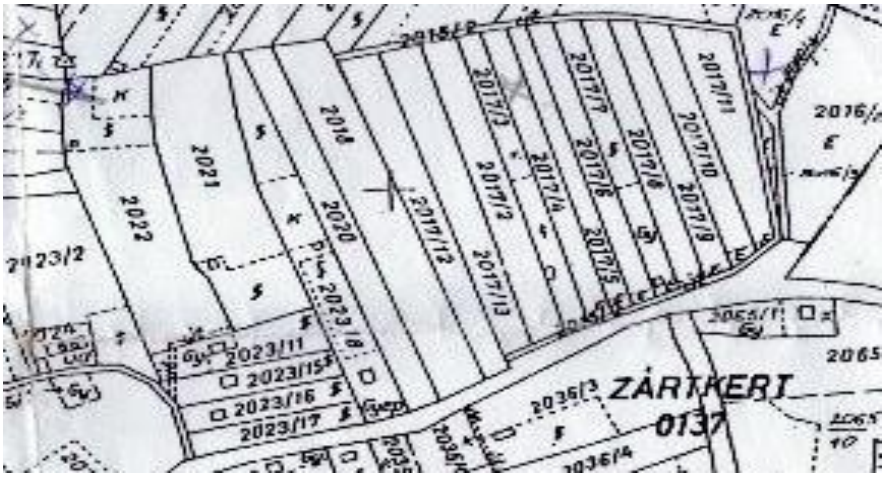
The baseline situation for the development of agroforestry system was constituted by the spatial structure of the enclosed gardens that forming the area, the aging of the previous owners and the widespread acacia plantations during the 1990s. These special features are explained in the next two subsections.

The spatial structure of enclosed gardens that forming the study area

The study site is located in the south of the village of Döbrököz, south of Kapos. Its terrain is characterized by slightly higher hills and steeper valleys than ones located on the northern side of Kapos. The vineyards and orchards of the local households had been established on these relatively higher hills. In the last century, the larger contiguous lands has been divided in such a way as to provide access to each owner's landpiece from the vineyard lanes, resulting in long, narrow north-south parcels (*Figure 1*).

Figure 1

Location of enclosed gardens in 'Homokhegy' peripherial district of Döbrököz



The agroforestry system presented in this paper begins with parcel No 2022 and end parcel No 2017/1.

Acacia plantations and changed ownership structure

As the previous owners of these areas became old, some of the parcels were converted to acacia. Such plantations make up a large part of the No 2023/2 (a neighbor area), the small part of No 2021, No 2017/2 and /3, No 2017/5 and 6, and finally No 2017/9, 10 and 11. These plantations act as a dividing band for the areas between them. By 2015, all these areas have been taken by the members of a local agricultural cooperative. Thus, the first steps in the development of the agroforestry system have already been implemented by previous owners and current neighbors.

The characteristics and most important impacts of the examined agroforestry system

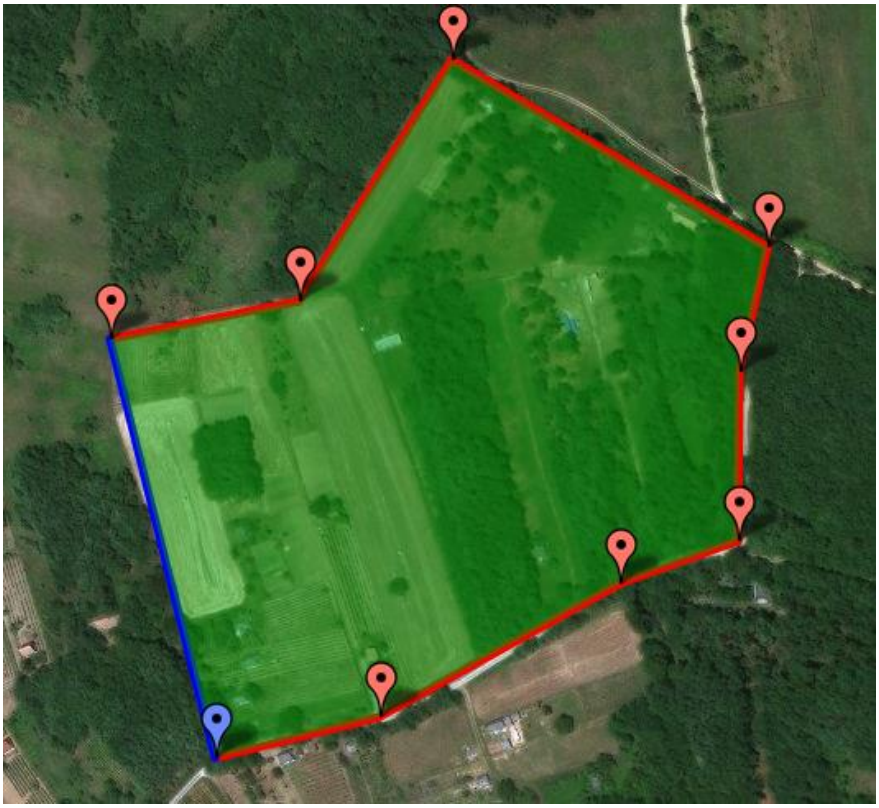
The thinning of the acacia plantations on the north-south plots was started by the new owners. Meantime, walnuts, oak and other fruit trees hatched spontaneously in the area. Leaving the seedlings on the site, the former acacian strips became increasingly mixed forest strips.

As shown in *Figure 2*, the forest strips are oriented mainly north-south and, as a heritage of enclosed landscapes, have a narrow east-west dimension. Based on our experience, this orientation has a positive effect on both water supply and sun exposure. In the early morning, the forest strips act as a humidity trap and the shading effect does not allow the fields between the strips to warm up quickly during the day. At noon, the sun shines between the strips and then the shading effect disappears. In the afternoon, the shading effect comes back again decreasing the risk of heat stress.

The extent of the shading effect written above is very similar to the well-known wind shading effect of the tree belts: favorable impacts prevail along the forest strip, with a three to four times of its width. In that way the true shading and the wind shading effect results in humidity surplus which can be seen in the height and maturity of crops and grass.

Figure 2

Location of forest strips



The following two points provide a short qualitative description about how this specific system answers the negative effects of climate change in Hungary identified by *Hetesi and Kiss* (2017).

- Increasing average temperature. This phenomenon has an adverse effect especially in the summer months when the weather is warmer and often drier. The production of late sown crops (soy, maize) or hay in dry, warmer weather leads to heat stress and yield loss. The shading effect of agroforestry system decreases the heat stress. Due to the North-South orientation, crop fields enclosed by forest strips are shaded in the morning and afternoon.
- Decreasing precipitation during the growing season. A forest belt with lawn, shrub and canopy level increases the groundwater level in soil even in neighbouring areas. The humidity trap provided by the trees is also favorable for water retention.

A comparison of the crop yields of agroforestry systems and control areas

In terms of yields, data on the agroforestry system and a control area with a similar feature but not adjacent to a forest strip are provided (*Table 2*).

Table 2

Yield of different type AF- and control parcels

Year	Yield period	Agroforestry areas		Control areas		Weather (humidity)
		AF Forage field (0.4 ha)	AF Meadow (0.75 ha)	Forage field (0.36 ha)	Meadow (1.4 ha)	
2015	first yield/ first crop	3	4	-	6	humid
	aftergrass/ second crop	0	2	-	4	
2016	first yield/ first crop	3	3	-	6	average
	aftergrass/ second crop	2	2	-	3	
2017	first yield/ first crop	3	4	4	6	dry
	aftergrass/ second crop	0	0	0	0	
2018	first yield/ first crop	4	4	3	4	dry
	aftergrass/ second crop	0	0	0	0	

The table shows two parcels of the agroforestry parcels. The first of one, the forage crop rotation area, has an area of 0.4 hectares, and a value of 20 AK with basically sandy loam soil. The control area for this parcel is classified as inland, so it has no AK value. However, both its soil (loam) and its location (former floodplain) make this reference parcel a better cropland. Despite this quality disadvantages, although the differences are not significant, it can be seen that the yield of the agroforestry system in a dry year exceeds the yield of the otherwise better control area.

The second agroforestry parcel examined is a traditional meadow sown with a grass mixture. The size of the parcel is 0.7 hectars and has also a low AK value of 19. The control parcel has an area of 1.4 hectares, which in terms of soil is most similar to the AF-meadow, being both loose sandy soils. Part of the area has illuviated layers close to the soil surface, where the maintaining of grassland management is theoretically unfavorable. In spite of these disadvantages, the yield per hectare of the test area is practically always higher than the yield per control hectare.

Driving factor analyses of the agroforestry adoption process

Using the categories of *Table 1* as framework, we applied a driving factor analysis of the agroforestry adoption process. The results of the analysis are summarized in *Table 3.*

Table 3

Results

Factor categories	Original characteristics	What is changed due to agroforestry adoption?
Natural resources and ecological factors	a)Unfavorable spatial structure of enclosed gardens. 2)Afforestation of farmlands by acacia	a)Making an advantage from the spatial orientation: utilization of shading effects. b) Development of mixed forest strips partly based on spontaneous processes of the nature.
Agricultural demography and resources	Aging of owners	coordinated change of ownership by the members of a local cooperative
Markets, institutions and policies	Fragmentation of the area into narrow parcels by the former decision makers.	Establish a mosaic-like agroforestry area using forest strips as humidity traps and shading objects.
Networks and partnerships	Fragmented owner structure	High-level cooperation between the cooperative members
Expectations and technological knowledge	N.A.	Try-and-error new practices and technologies (e.g. no till practices, thinning the forest strips)
Path dependency and cognitive lock-in	Agricultural land use OR afforestation	Agricultural land use AND afforestation

CONCLUSIONS

The case study presented in this paper provide a solid justification for small-scale agroforestry systems. The system can be adopted in many hilly areas of the Transdanubian Region. With the help of a good designed agroforestry system, it is possible to turn unfavorable geographical conditions into environmental and economic advantages. The North-South oriented and narrow forest strips are very useful to decrease the negative effects of climate change e.g. heat stress and dry weather. The positive impacts of forest strips can also be observed on average yields.

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INVESTIGATION OF VOC COMPONENTS OF HONEY

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ABSTRACT

Volatile organic compounds (VOCs) contribute to the aromatic shape of honey. These compounds are categorized into different chemical groups, like terpenes, aldehydes, alcohols, hydrocarbons, benzene derivatives, etc. They are considered as fingerprints of honey varieties; unifloral honeys have their specific VOC composition. It is influenced by several effects like the geographical origin, vintage, metabolism of bees, microbial and environmental contaminations. The mixed flower honeys have the most complex VOC compositions. The main compositions can be identified by comparison of VOC caracters of unifloral honey types. The majority of honey VOC compound analyses is based on SPME-GC techniques, but several authors used static HS-GC analysis too. The identification of numeruos components is carried out by applying MS detections; however, the recognition of composition from metabolic origins besets with difficulties. In this article we investigated the VOC components of most relevant Hungarian unifloral honeys, the effect of vintage on their compositions and compared honey VOCs originated from different agroforestrial systems.
Keywords: honey, VOC, gas-chromatography (GC), agroforestry

INTRODUCTION

Honey plays an important role in human nutrition since the ancient time. Due to its excellent nutritional value, high antioxidant content and significant antibiotic effect, honey is regarded as an important foodstuff (*Blair and Carter*, 2005; *Johnston et al.*, 2018; *Majtan et al.*, 2011; *Vasić et al.*, 2019). The presence of 50-250 different volatile organic compounds (VOCs) contribute to the aromatic shape of honey, while the odour of honey is determined by the composition and relative quantity ratio of VOCs. These compounds are categorized into different chemical groups, like terpenes, aldehydes, alcohols, hydrocarbons, benzene derivatives, etc. (*Jerković and Kuś*, 2014) They are considered as fingerprints of honey varieties; unifloral honeys have their specific VOC composition. It is influenced by several effects like the geographical origin, vintage, metabolism of bees, microbial and environmental contaminations (*Barra et al.*, 2010., *Karabagias et al.*, 2014; *Manyi-Loh et al.*, 2011). This allows the use of honey as potencial biomonitor to assess environmental conditions (*Quigley et al., 2019*). Ageing of honey decrease the aromatic and enzymatic compounds, the colour turns dark (*Moreira et al.*, 2010). The alterations of honey's VOCs depends on storage time, some components arise by secondary chemical reactions, while others disappear (*da Silva et al.*, 2016).

Several studies have been published on the usage of different fractionation techniques to evaluate of VOC content of different honeys. Solid phase microextraction (SPME) is the most

frequently used sample preparation method for the extraction (*Baroni et al*, 2006; *Špánik et al.*, 2012*)*, but some papers published the application of static head-space method (*Rowland et al.*, 1995). Due to the high sensitivity and efficacy of separation and evaluation of complex volatile compounds gas-chromatography coupled with mass spectrometry (GC-MS) provides adequate qualitative and quantitative information of sample composition (Jánošková et al., 2014). The aim of present work was to determine the most relevant VOC contents of different Hungarian honeys to improve the methodology of honey characterization.

MATERIAL AND METHODS

21 honey samples were investigated in this study: 3 sunflower, 4 canola, 3 acacia, 1 sweet chestnut, 1 silkweed and 9 mixed floral honey samples. They originated from several parts of north-western Hungary and the vintages were between 2016 and 2019. The samples were stored at -20 °C. The analysis of VOC components was carried out by a generally used head-space sample preparation followed by gas chromatograph separation coupled with mass spectrometrial detection (HS-GC-MS). The applied equipment for analysis was a Shimadzu GCMS TQ-8040 with AOC-6000 autosampler. 4 g of honey together with 0.5 g NaCl was disssolved in 2 ml of distilled water. After a 20 min. incubation time at temprature 80 °C, 500 µl of sample was injected at temperature 90 °C with heated needle. Applied parameters of analysis were the following: injector temperature 280 °C, split ratio of 0, type of middle polarity column was TG-5MS (Thermo Scientific Co.). Detection was performed by SCAN mode of single quadrupole.

Identification of compounds was carried out from WILEY 229 and NIST 107 spectrum libraries. Because of numerous quantified components, qualification was not executed, although peak areas were compared for relative determination.

RESULTS AND DISCUSSION

Among the identified components of VOCs, aldehydes and terpenes were highlighted; the non-specific biomarkers (linalool, lilac alcohol and lilac aldehyde) dominate in the different honey samples. Similar findings were reported by *Jerković and Kuś* (2014).

The highest abundance of volatiles was determined in polyfloral honeys, the lowest were found in the unifloral canola and acacia samples (*Figure 1*). Low amount of VOCs was detected in a sweet chestnut honey, however, it was found only in a single sample. Canola classified (by their physical and organoleptical features) honeys from Sopron and Harka (2019) showed significantly higher VOC levels, therefore their classification seems to be ambiguous. Among the group of unifloral honey samples the highest VOC content was found in case of sunflower honeys. During the examination the highest total VOC content appeared in polyfloral honeys, however, remarkable alternations were observed between the samples.

Polyfloral honey from *Harka* (2019) was characterized by relative low VOC content, the reason might be the presence of high amount of acacia honey. Similar composition can be found in case of polyfloral sample from the botanical garden of University of Sopron, 2018. Date of sampling and spinning of these two samples strengthen this conclusion.

Figure 1

Peak areas of honey volatiles by date and origin

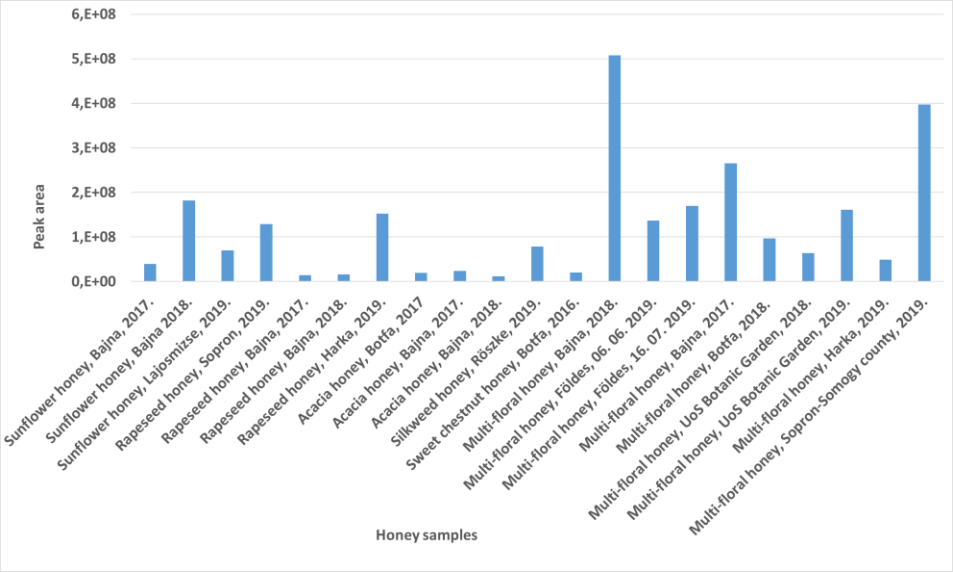

Table 1 shows the composition of volatiles in sunflower honey samples indicated the highest ratio of monoterpenes and their derivatives such as terpene alcohols. In case of Lajosmizse the sample had an outstanding ratio of other classified components, caused by high peak area of cyclobutanol and farnesol. Although samples were not only sunflower honeys, valencene was found in sample from Bajna 2017, which indicates presence of silkweed honey. High content of farnesene was found in sample from Lajomizse, which has relaxing effect, it is a general ingredient of linden honey.

Canola honey contained overriding amount of aldehydes beside monoterpenes and terpene alcohols (*Table 2*). Sample from Harka showed a significant difference in VOC component from the others. Sesquiterpenes content is preeminent in the sample from Sopron as well.

VOC ratio of different acacia honey samples alterated, but it corresponds to the lack of sesquiterpenes. Any correlation to the volatiles compound of acacia honey samples could not be concluded due to the low number of samples (*Table 3*).

Multi-floral honey samples collected by migratory apiary had higher content of VOC represented by monoterpene derivatives (*Table 4*). On the other hand, monoterpenes levels in polyfloral samples from botanical garden, Sopron (2018) and Földes were very low . The ageing caused changes in physical-chemical features in honeys from Bajna. *Kaškonienė et. al* (2008) published the same tendency. They analysed fresh honey samples and after 3-months storage, they found significant (70%) decrease of VOC content in caraway and white clover honey. The low number of samples and the uncertainty of identification did not allow further interpretation of VOC ratio, although the typical components might refer to the origin of honey.

Table 1

The rate of VOC components in sunflower honey

	Aldehydes (%)	Monoterpenes (%)	Terpene alcohols (%)	Sesquiterpenes (%)	Other compounds (%)	All of peak area
Sunflower honey, Bajna, 2017.	11	39	28	3	19	39 218 636
Sunflower honey, Bajna 2018.	1	28	52	1	18	181 703 066
Sunflower honey, Lajosmizse, 2019.	5	23	24	0	48	69 577 705

Table 2

The rate of VOC components in canola honey

	Aldehydes (%)	Monoterpenes (%)	Terpene alcohols (%)	Sesquiterpenes (%)	Other compounds (%)	All of peak area
Rapeseed honey, Sopron, 2019.	4	4	15	63	14	129 041 635
Rapeseed honey, Bajna, 2017.	31	27	42	0	0	14 168 343
Rapeseed honey, Bajna, 2018.	47	19	7	0	27	16 225 229
Rapeseed honey, Harka, 2019.	55	1	3	0	41	152 484 867

Table 3

The rate of VOC components in acacia honey

	Aldehydes (%)	Monoterpenes (%)	Terpene alcohols (%)	Sesquiterpenes (%)	Other compounds (%)	All of peak area
Acacia honey, Botfa, 2017	10	63	27	0	0	19 407 329
Acacia honey, Bajna, 2017.	8	12	79	0	1	23 802 341
Acacia honey, Bajna, 2018.	60	6	26	0	8	12 035 560

Table 4

The rate of VOC components in multi-floral honey

	Aldehydes (%)	Monoterpenes (%)	Terpene alcohols (%)	Sesquiterpenes (%)	Other compounds (%)	All of peak area
Multi-floral honey, Bajna, 2018.	2	45	53	0	0	507 378 758
Multi-floral honey, Földes, 06. 06. 2019.	2	0	79	0	19	136 535 577
Multi-floral honey, Földes, 16. 07. 2019.	0	5	69	0	26	169 595 944
Multi-floral honey, Bajna, 2017.	0	51	18	0	31	264 949 909
Multi-floral honey, Botfa, 2018.	28	2	17	0	53	97 074 613
Multi-floral honey, UoS Botanic Garden, 2018.	26	0	26	18	30	63 600 466
Multi-floral honey, UoS Botanic Garden, 2019.	10	41	9	6	34	160 773 216
Multi-floral honey, Harka, 2019.	22	19	13	0	46	48 691 281
Multi-floral honey, Sopron-Somogy county, 2019.	1	85	13	1	0	397 537 741

Such as alpha-pinene, found in all of the sunflower samples and the presence of aliphatic aldehydes in acacia samples. Some of the detected components implied to floralsource, especially lavender (hexanal, heptanal), eucalyptus (diketone, alkanes, sulphur compounds) as well as dandelion and canola honeys. There are compounds such as alcohols, branched aldehydes and furan derivatives, which reflect the microbiological purity and processing-storage conditions.

In the polyfloral honeys sample from Bajna 2017 we found alpha-pinene, which refers that honeybees collected sunflower nectar also. However, in most of the investigated samples ho-trienol was observed, which can be formed from heat load of headspace analysis.

The effects of components to organoleptic features is determined by ratios and total peak areas. Thus, aldehydes from multi-floral honeys may play a role in formation of characteristic taste. Damascenone and its derivatives can be responsible for „honey-smell" (Plutowska et al., 2011), which was detected from the following samples: acacia Bajna, 2018; canola Sopron, 2019; canola Bajna, 2018; multi-floral honey Bajna, 2017, 2018; multi-floral honey Botfa, 2018; multi-floral honey botanical garden University of Sopron, 2018.

In multi-floral samples the following components were detected with relative high peak area: carvacrol, which has antibacterial and antiseptic feature, recline in thyme and oregano; mircene found in basil, hop or cannabis; nerol, which is a terpene alcohol, situated in elderberry; hexanal and heptanal aldehydes refers lavender.

CONCLUSIONS

The analysis of volatile compounds of honey samples revealed that the unifloral honey contain less VOCs comparing to multi-floral honey. Aldehydes and terpenes and their derivatives are the main ingredients of the indentified volatiles. Some components were analysed in the unifloral honey samples which refer to the presence of different floral sources. Many environmental and apiarian technology factors act on the evolution and composition of VOCs in honey. Thus, numerouos samples are nessesary for finding relationships between the origin of samples and VOC components.

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INFLUENCE OF ASPECT AND VEGETATION ON THE DIURNAL TEMPERATURE CONDITIONS

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ABSTRACT

Orography and vegetation can be important climate forcings from local to regional scales. Our case study focuses on the assessment of the microclimatic processes in a forested hill. First, we quantified the impact of orographic aspect and vegetation on the diurnal temperature cycle. In the Harkai-hill (close to the city Sopron), mobile devices were installed on the northern and southern slope of the hill. The precipitation time series originated from the weather station in Sopron. In the dormancy season (leafless canopy), in daytime (no rain), the southern slope was up to 5 °C warmer than the northern slope. In nighttime the northern slope was characterized by higher temperatures (by up to 2 °C). In the growing season (foliated canopy) the temperature difference between the slopes was smaller than for leafless canopy, for both daytime and nighttime. The results support our hypothesis that rainfall reduces significantly the temperature differences between the slopes, independently from the leaf coverage. These measurements provide useful information to the quantification of the microclimatic conditions and potential benefits of agroforestry systems.
Keywords: agroforestry systems, orographyc aspect, temperature, precipitation

INTRODUCTION

Based on the literature it is a well known fact that the topography and vegetation have a microclimate modifying effect (*Péczely*, 1984, *Szász et al.*, 1997, *Foken*, 2008), and the southern slopes of mountains and hills are warmer than those of the north. However, there is hardly any literature available to support this effect with measured data (*Mohammad*, 2008, *Zellweger et al.*, 2019). So far, there have been very few attempts in Hungary to measure the vertical temperature gradient on forested hillsides with opposite exposures (Vig P., pers. comm.). Microclimate measurements were carried out in the Matra Mountains (*Hargitai* 1957, *Kovács*, 1966), Nagymaros area (*Horánszky*, 1957) and in the Tornai Karst, with special focus on wood production and karst planting (*Jakucs*, 1954, 1959).

One reason for the lack of measurements is that these require special equipments and their proper implementation has large methodological difficulties. The existing results are therefore mostly in the form of lectures, conference abstracts, or oral presentations.

Similarly to forests, agroforestry systems are generally expected to have a favorable microclimatic effect, but their existence and magnitude have not yet been quantified in Hungary.

Therefore, in the frame of the EFOP-3.6.2-16-2017-00018 Agroforestry project, we started collecting meteorological data on a hill near Sopron. We aimed to quantify the diurnal cycle of temperature difference between the southern and the northern slope, and how this difference is influenced by vegetation and precipitation.

MATERIAL AND METHODS

The measurements were carried out on the Harkai-hill (*Figure 1*). The area is 2 km south from Sopron. The hill is unlikely influenced by the Sopron Mountains (*Figure 2*).

Figure 1

Case study area: Harkai-hill (close to the city Sopron)

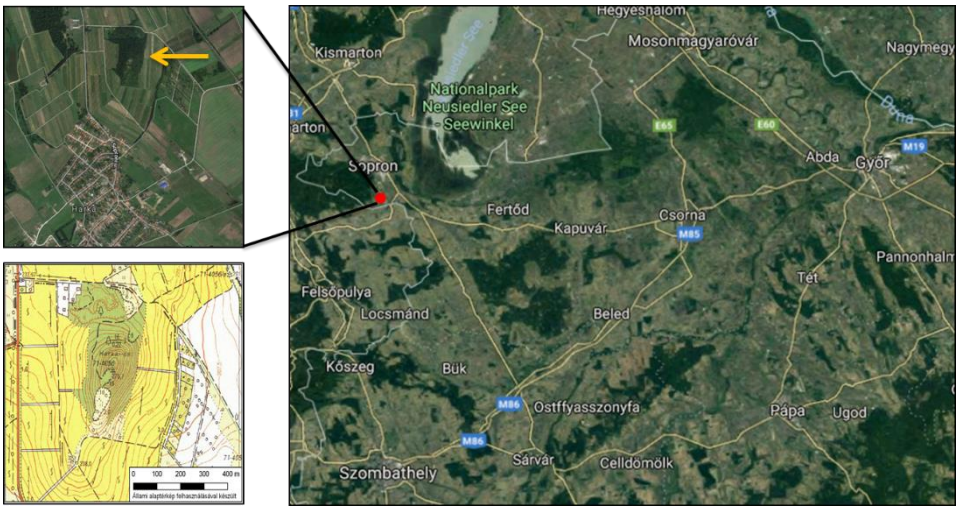
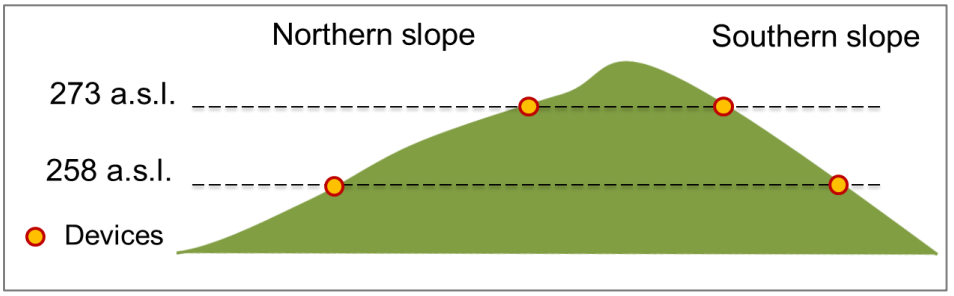


Figure 2

Schematic illustration of the installation of the devices



Voltcraft DL-121TH USB Data Loggers were installed on both the southern and northern slopes of the hill (*Figure 3*). Because of their small size and easy handling, these devices are optimal for our purpose. Temperature, relative humidity, and dew point data were collected in 10 minute intervals between April 1, 2018 and September 30, 2019. The daily and hourly average temperatures were calculated for the vegetation period and dormancy season, as well as for the warmest (July) and coldest (January) months.

Figure 3

Applied moble device

Furthermore, the mean and maximum temperature differences between the southern and northern slopes were determined. Finally, typical rain-free, rainy and extremely high-temperature days were selected, for which the temperature difference of the two sides was analyzed in hourly time step.

RESULTS AND DISCUSSION

First, the mean temperature difference between the southern and northern slopes was investigated for the whole measurement period and during the vegetation and dormancy seasons. On average, daily mean temperatures were 0.5 °C higher on the southern slope than on the north (*Table 1*). This is in line with our expectations, as during the day the southern slope is exposed to more radiation (warming effect) than the northern slope. The difference for the vegetation period is 0.1 °C lower than for the dormancy period (however, this is not a statistically significant difference). The highest daily mean temperature difference was observed in the dormancy season (2.0 °C; Table 1), and daily average difference values larger than 1.5 °C were only measured in the dormancy period between the southern and northern slopes. A possible reason for this phenomenon can be that due to leaf emergence, the southern side become less warm in daytime, therefore the temperature difference between the two sides is smaller.

Temperature differences were also analyzed in hourly time step. During daytime, the temperature difference between the two sides of the hill is always larger than at night (Figure 4). Average hourly temperature differences in the vegetation period and dormancy season supported our hypothesis, that the temperature reducing effect of the foliage is highest in the warmest hours (*Figure 4*).

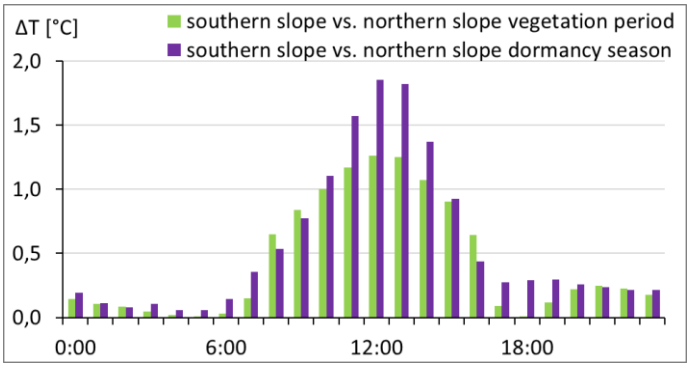
Table 1

Temperature difference between the southern and northern slope of the hill

	Average daily temperature difference (southern slope – northern slope) [°C]	Largest average daily temperature difference (southern slope – northern slope) [°C] and its occurence
Whole measurement period	0.5	
Vegetation period	0.4	1.5 (31.05.2018)
Dormancy season	0.5	2.0 (17.01.2019)

Figure 4

Temperature difference (ΔT) between the southern slope and the northern slope in the vegetation period and the dormancy season



On a rainless day at noon (dormancy season), the southern slope can be warmer by up to 5 °C than the northern slope. At night, the northern slope was warmer by 1-2 °C (Figure 5). This is also consistent with the relative humidity difference between the two sides, the warmer side is consistently the drier and the cooler side the wetter (*Figure 6*).

Figure 5

Characteristic diurnal cycle of temperature (T; left) and the difference (ΔT) between the southern slope and the northern slope (right) for a rainless day

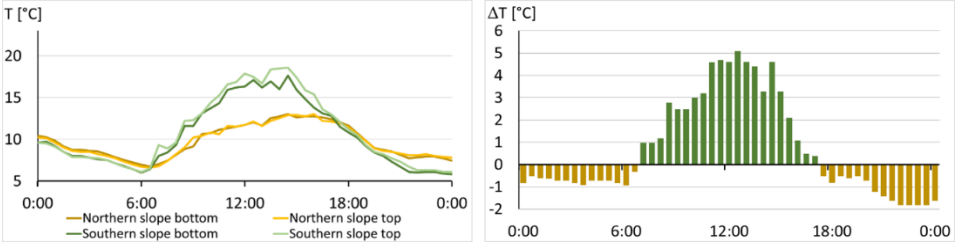
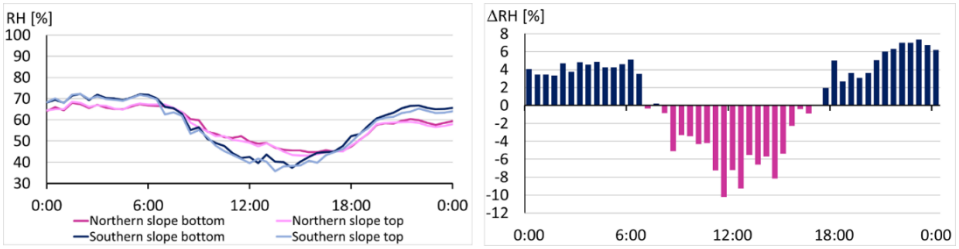


Figure 6

Characteristic diurnal cycle of relative humidity (RH; left) and the difference (ΔRH) between the southern slope and the northern slope (right) for a rainless day



On a rainy day, the temperature difference between the two sides is significantly reduced, and falls below 1 °C during the rainfall event (*Figure 7*). When the rainfall starts, humidity increases, relative humidity reaches 100%. Regardless of exposure, this value was typical for both sides of the hill (*Figure 8*).

Figure 7

Characteristic diurnal cycle of temperature (T; left) and the difference (ΔT) between the southern slope and the northern slope (right) for a rainy day

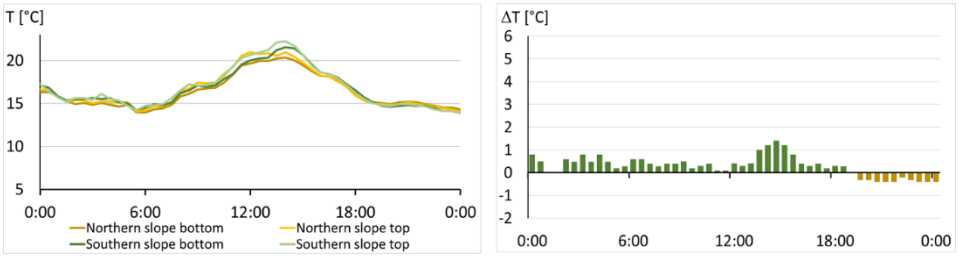
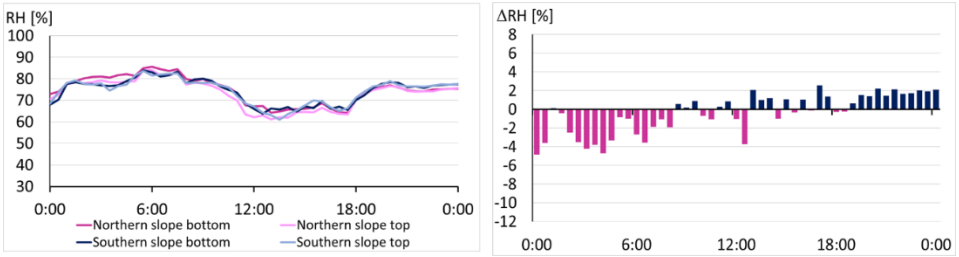


Figure 8

Characteristic diurnal cycle of relative humidity (RH; left) and the difference (ΔRH) between the southern slope and the northern slope (right) for a rainy day



We hypothesized that the temperature dampening or amplifying effect of exposure is the largest on days with extreme high temperatures. The highest daily mean in the Harkai hill during the investigation period was in July 26, 2019 (27.8 °C), and the daily temperature maximum on the southern side exceeded 35 °C. On the northern slope, temperatures were only up to 2-2.5 °C cooler. Results for the selected day show smaller effect than we expected. In our opinion, wind also can influence the magnitude of the temperature differences between the southern and northern slopes, but further investigations are essential to prove this.

CONCLUSIONS

Our study aimed to quantify the diurnal cycle of temperature difference between the southern and the northern slope of a forested hill, and how this difference is influenced by vegetation, precipitation and extreme high temperature.

The main findings are:

- The warming effect of exposure is the largest in the warmest hours of the day.
- For leafless vegetation, the temperature difference between the two sides of the hill is larger than for foliated canopy.
- On rainy days, the relative humidity increases, and the temperature difference between the slopes is reduced significantly, independently from the leaf coverage.

The measurements have uncertainties due to the uncertainties of the applied mobile devices. Thererfore we draw conclusions on the temperature difference between the slopes rather than on the measured absolute values. Longer time series on multiple sites are essential to better understand the processes, and to draw more reliable conclusions. However, such kind of measurements can be important for the forestry paxis. They can provide useful numerical information about the temperature mitigating effect of the northern slope on extremely hot days. These events are projected to be more frequent under future climate conditions.

From the point of view of agroforestry, information on the climatic and microclimatic conditions can support the selection of plant species that are able to adapt to the expected climatic change. Furthermore, it helps to propose agroforestry systems that have the most favorable microclimatic effects (humidity increasing, temperature reducing, and shading effect).

ACKNOWLEDGEMENT

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RIPARIAN ZONE FOREST AS AN AGRO-FORESTRY SYSTEM AND ITS WATER SUPPLY

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ABSTRACT

The word "riparian" means an ecosystems (generally forest) that are associated with bodies of water - dams, rivers, springs, streams and lakes. Among their many services, riparian zones: protect the quality of the water, stabilize stream banks and minimize erosion. Riparian zone forest is one type of ago-forestry systems. This vegetation belts have high water demand and they will likely be the most influenced by the changing climate. This study aims to describe the water balance of riparian forest especially focusing on surplus water use from groundwater. Driven by rising temperatures, increasing evapotranspiration demand in the future will probably induce enhanced groundwater uptake of those plant communities. Eventually this could lead to the lowering of the groundwater table. If this occurs, the existence of groundwater-dependent riparian zone forests will be questionable since tree roots will not be able to reach the additional groundwater source in the future. For handling the problem, the excessive water demand of that groundwater dependent forest can be supplied e.g. from the flooding waves of streams and rivers. Last, but not least a collection of studies was presented also about water supply experiments of forest in hungarian plains.

INTRODUCTION

Climate change will have one of the most significant impact on water cycle. Temperatures was predicted to increase even more 3 °C to 5 °C by the end of the 21st century. These effects will probably modify rainfall patterns and evapotranspiration processes at multiple scales (*Szilágyi and Józsa*, 2008). Extreme events like thunderstorms and droughts are expected to occur more often and such impacts will considerably affect forest ecosystems mostly in the forest/grassland transition zone (dry edge of the closed forest belt) (*Mátyás and Sun*, 2014).

Water cycle of forest

Significant portion of the rainfall in a forested area is intercepted by the canopy (canopy interception), from where the precipitation returns to the atmosphere through evaporation. Water that flows down along the stem (stemflow) or falls and drips through the canopy (throughfall) reaches the ground where another portion of it is intercepted by the forest floor through litter interception. The rest infiltrates into the ground and after flows downhill as subsurface runoff or is consumed by plants for transpiration. The remaining part either increases the soil moisture content or recharges the groundwater storage.

Surface runoff occurs if the amount of precipitation reaching the ground is greater than its infiltration capacity (but it is rarely happens in case of forested areas) (*Figure 1*).

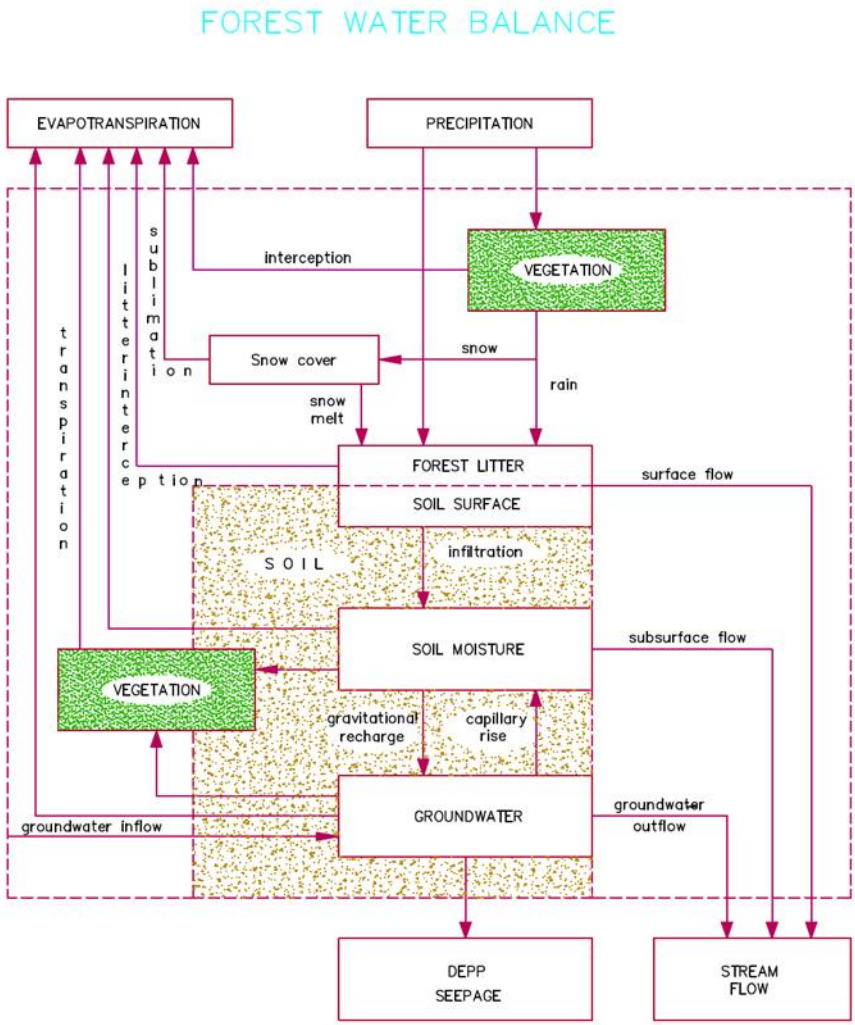
Based on the conservation of mass, the water balance equation of a forested area is the following.

$$P + p + Rin_{s,g} - I - T_{soil} - T_{gw} - Rout_{s,g} = dS \quad (1)$$

Where: P: fluid and solid macro-precipitation; p: fluid and solid micro-precipitation; $Rin_{s,g}$: surface and subsurface inflow; I: interception (canopy and litter); T_{soil}: transpiration from vadose zone; T_{gw}: transpiration from groundwater; $Rout_{s,g}$: surface and subsurface runoff; dS: change in storage.

Figure 1

Forest water cycle (after Kucsara 1996)



Precipitation

Macro-precipitation is the main source of water for forested areas. Climate change greatly influences the amount and spatiotemporal resolution of precipitation, which has a direct effect on the primary production of specific forest types. The presence of forests in the xeric limit area could also be affected. The possible influence of forests on macro precipitation amounts has been highly debated until now, but nowadays the complex-network analysis reveal direct connection between the forest evapotranspiration and the rainfall formation of the downwind areas. Lower amount of rainfall raises the risk of forest dieback, while in return deforestation might intensify regional droughts.

Interception

According to *Delfs* (1955), interception equals the amount of precipitation that is intercepted and evaporated back to the atmosphere by the canopy or any other aboveground vegetation. Interception loss varies between 10 – 40% depending on the type of forested ecosystem (*Dingman*, 2002). Neglecting interception when modelling the water balance of a forested ecosystem could result in a major miscalculation (*Savenije*, 2004). Interception is often only considered in terms of canopy interception, but a more comprehensive definition includes the sums of both canopy and litter interception.

According to *Járó* (1980) and *Führer* (1992), canopy interception rates in Hungary amount to 20 - 45% of annual precipitation. Generally, interception rates are higher in coniferous forests than in deciduous forests. Interception of forests with multi-layered canopies is higher than in single-layered ones. At similar canopy closures, the interception loss is higher for aged forests due to their bigger surface for evapotranspiration.

Litter interception does not necessarily have to be accounted for as interception loss since forest litter considerably reduces the evaporation of the underlying ground layer. In the United States, the annual litter interception was estimated to be 1 - 5% of the annual precipitation (*Helvey and Patric*, 1965) whereas in a sessile oak forest in west Hungary this value varies between 5 - 7% according to *Zagyvainé et al.* (2014).

Transpiration and Groundwater

Transpiration is an evaporation-like process controlled by similar factors, but transpiration occurs on a different and, usually, larger surface where surface resistance plays a more determinative role (*Lee*, 1980). Relative to other vegetation types, the roughness and leaf area index of a forest determines its transpiration demand, which is increased by both factors. The root system of forested vegetation reaches deeper soil layers with higher water storage capacities making them less vulnerable to extended dry periods.

As long as the available amount of water does not limit it, transpiration rates will increase as temperatures increase. Soil moisture content supplies the water demand of forests in mountain and hilly areas; therefore, water storage capacity of soil is a crucial factor in overcoming the water stress of dry periods and securing the long-term viability of a forest. The required volume of the moisture storage space depends on the rooting depth and physical properties of the soil.

In semi-hunid climate of the Hungarian Great Plain where precipitation is generally inadequate to support woody vegetation; trees there survive drought periods by utilizing groundwater resources. Groundwater are especially important for riparian forest vegetation, therefore this topic is dicussed with more detail.

Major (2002) has reported that under a middle-aged pine forest in the Danube-Tisza Sand plateau region the groundwater was on average 0.8–1.1 m deeper than in the surrounding non-forested areas. On average, this forest uses 130 mm more water than it receives from precipitation annually.

Gribovszki et al. (2014) compared the groundwater balance of two neighboring plots (a common oak forest and a pasture) in a sandy soil environment. The water table under the oak forest was 0.44 m lower, and the groundwater uptake of the oak was more than twofold in the very dry summer of 2012. The larger groundwater use of the forest was not parallel with salt uptake; therefore, salts accumulated in both the soil and groundwater. The measured differences in salt content, however, were small when compared to similar research results for clayey soils (*Nosetto et al.*, 2007).

Móricz et al. (2012) compared the water balance of a lowland common oak forest and a neighboring fallow in the northeastern part of the Hungarian Great Plain (Nyírség). Measurements showed that oak forest had approximately 30% more evapotranspiration than fallow. Groundwater use difference of the vegetation types was even more significant (threefold).

Driven by rising temperatures, increasing transpiration demand in the future will likely induce an enhanced groundwater uptake by plant communities. Eventually this could lead to the lowering of the groundwater table and salt accumulation. If this occurs, the existence of groundwater-dependent forest communities will be questionable since the root structures of younger forests will not be able to reach the additional water source. Surplus water demand of that groundwater dependent forest can be supplied by the flooding waves of rivers.

Water supply studies

Large river flooding waves can be a source of riparian forest water supply in Hungarian Great Plain. Water supply of a large forest compartment was employed in the 1990-s in the area of Mályvádi flood conrol reservoir (Békés county) along the Fekete-Körös river.

The riparian forests along the River Fekete-Körös were separated from the river by dykes during the river regulation works (19th century). Groundwater conditions were worsened in the outside protected area. Restoration of the river connection and the floodplain watercourse network provide surface water supply from the backwater of flood waves to 2000 ha forest. The result of the interventions was 38.8 km long water-flow and a free water surface of 15.7 ha. Positive ecological impact of the water supply can be detected on more than 400 hectares forest area (*Puskás*, 2006).

The Gemenc floodplain, located along the lower reach of the Hungarian Danube, is one of the largest continuous floodplain forests in Europe, covering 18,000 hectares. River regulation works have shortened and narrowed the river channel. The higher water velocities (induced by river regulation) and lower sediment transport (reservoir sediment retention on the Upper Danube) lead to the incision of the riverbed. In paralell with incision and aggradation (sedimet settling on the floodplain arae) processes significantly reduced the frequency and duration of inundations, which triggered the vegetation change from hydrophita azonal forest to drough tolerant species. To counteract the negative ecological impacts of the hydro-morphological changes the following technical restoration were implemented in frame of the GEF (Global Environmental Facility) project in the 2010s.

- Increased the size of water bodies by means of weirs or bottom sills that retain water on the floodplain after the floods.
- Dredged the beds of the water bodies to increase depth and water volume.

Above mentioned interventions enhanced the ecological status of riparian vegetation on short time scale, but on longer run can not completely prevent those ecesystems from the negative effects of the river regulation works (*VTK Innosystem*, 2009).

In the middle of Somogy county (South-west Hungary) there is a valuable forest called Kaszó. The area was characterized by groundwater level recession in the last decades caused by water management/drainage and climate change impacts.

Specific objectives was the KASZÓ-LIFE project to improve the water supply of the forests, smaller swamps and grasslands using the following water supply activites:

- bottom tresholds settled perpendicular to the flow direction of the ephemeral stream system;
- heightened the dams of reservoirs, and built new reservoirs (*Eötvös and Horváth*, 2018).

Monitoring groundwater wells showed 40-50 cm water table rise (compered to control wells), in the neighbourhood of the new lakes. The effects of the bottom tresholds was not always significant (*Szőke et al.*, 2019).

CONCLUSIONS

High water demand of riparian forest in the changing climate can be supplied using groundwater replenishment from flood waves of rivers and streams. All in all it can be stated that water supply interventions have a general positive impact on riparian forest ecosystems not only from ecological but also from economical point of view.

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SHRINKAGE AND SWELLING EXAMINATIONS OF LONGITUDINALLY COMPRESSED WOOD

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ABSTRACT

With longitudinal wood compression (aka. pleating), a material can be produced that can be bent to a greater extent with less force compared to other common wood-bending technologies, and it has of course different properties than untreated wood. Using this technology, wood retains its pliability even at room temperature over a long time, when it is stored properly. High-density hardwood species are the most suitable for pleating. The process requires high-quality, defect-free wood, otherwise the compression can not be performed properly, or problems may occur during bending. Tests were carried out on oak and beech, wood species which are frequently used both for pleating and bending, with optimal compression ratio and fixation time as defined in previous studies. Because wood can show significant differences in its mechanical and physical properties even within one species, samples were taken from the same section of a tree trunk to eliminate this problem. The examination of shrinkage and swelling of the specimens was performed according to the relevant Hungarian (MSZ) and international (ISO) standards. During the tests, the dimensional changes of compressed wood were compared to the dimensional changes of the untreated specimen groups. In the course of wetting and drying, compressed wood has significantly greater deformation in the longitudinal direction, compared to untreated wood. This result suggests the limits of the potential use of compressed wood, furthermore the results shows the possibilities for further researches to reduce the deformation of longitudinally compressed wood.

INTRODUCTION

The need for curved elements has been present in the furniture industry for thousands of years. Steam bending has long been known in the manufacture of single-piece bent solid wood components. Its industrial application and serial production technology was developed by Michael Thonet in the mid-19th century. From this time, bendable wood and products made of it were of importance in the industry and in large mass production. In this process, the wood is steamed or cooked, causing it to soften, making the material easier to shape. Attached to a template, it retains the desired shape after cooling. The disadvantage of the technology is that the wood can only be formed at temperatures above 80 °C and loses its formability after cooling. Due to the great demand for products made from bent wood, it was necessary to develop, simplify, and create new technologies which produce materials that can be shaped at lower temperatures for a longer period of time, and which can be bent with less force and simpler tools. Most of these properties were mainly specific to the longitudinally compressed wood and its processing technology, which was patented in the early 20th century. Since then, continuous improvements have been made, but the principle has not changed. The industrial application of longitudinally compressed wood was made possible by

the creation of the right machine, nearly a century and a half after the advent of Thonet technology.

This wood modification method is usually used mainly on high-density deciduous species. Low-density deciduous species studied are less or not suitable for compression and little research is available in their case. Among wood species studied for longitudinal compression, conifers are the clear exceptions. Conifers cannot be compressed longitudinally, since the earlywood tracheids are inclined to micro-buckling and fiber rupture resulting in failure of the material on the macroscopical level, rather than longitudinal compression (*Iványovics*, 2012). Mostly beech has a significant role in the industry in terms of compression and bending, but longitudinal compression can be applied to both ring-porous and diffuse-porous species. In order to ensure that the research is representative in case of both groups, the tests were also carried out on oak wood. Aside from the wood species, the material to be compressed must meet a number of quality requirements. This wood modification process can only be carried out on defect-free wood material in order to achieve appropriate quality. The reason for this is first of all: the compression itself. If the fibers are not parallel to the sides of the compressed material, the wood may split along the fiber direction during compression, or later, during the bending process, fiber rupture may occur. A slight fiber slope is allowed, with maximum value of 7°, in this case, the wood can be compressed and bent in a satisfactory quality. The non-uniformity of the fibrous structure is also a disadvantage, since it may be unevenly compressed, this way the flexibility of the finished product may vary along the length. The presence of small knots does not affect the ability to compress the wood, but can lead to fracture during bending. Red heartwood significantly restricts compression, and since compressed wood is a high value-added product, red heartwood and other aesthetic flaws are unacceptable. Another important factor is the moisture content (*MC*) of the wood to be treated. For the raw material, it is ideal to have it freshly-cut, green state, but it is also possible to compress wood with lower initial *MC*. A minimum initial *MC* of 16% is required at each point of the sawn timber (*Kuzsella et al.*, 2011). *MC* is of great importance both before and during compression. The wood must be plasticized before the process. This is typically done by steaming in this technology. Wood can only be plasticized in the presence of sufficient moisture. For this, the presence of steam is not sufficient, it is necessary that moisture be in the wood in the right amount and form. Water can be present in wood in four ways. Free water, which can fill the lumen in the form of a liquid, water vapor also in lumen, bound water that binds to the cell walls and can be removed by drying, and water bound to the chemical components of wood (*Németh*, 2002). The point at which the bound water in the wood reaches its maximum but no free water is present, is called the fiber saturation point. During compression, the wood must be close to the fiber saturation point, otherwise it may not be compressed properly. Prior to compression, the wood is the same as that used for Thonet technology in terms of fiber softening. The time required for this is affected by the wood species, *MC*, and to a large extent, the size of the wood to be treated, in particular its cross-section. The purpose of steaming is to heat the entire cross-section evenly and plasticize. After steaming, the properties of the wood change, by maintaining the appropriate temperature, the wood can withstand the fiber compression without visible structural damage. Lignin in the wood is most important in case of plasticization, but hemicelluloses also play an important role. Lignin fills the intercellular region in the wood, forming the so-called middle

lamella. The role of lignin is responsible for the joining of the wood components and for the stiffness of the wood. Lignin is attached to the outermost part of the cell wall. The bond between the crystalline cellulose and the amorphous lignin is provided by hemicelluloses forming the outer part of the cell wall. During steaming, the bonds between the lignin and the other elements are broken. This allows the wood to be bent and compressed so that its fibers can move side by side and then stabilize when cooled. The maximum plasticity of the wood is reached at a *MC* of 25-30% and a minimum temperature of 70-80 °C, with minimal degradation of the components.

The aim is to longitudinally compress the wood evenly over the entire length and cross-section, so that the finished product will have uniform properties over the entire length. During compression, the timber must be supported on the sides to prevent bending. The compression force is also transmitted to the supporting sidewalls because the resulting frictional force would prevent the wood from being compressed uniformly over the entire length. The easiest way to prevent this is if the sidewalls, with the wood, can move or are slippery. This method ensures even compression throughout the length. It is important that the wood remains in the range of 80-100 °C during treatment, otherwise it will lose its deformability. To avoid this, heated sidewalls are always used or the equipment is preheated with steamed wood. During the process, the wood changes only along its length, its cross-section is constant or the degree of change is negligible. During compression, the fibers of the softened wood move side by side or the cell walls are folded like an accordion. Based on this phenomenon, the short name of this modification is pleating. During the compression, the weakest part of the wood undergoes changes first, and as the ratio of compression increases, the previously uncompressed material also changes. With a compression ratio of 20%, the walls of the tracheids and other components are buckled in the entire material. During the process, the material may also penetrate into the lumen, which ensures that the cross-section remains constant at higher compression ratios (Báder, 2015). In the case of longitudinally compressed wood, the combination of creasing of the cell walls and the displacement of the fibers provide easier bending, beside proper humidity and temperature.

Compression can be done in any length and cross section if proper support and pressure are provided. This hygro-thermo-mechanical wood modification process can help produce a variety of materials with planned properties. In order to achieve these, changes can be done in case of the compression ratio and the fixation time (pressing time after compression). The compression velocity could also be a variable parameter, but it is advisable to keep it at the optimum value, otherwise damage to the wood could occur or the treatment would take an unreasonable amount of time. By increasing the compression ratio, the bendability of the wood can be increased. Of course, there are physical limitations to compression. The generally accepted compression ratio is 20%, at which the wood, despite its anisotropic properties, undergoes uniform changes in all parts, even for beech and oak species. It is possible to differ from this, depending on the property of the material we want to produce or the wood species we are working on. The maximum ratio is typically 30-32%. By changing the fixation time, the final deformation of the wood can be controlled. With a short fixation time, the wood springs back to a greater extent and the final deformation is significantly less than that compressed on the wood during treatment. In this case, a hot and wet material is obtained that can be bent immediately after compression. This material is easy to shape and retains its

shape after cooling and drying. Increasing the fixation time can increase the amount of permanent deformation. Compressing the wood and then fixating and cooling it at the appropriate humidity, keeping it cold and properly stored, can be bent and stored in shape in the long term. It retains the desired shape after drying. In this case, the final deformation, depending on the species of wood, may even approximate the ratio of the change suffered during compression.

Regardless of the treatment, the material undergoes the same process during bending. The outer part of the bent material is subjected to tension while the inner part is subjected to compression. The wood is capable of withstanding significantly greater deformation under compression, so the failure during bending occurs in the outer part. In case of both steam bending and longitudinally compressed wood, the bending strength can be increased if the outer part is supported by a metal band, in which case the neutral line in the material is shifted toward the outer side, thus allowing greater bending without breaking. During bending, in the outer part of compressed wood material, first the creased cell walls straighten, and only after that are the cell walls subjected to tension. As a result, longitudinally compressed wood can be bent without any significant failure compared to steamed wood. The compression also changes the physical and mechanical properties of wood. Because the cells have been destroyed to some extent compared to their original state, they have a different load-bearing capacity and are less capable of resisting it. Resistance to static loads is reduced as the damaged cells are able to absorb less force and do so with greater deflection. However, it bears much more dynamic load. This indicates that the longitudinally compressed wood is easier to shape, but cannot be used as a structural supporting element.

The modulus of elasticity can be determined if we know of the bending stress and its specific deformation. It is a characteristic parameter of the material and its extent is given in the first, linear section of bending. Its value can be used to make conclusions regarding other material properties. In case of longitudinally compressed wood, the modulus of elasticity is significantly reduced compared to untreated wood, so it can be seen that this material is able to bend more under the same stress, and it is easier to shape. At a compression ratio of 20%, the modulus of elasticity decreases to one third and to half in case of beech and oak, respectively (*Kuzsella*, 2006).

The bendability of materials depend on a lot of factors, also in the case of longitudinally compressed wood. This includes the compression ratio, the fixation time, wood species and *MC*, since regardless of technology, wood can only be bent properly in the presence of moisture. Pliability is characterized by the ratio of the thickness the inner radius of curvature of the wood material. This can quantify the difference between treated and untreated materials. All compressed wood materials have better bending properties than untreated or steamed wood. Both bending radius and bending force are reduced so that the material will be easy to work with. However, bending large cross-sections still requires considerable force to achieve the desired result. For untreated beech wood, the bending ratio is 1:15. This can be optimized to 1:5 at a compression ratio of 23%, and a heating to 80 °C gives a 1:4 value (*Báder*, 2015). This is a good representation of the increase in flexibility due to longitudinal compression.

When shaping longitudinally compressed wood, templates and clamps are used to bend and fix the wood material, just like in the case of Thonet technology. Machining is not

different from untreated wood, it can be sawn, planed, glued, sanded and surface treated the same way. The advantage of bent wood is that it results in less waste than any curved solid wood technology. Compression means less chance of wood failure and easier bending at a smaller curve.

MATERIAL AND METHODS

The shrinkage and swelling test was performed on oak and beech wood. These species are often used for bending and for wood compression. Beech is diffuse-porous, oak is ring-porous, both are deciduous species, so the change of dimensional stability due to longitudinal compression can be examined. The test was carried out in accordance with the guidelines of the relevant international (ISO) and Hungarian (MSZ) standards.

The shrinkage and swelling results of wood treated with two different compression methods were compared to untreated and steamed wood. One group was compressed, the other was compressed and fixated, just like it was previously described. The compression ratio was 20% in both cases. The compressed samples were held compressed for one minute after compression, and consequently, the wood sprang back with a significant degree. In case of compressed and fixated samples, the fixation time was significantly longer, 18 hours. In this case, the final deformation is greater.

For compression, 30 × 20 × 200 mm^3 samples were cut from green wood material. From these, it was possible to produce small specimens for the study of shrinkage and swelling. During the tests, the specimens were dried for several periods, then conditioned at 20°C and 65% relative humidity, and then finally soaked in distilled water. The values obtained were used to determine the ratio of shrinkage and swelling in case of each period. To reduce the anisotropic properties of the wood, the specimens were made of the same section of the same log. This ensures that changes in treatment play the major role in the measurements.

Previous studies have shown that compressed wood tends to retain to its original shape when exposed to moisture (*Báder*, 2015). This means that the maximum deformation ratio in the longitudinal direction increases significantly. The ratio of dimensional change is influenced by the fixation time, which is related to the final deformation. Thus, the deformation of compressed and fixated wood is the largest among the tested materials, but also there are significant differences in longitudinal direction if untreated wood is compared to compressed wood which was fixated for one minute.

RESULTS AND DISCUSSION

As a result of pleating, many properties of wood change significantly: micro- and macroscopic properties, physical and mechanical properties of wood change as well. The relationship between wood and water plays a major role, just like in the case of untreated wood. Wood, as an anisotropic material, undergoes varying degrees of dimensional changes under the influence of moisture under the fiber saturation point. The greatest deformation is in the tangential, then the radial, and finally the longitudinal direction; the percentage of deformation in the same order for beech wood is 11.8%, 5.8% and 0.3%, while for oak it is 7.8-10.0%, 4.0-4.6% and 0.4% (*Molnár*, 1999).

The treatments resulted in varying ratios of dimensional change in the different anatomical directions. Differences between beech and oak are visible, and the shrinkage and swelling properties show the same pattern in transversal direction within the species. For both types of wood, compression causes identical changes. As a result of the treatments, the transversal shrinkage and swelling properties changes only slightly.

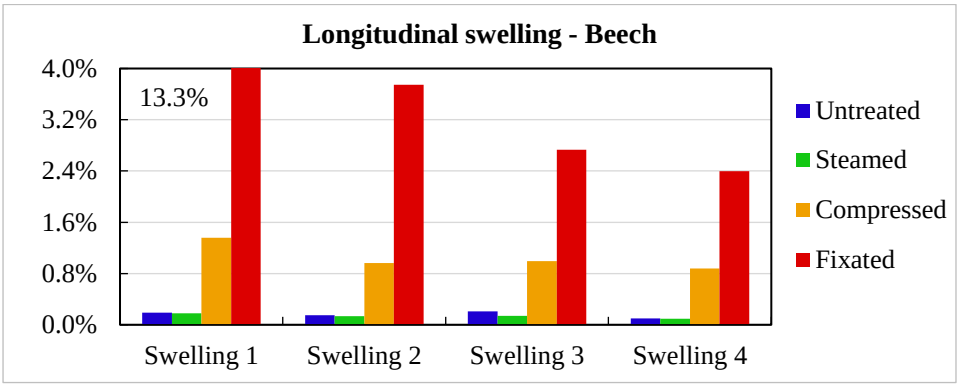
In case of beech, dimensional changes in radial direction show similar changes for the different treatments. The shrinkage and swelling properties of the untreated wood are equal or slightly less than the literature values. Steamed wood has the highest value in all cases, followed by compressed, then untreated wood. Compressed and fixated wood has the lowest value. During the cycles, the results show an increasing trend, but to varying degrees. As a result, by the end of the cycles, the swelling of the compressed and fixated wood is equal to that of untreated wood, or even in the case of shrinkage. The tangential change of beech wood is similar to the radial direction. The shrinkage and swelling properties of the untreated wood are equal or slightly higher than the literature values. The value of the untreated specimen in the fourth measurement cycle is 12.1%. Also in this case, steamed wood has the highest values in the measurements, followed by compressed wood by a few tenth of a percent, and then compressed and fixated wood. In this case, the value of the fixated wood does not reach the value of the untreated specimen, and also the difference of the compressed and fixated specimen is more significant during the first cycle compared to untreated wood. During the cycles, the values of the specimens fall between 9.7% and 13.0%.

Similar changes can be observed for oak wood. The significant difference here is that shrinkage and swelling of steamed wood does not increase, rather decrease. In all cases, the radial change in untreated wood is a few percent higher than the literature value of 4.0-4.6%. Compressed and untreated oak wood has the greatest shrinkage and swelling values during measurement cycles. In some cases, the value of the compressed specimen is slightly greater or equal to that of the untreated wood. For oak, the compression and fixation results in a greater degree of change compared to beech. During the first cycle, the dimensional change of the untreated specimen decreases by almost half, whereas in the case of beech, the reduction is only a little more than 10%. In the case of compressed and fixated wood, it is clear that longitudinal compression reduces the shrinkage and swelling of the wood. Similar to beech, during the cycles, the difference between the untreated and the compressed and fixated specimens decrease, but in the fourth cycle there is a significant difference between the two values. Also similar to beech, that the change in the tangential direction follows the radial changes. Here, the values of compressed and fixated specimens show a greater change compared to untreated specimens, too. The dimensional change is less than half in case of compressed and fixated wood compared to untreated, in the first cycle. Due to periodic soaking, these values also increase, by 30% by the end of the fourth cycle.

The change in shrinkage and swelling of treated specimens in their longitudinal direction is much more intense compared to the change in the transversal directions and significant changes can be observed over the cycles. When examining the radial directions, shrinkage and swelling had similar tendency, but in this case, it was not always clear. For longitudinal swelling of beech wood there is a significant difference between the values of compressed and untreated specimens (*Figure 1*). In this case, steaming does not cause any visible change. There is also a significant difference between the swelling of the compressed and compressed and fixated material.

Figure 1

Swelling of Untreated and Treated Beech Wood Over Several Measuring Cycles



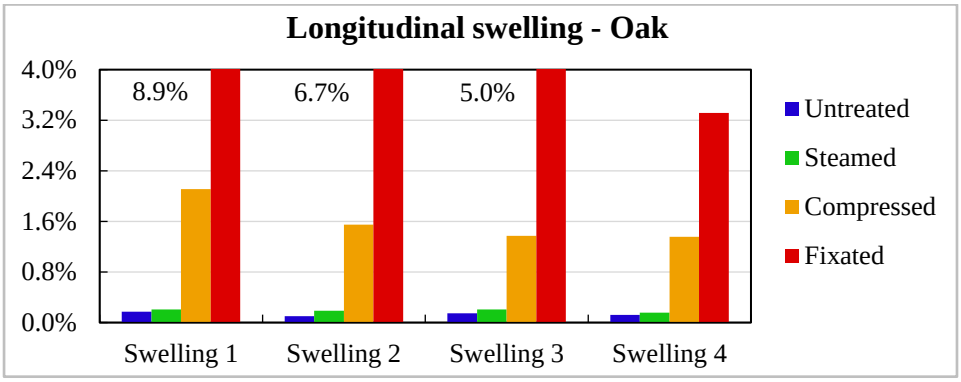
The values of untreated wood are in all cases a bit below the literature value of 0.3%. The values of compressed, and compressed and fixated specimens are significantly higher than those of untreated specimens. The swelling of compressed and fixated wood is 66.5 times higher than that of untreated wood. The value of the untreated specimen in this case is 0.2% and that of the fixated is 13.3%. This is significantly reduced by the periodic soaking and drying in the first cycle, later the magnitude of this change significantly reduces. The swelling of compressed wood at the beginning of the measurement cycle is seven times than that of untreated wood. These differences are reduced by the end of the measurement cycles, but are by no means insignificant during the fourth cycle. In this case, it is noticeable that after a few cycles the swelling value begins to reach a constant value. At the end of the fourth cycle, the compressed wood had 9x, the compressed and fixated wood had 22× higher swelling value than that of the untreated specimen.

The longitudinal shrinkage of beech shows a different pattern from the swelling, but to some extent the reduction in deformation can be traced. Here again, the longitudinal shrinkage values of the untreated specimen remained below or at most equal to the literature value in each cycle. In any case, shrinkage of compressed and fixated beech wood does not have such high values as the swelling of compressed and fixated or only compressed wood. The values are 2.2% in the first, 1.6% in the second, 2.4% in the third, and 1.9% in the fourth cycle for compressed and fixated wood. From this, it can be seen that there is no clear reduction in the cycles studied. The value of shrinkage is smaller compared to swelling, but at best it is more than five times than that of untreated wood. In the case of compressed wood, the rate of shrinkage and swelling gradually decreases over time. The shrinkage decreases from 1.2% to 0.8% in the cycles tested. At the beginning of the cycle, similar to swelling, there is a greater change. Based on the results of the last two cycles, it can be said that it is approaching a constant value.

The longitudinal swelling of oak specimens follows a similar pattern to beech. Here, the results of the compressed specimens also follow a downward trend. The difference is large compared to both untreated specimens and literature values. The changes in untreated wood correspond with the literature values (*Figure 2*).

Figure 2

Swelling of Untreated and Treated Oak Wood Over Several Measuring Cycles



It is interesting to note that for untreated wood, oak has a greater longitudinal swelling than beech, but not in the case of compressed and fixated specimens. At the beginning of the study, beech had a swelling value of 13.3%, while it was 8.9% for oak. A gradual decrease can also be observed for compressed specimens, similar to beech. The highest value at the beginning of the cycle is 2.1%. This is 10.5x the value of the untreated specimen. By the fourth cycle, this value will drop to 1.4%. Here, the value of the third and fourth cycles is the same. The longitudinal shrinkage values of oak specimens show a similar tendency to beech during the cycles. At the beginning of the cycle there is a significantly low value. The changes in the cycles do not follow a clearly described tendency. The maximum shrinkage for fixated wood is 3.5%. Compared to beech, a decreasing tendency can be observed for compressed wood, but the degree of change is not as large as in the case of swelling. Here, the longitudinal shrinkage of compressed oak wood decreases from 1.6% to 1.2% by the fourth cycle.

The data presented clearly point out the problems of longitudinal deformation of the wood. The treatments applied result in different changes in different anatomical directions. The change in shrinkage and swelling values in the radial and tangential directions during periodic soaking is not considered significant compared to untreated wood. This change is not problematic from the usage point of view, since in this case the difference is not large and due to the anisotropic properties of the wood it can be said to be close to the literary values. Nonetheless, dimensional changes can be traced well to the types of treatments for both species.

The ratio of longitudinal changes, in contrast to transversal changes, is considerable. Depending on the wood modification method used, the treatment can increase the longitudinal swelling of the wood by up to two orders of magnitude during the first measurement cycle. Examination of longitudinal changes clearly shows that shrinkage and swelling properties of compressed wood cannot be characterized by a percentage value, but the whole process must be considered. The longitudinal shrinkage and swelling of compressed wood changes significantly during measurement cycles. Particularly in the case of compressed wood, the value of shrinkage and swelling decreases during the measuring cycles, reaching a

constant value. This suggests that, for a sufficient number of measurements, the values of compressed and compressed and fixated wood would be close to constant. The greatest changes were observed in the first cycle. This is obvious when examining the longitudinal direction, but it can also be observed both for radial and tangential directions. The fact that wood has lower shrinkage and swelling values in transversal directions than untreated wood suggests that, due to the wrinkled fibers, the deformation that would normally occur in the transverse direction also appears in the longitudinal direction. The increase of radial and tangential values, as well as the decrease in longitudinal values due to periodic soaking, clearly indicate that wood is trying to restore its original form, and accordingly it is capable of extreme longitudinal deformations. Lower longitudinal shrinkage values relative to swelling during cycles also support this. After pleating, wood still has a memory effect. This is true not only for longitudinal change but also for bent elements.

The differences between the results of beech and oak wood are due to the characteristics of the species. Compressibility is specific to wood species, so modification of other species may cause slight differences. Nevertheless, it can be observed that in the case of treatments with large permanent deformation, the same change is caused by the compression and fixation of the wood for both species. It is a high added-value material, so it is unlikely to be used outdoors, so the material is not expected to be exposed to extreme conditions during use, but pleated wood also reacts to the humidity of the environment, and this can cause problems in case of different manufacturing and installation climates. This property of wood is not a problem in for untreated wood, as longitudinal shrinkage is small and proper structural designs are known in the furniture and construction industries to overcome the difficulties of radial and tangential changes. Longitudinal compression changes many properties of wood, making it more plastic, deformable and bendable in the presence of moisture. The condition of keeping the form is the drying of the wood. With the uptake of moisture, the wood is once again becoming more plastic, which means that, in order to stabilize it, further research into reducing the moisture sensitivity of pleated wood may be advisable. Because moisture uptake results in shrinkage and swelling of wood, any treatment that reduces the amount of free hydroxyl groups present in the wood, can help increase and facilitate the utilization of pleated wood.

CONCLUSIONS

The purpose of longitudinal compression is to make the wood easier to bend and shape. Accordingly, this wood modification process modifies many properties of the wood. Along with significant changes in the strength values, the longitudinal shrinkage and swelling of the wood is also greatly modified. The topic of this article is to introduce this. The tests were carried out on two species, beech and oak. In the case of industrial wood bending, beech has a major role, but longitudinal compression can be performed on several species of wood, so the effect of the treatments on ring-porous species can be characterized by the examination of oak.

Longitudinal compression increases the longitudinal shrinkage and swelling of the wood, and shrinkage and swelling values do not match in the particular anatomical directions. The results of the tests have shown that the length of compressed wood increases during the soaking and drying periods, so that the longitudinal swelling values at the beginning can be very high, up to 10%, which negatively affects its usability.

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CHANGES IN EGG VOLUME AND EGG WEIGHT DURING EGG PRODUCTION PERIOD BY GREY PARTRIDGE (*PERDIX PERDIX*)

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ABSTRACT

In Hungary, hand-rearing of winged game, especially pheasant and grey partridge, is a well-known management form of small game management. In the latest decades the intensive hand-rearing methods are the domineering procedure. Well-known phenomenon that egg size varies greatly within many avian species. Many researches pointed that variation within species is greatly high but within clutches the flexibility is altered depending on species, clutch size, laying date or sequence of egg. We have only a few information about winged game species egg mass alterations. For new information we manage egg produce stock population in fenced circumstances and these stock population produce for our investigation hatching eggs. During our investigations we checked the main data of the eggs: laying data, weight, width, length and from these data we calculated the egg volume and egg shape index as well. We have exact data from each partridge female eggs. During egg production period (lasts about 90-100 days, respectively) we found in general weight and volume increasing tendency by grey partridge, but only by a few breeding pairs were this growing significant. These data provide new information about egg production and serve new possibilities for renewing intense technologies of winged game management.

INTRODUCTION

In Hungary, hand-rearing of winged game, especially pheasant and grey partridge, is a well-known management form of small game management. In the latest decades the intensive hand-rearing methods are the domineering procedure (*Jánoska*, 2016; *Bagi et al.*, 2018). In 2017 hunting year, more than 600000 pheasants and about 12000 partridges were released to hunting territories in Hungary, more than 85% for hunting purposes (*Csányi*, 2018). During intensive captive rearing the breeding pairs of grey partridges are usually in the first year of their life. The selected breeding pairs originated from the first artificial hatching of the previous year, that is, the breeding pairs come from the very first eggs of past capture-brereding population (*Androvicz*, 2013).

Egg size is a widely studied trait and yet the causes and consequences of variation in this trait remain poorly understood. Egg size varies greatly within many avian species, with the largest egg in a population generally being at least 50% bigger as the smallest, or even twice as large (*Christians*, 2002). Intraclutch egg size variation is probably a mechanism of female birds to modulate reproductive effort and offspring quality (*Gibson and Williams*, 2017), especially by altricial bird species. However, different species showing dissimilar figure of laying-sequence-specific egg size, e.g. Goldcrest, *Regulus regulus* (*Haftorn*, 1986) increase egg size with laying sequence whereas other species (e.g. European Starling, *Strunus vulgaris*) decrease egg size with laying order (*Gibson and Williams*, 2017). At the same time, by other

altricial species researches found no relation between egg mass and position in the laying sequence, e.g, by blue tit (*Nilsson and Svensson*, 1993). In many species of passerine birds egg size increases with the laying order, and this phenomenon is indeed difficult to give a reasonby means of the brood-reduction hypothesis (*Clark and Wilson*, 1981; *Slagsvold et al.*, 1984).

Pheasant and grey partridge are precocial bird species. In precocial species egg laying and incubation are important stages of reproductive investment, and may perform critical energy bottlenecks, particularly in harsh environment conditons (*Shi et al.*, 2019). *Magrath* (1992) advised that egg mass might have a greater effect on chick survival in precocial than altricial species (with relatively little investment in egg production). It is evident, the mass and composition of an egg have considerable impact on the successful development of the embryo and may infuence the subsequent survival of the hatchling (*Finkler et al.*, 1998), especially in precocial bird species. Volume and fresh egg mass are generally highly correlated (*Reid and Boersma*, 1990).

Our target was to analyse the egg mass alteration during laying period in hand-reared grey partridge, a precocial species characterized by fairly large clutches.

MATERIAL AND METHODS

Examinations were carried out in three ensuing years (2016-2018) during the reproductive season of grey partridges (March – July) on the Botanical Garden belonging to the University of Sopron. Mean birds were chosen from the gaggle each year for the egg-productive season. During winter months, birds were fed entirely wheat grain. From Mid-February wheat was gradually replaced by complete nutrition which contained: 16,4 % crude protein and 11.05 MJ ME and 2.49 % calcium, so that by March 1st, it was the only feed fed ad libitum.

Partridge pairs were placed in open-air wire cages (1×1 m, respectively). Breeding pairs of partridges we formed about Mid-March. We investigated 10, 12, 15 breeding pairs of grey partridges in 2016-2018, respectively.

When hens started laying we gathered the eggs by late afternoon each day. We marked each egg with a non-toxic permanent marker pen (date of laying, the number of partridge hen). Because of methods of egg producing, we have exact data from each partridge female eggs.

Just after collection eggs were weighed to the nearest 0.01 g with a digital balance. Egg breadth and length we measured with a digital caliper to the nearest 0.01 mm. Egg volume we calculated with the method of *Hoyt* (1979) from the length and breadth of the egg.

We investigated the relationship between laying order, egg weight and egg volume. For statistical analysis we use Student's t-test.

RESULTS AND DISCUSSION

During egg production period (lasts about 90-100 days, respectively) we found in general weight and volume increasing tendency by grey partridge, but only by a few breeding pairs were this growing significant ($p<0.005$) (*Figure 1-4*). That means, from altogether 37 breeding pairs we found only 4 pairs with explicit growing tendency in egg weight after laying order. Other breeding pairs showed light increasing or stagnation.

Figure1

Egg weight alteration in 2018, 1st breeding box

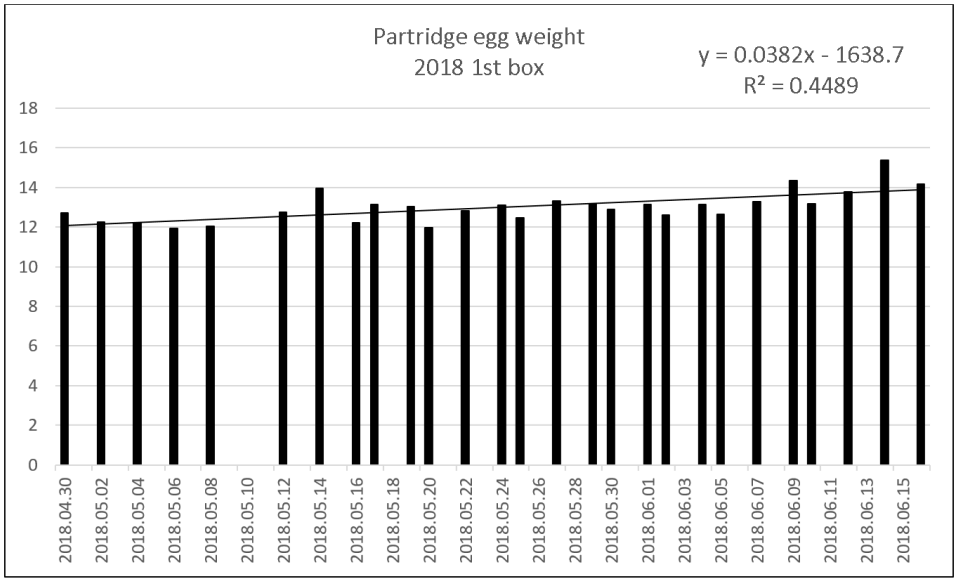


Figure 2

Egg weight alteration in 2018, 2th breeding box

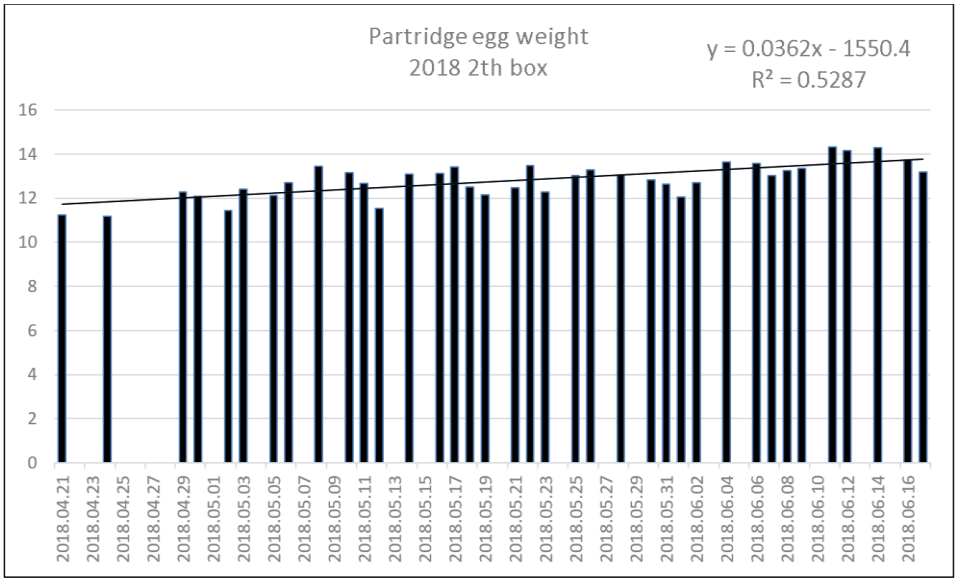


Figure 3

Egg weight and egg volume alteration in 2017, 12th breeding box

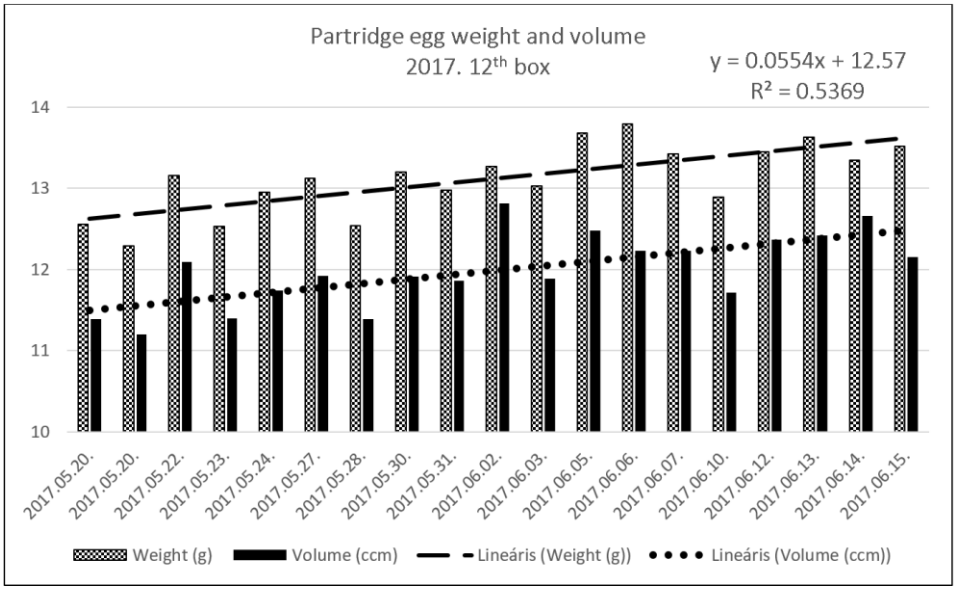
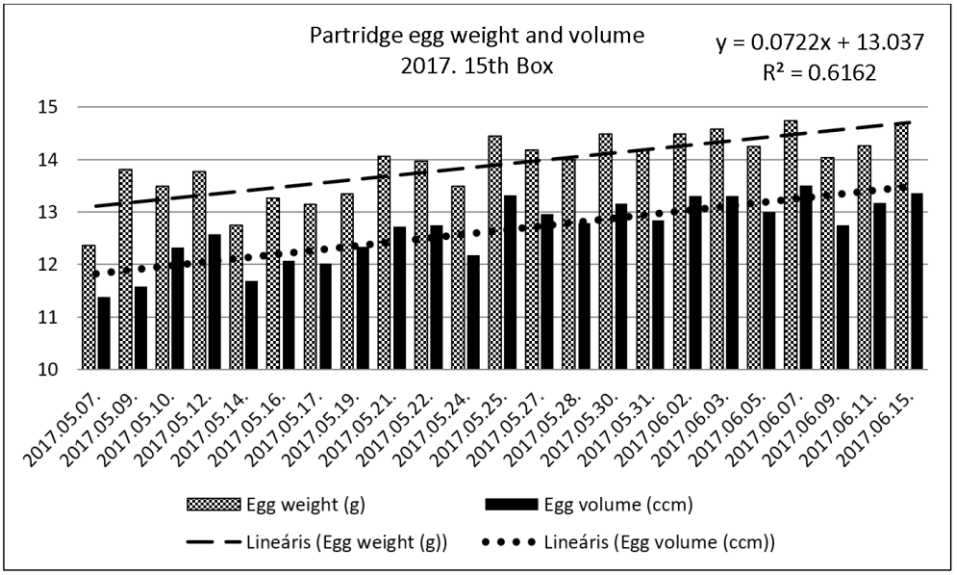


Figure 4

Egg weight and egg volume alteration in 2017, 15th breeding box



In the literature there are only a few data about egg mass alteration within years by partridge species. Variation in egg mass and period between eggs within years was attributable more to variation among individual females by red-legged partridge (*Alectoris rufa*), after *Cabezas-Díaz et al.* (2005). In an Italian research with grey partridge (*Cucco et al.*, 2010), egg characteristics were unrelated to egg position in the laying order, but in this research were measured only the first 20 eggs of each hens.

Investigated the laying gaps by grey partridge, the egg position in the laying order was significantly related to several egg characteristics. In particular, along the laying sequence there was a significant decrease in egg mass (*Cucco et al.*, 2017). It has to be noted, they used only the 4th - 20th eggs because the 1st – 3rd eggs are usually low in quality and last-laid eggs are outside of the range occurring in natural positions (*Cucco et al.*, 2017; *Potts*, 1986).

With an increase in egg mass, the most notable increase in component mass was that of albumen, constituting approximately 77% of the increase in initial egg mass. Yolk and shell constituted roughly 19% and 4% of the initial egg mass increase, respectively (*Finkler et al.*, 1998).

In a common precocial species, the Lapwing (*Vanellus vanellus*) egg quality and chick survival rate were studied in southwestern Sweden (*Blomquist et al.*, 1997). They found egg size did not affect chick survival independently of parental quality. The correlation between brood survival and egg volume was significant only for first clutches, suggesting that other factors than egg size were important for chick survival in replacement clutches (*Blomquist et al.*, 1997).

It seems in egg production of grey partridge also shows a similar pattern than lapwing.

CONCLUSIONS

During egg production period (lasts about 90-100 days, respectively) we found in general weight and volume increasing tendency by grey partridge, but only by a few breeding pairs were this growing significant ($p<0.005$). That means, from altogether 37 breeding pairs we found only 4 pairs with explicit growing tendency in egg weight after laying order. Other breeding pairs showed light increasing or stagnation. This data is a novel approach of egg-laying investigations in a precocial bird species, the grey partridge.

Further investigations required to find other tendencies on egg production of grey partridge, starting from the related literature cited.

ACKNOWLEDGEMENT

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THE EFFECT OF DIFFERENT CRUDE PROTEIN CONTENT OF FORAGES TO THE GROWING TENDENCY OF PHEASANT CHICKS

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ABSTRACT

The research was conducted to determine relationship between growth traits and crude protein content of different forages in Pheasants (Phasianus colchicus). During our investigation we used different forages with different crude protein content (18.0%, 21.5% and 28.0%, respectively) to feed pheasant chicks from day-old to 4 weeks-old time. The chicks were raised in broad houses in our university lab, under regular temperature and humidity conditions, ad libitum food and water provided. We made daily weight measuring at the same time of the day (at 5 p.m.) and from all broad we selected randomly 10-20 chicks each day. The study was conducted with 852 game pheasant chicks in two years, 2017 and 2018. In 2017 we measured 241 P. colchicus mongolicus, 104 P. c. tenebrosus and 59 Syrmaticus reevesi chicks. In 2018 we measured 458 P. c. mongolicus chicks. The growing tendencies were different after the crude protein content of forage. Lower protein content is not appropriate for pheasant chicks, as we found in 2018 with two different nutirition with 18.0% and 21.5% crude protein content, respectively. We didn't find any differences depending on pheasant chick subspecies or species. Suggestions were made for more efficient foraging strategies and for further examination.

INTRODUCTION

In gallinaceous birds, both Tetraonidae and Phasianidae, invertebrate food plays a subtancial role in their diets, but vary greatly between and within species (*Savory*, 1989). During the egg-laying and nestling-rearing periods, female grassland birds require a large proportion of protein in their diet, which originated mainly from invertebrates (*Doxon and Carroll*, 2010). It is a well-known fact since decades, the decline in survival of grey partridge chicks in Britain has been attributed to reductions in their insect food supply (*Potts* 1986), but very little was known about the precise diet of pheasant chicks, especially in the first weeks of their life (*Hill*, 1985).

Significant correlations between breeding success and/or chick survival and insect abundance have been shown with grey partridges and pheasants, however, both between and within years (*Savory*, 1989). Mortality rate of young pheasant chicks were significantly higher by low arthropod food availability not only because of starvation, but it might be expected when rainfall or ambient temperatures are abnormally above or below normal (*Riley et al.*, 1998).

At the beginning of intensive captive rearing of pheasant chicks the nutrition played an important role, especially the required proportion of crude protein for chicks in the first weeks of their life. In an earlier report excellent growth was obtained up to five weeks of age with diets containing 28% of protein (*Scott and Reynolds*, 1949). Some other early papers indicated the same protein requirement for early growth, but also failed to show the age at which the

protein level may drops to a lower level (e.g. *Scott et al.*, 1954). Later, beside the proportion of crude protein, series of studies reported optimum levels of many micronutrients and optimum energy content, too (e.g. *Scott et al.*, 1964; *Warner et al.*, 1982; *Cain et al.*, 1984). Protein and energy content in nutrition play also an important rule in the development of feather picking phenomenon, which is a severe problem during not only by pheasant rearing, but in egg and hen industry, too (e.g. *Cain et al.*, 1984; *McKeegan et al.*, 2010).

Growth traits of young pheasants were investigated by some researchers (e.g. *Straková et al.*, 2005; *Ipek and Yilmaz-Dikmen*, 2007; *Kuźniacka and Adamski*, 2010; *Kokoszyński et al.*, 2011), but these papers did not investigated the daily growing rate of young pheasant chicks.

The main goal of present investigation was to find relationship between growth traits and crude protein content of different forages in Pheasants (*Phasianus colchicus*), and to examine possible differences of growing tendencies of distant subspecies/species of pheasant in the first four weeks of their life.

MATERIAL AND METHODS

The study was conducted with two different subspecies of pheasant: Mongolian (*Phasianus colchicus mongolicus*) and Melanistic (*P. c. tenebrosus*) pheasant. As a control species we examine a distant species, Reeves's pheasant (*Syrmaticus reevesi*), too. The study was conducted with 852 game pheasant chicks in two consecutive years, 2017 and 2018. In 2017 we measured 241 *P. colchicus mongolicus*, 104 *P. c. tenebrosus* and 59 *Syrmaticus reevesi* chicks. In 2018 we measured 458 *P. c. mongolicus* chicks.

In 2017 all chicks received a diet including 28.0% crude protein and 11.5 MJ metabolizable energy during our examination (up to 4 weeks).

In 2018 we used two different commercial nutrition:

1. Common nutrition for Broiler chicks (18.0% crude protein, 9.55 MJ metabolizable energy)
2. Extra nutrition for Broiler chicks (21.5% crude protein, 11.38 MJ metabolizable energy)

The daily-old pheasant chicks originated from our experimental pheasant- and partridge-rearing small farm. All chicks were weighed when dry on the day of hatching. The chicks were raised in broad houses in our university lab, under regular temperature and humidity conditions, *ad libitum* food and water provided. We made daily weight measuring at the same time of the day (at 5 p.m.) and from all broad we selected randomly 10-20 chicks, respectively.

For statistical analysis we use Student's t-test.

RESULTS AND DISCUSSION

At hatching, there were no differences in nestling mass, regardless of subspecies. At the same time, all species/subspecies investigated showed the same growing pattern during our investigations.

The results of investigations made in 2017 showed that 28.0% protein is appropriate for pheasant chicks during the first 3-4 weeks, regardless of subspecies/species (Figure 1-3).

Figure 1

Growing patterns of *P.c. mongolicus* chicks (1-6: different broods, 2017)

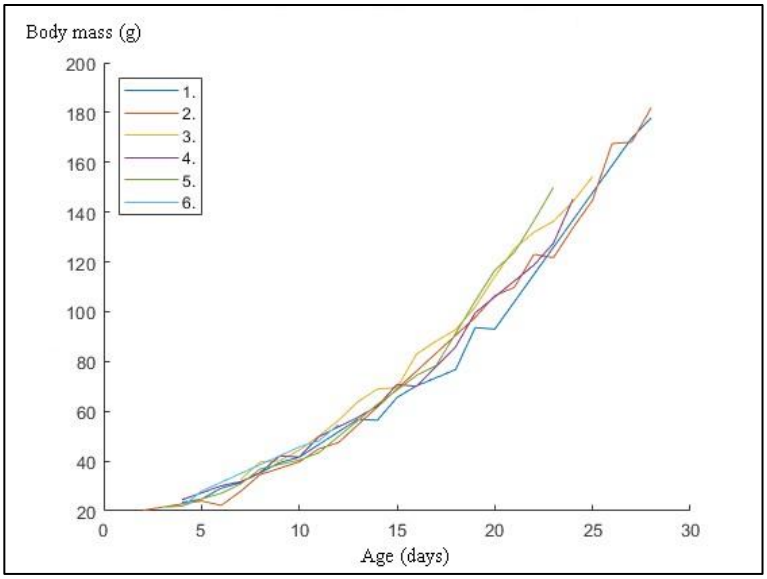


Figure 2

Growing patterns of *P.c. tenebrosus* chicks (1-6: different broods, 2017)

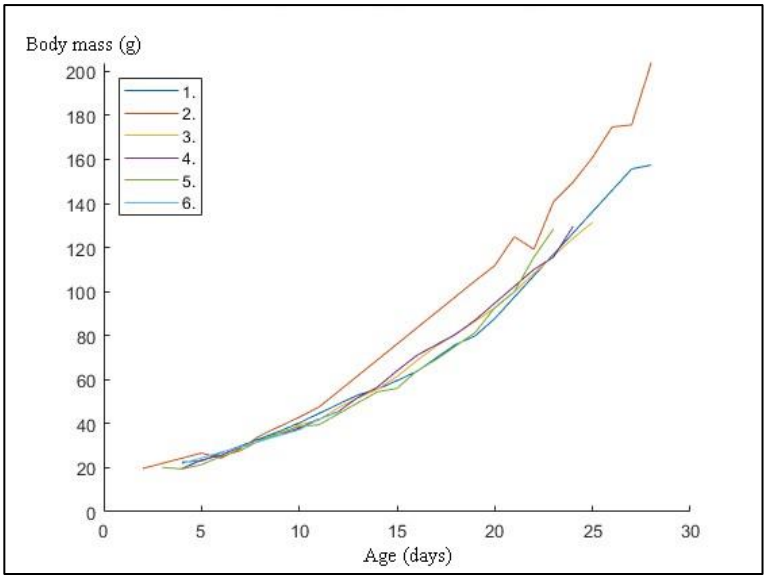
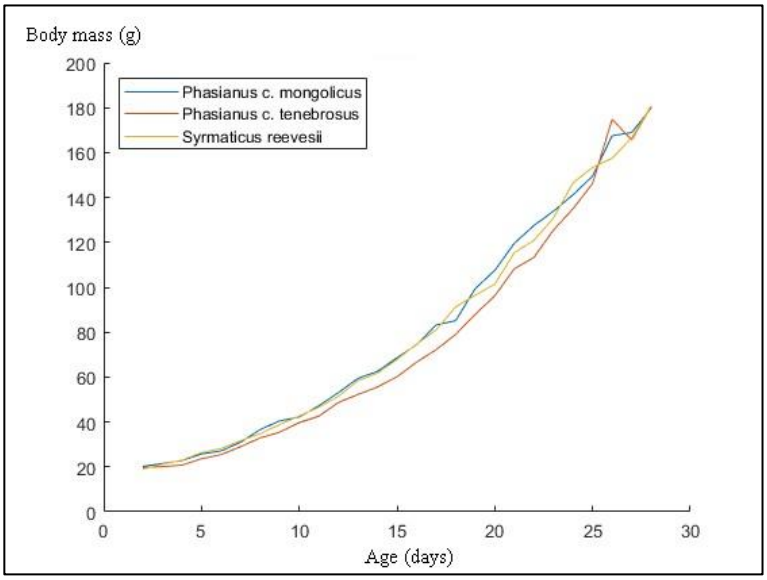


Figure 3

Growing patterns of different species' chicks (average of different broods, 2017)



As early as in the 1940' and 1950' years presented some papers that the nutrition requirement of pheasant chicks is not the same that of the domestic chicks. The protein requirement of pheasant chicks is about 28% at least for the first 2-3 weeks (*Scott and Reynolds*, 1949; *Scott et al.*, 1954). It is obvious the level of protein during subsequent feeding also is the most important factor affecting the growth of young pheasants (*Sage et al.*, 2002; *Straková et al.*, 2005). However, in their investigation *Woodard et al.* (1977) found Mongolian pheasants appeared to need no more than 20% dietary protein. This contradicts our own results.

Lower protein content is not appropriate for pheasant chicks, as we found in 2018 with two different nutirition with 18.0% and 21.5% crude protein content, respectively (*Figure 4*).

Unfortunately, in scientific literature there are only a few papers studied the early growing patterns and early growing rate of pheasant chicks. We found some examples with different crude protein content and different measured mass of chicks (*Table1*).

As can be seen from the results of the various tests in Table 1., the pheasants fed diets containing 20% or less protein grew at a slower rate during the first 3 – 4 weeks og age. But the main disadvantage in starting pheasants on low protein diets is the high mortality that acompanies this practice (*Woodard et al.*, 1977). At the same time, other investigation did not found a significant influence of the protein level on the mortality of pheasants (*Đorđević et al.*, 2010).

Lack of dietary protein may cause additional fitness costs because of enduring effects on morphology later in life. The protein content of the diet during the first 3 week had an effect on the degree of fluctuating asymmetry in tarsus length, suggesting persistent effects on the quality of birds (*Ohlsson and Smith*, 2001).

Figure 4

Growing pattern of *P.c. mongolicus* chicks fed by different protein content (18.0% and 21.5%) in 2018

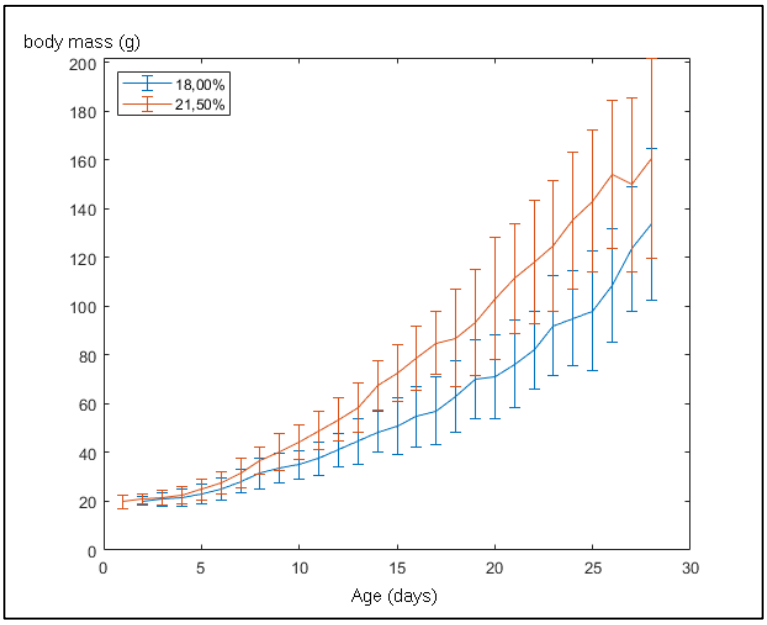


Table 1

Different mass of chicks after some former researches

	Age			
	7 days old	14 days old	21 days old	28 days old
Present study, *18.0% protein*	28.3	48.5	76.2	133.6
Present study, *21.5% protein*	31.6	67.5	111.4	160.9
Present study, *28.0% protein*	32.4	62.5	118.0	179.7
Szederjei (1952) *unknown (commercial food)*	24	32	60	124
Straková et al. (2005) *23.0% protein*	-		-	229
Kuźniacka and Adamski (2010) *27.3% protein*	-	-	137	-
Ipek and Yilmaz-Dikmen (2007) *26.2% protein*	-	51.2	-	157.8
Kokoszyński et al. (2011) *27.0% protein*	-	-	-	191.5
Woodard et al., (1977 16% protein	-	71.5	-	138.0
Woodard et al., (1977) 20% protein	-	69.0	-	154.5
Woodard et al., (1977) V 24% protein	-	75.5	-	179.0
Woodard et al., (1977) 28% protein	-	77.0	-	193.0

There are some other important factors, e.g. during the first period of growth (0-15 days of life) a significantly higher daily liveweight gain was achieved by the chicks kept at a lower

population density (*Đorđević et al.*, 2010). High protein level during the first three weeks of life affects larger and more colourful wattles of males when sexually mature than males receiving a low protein diet (*Ohlsson et al.*, 2002). However controversial during later feeding period (from 5 to 16 weeks) whole wheat grain in the diet caused a non-significant increase in dressing percentage and in the proportion of breast and leg muscles in eviscerated carcass (*Kokoszyński et al.*, 2014).

CONCLUSIONS

Based upon the accessed results of empirical pheasant growth with three levels of proteins and 3 different pheasant subspecies/species can be concluded the following:

At hatching, there were no differences in nestling mass, regardless of subspecies, and all species/subspecies (*Phasianus colchicus mongolicus*, *P. c. tenebrosus*, *Syrmaticus reevesi*) investigated showed the same growing pattern during our investigations.

Higher dietary protein level resulted higher body mass and higher daily liveweight gain. Our results and the revue of related literature show some contradiction especially the required protein level for Mongolian pheasant. In conlusion, pheasants should be fed diets containing at least 26-28% protein for the first 3 – 4 weeks.

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EMERGING NEW FOOD NETWORKS AS AN ALTERNATIVE FOR LOCAL AGRICULTURAL PRODUCTION

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ABSTRACT

Local food production has always been a part of tradition and an important component of life in rural areas in the Republic of Croatia. Recently, the great benefits of locally produced food for human health, community and economy have been recognized. This is one of the reasons why there is increasing interest in developing innovative food supply chains. They include locally produced agricultural products available on the local markets where farmers directly sell those products to the consumer, including a maximum of one intermediary. Locally produced food, or local food in general, is original and authentic in terms of the cultural identity of the area, traditional manufacturing practices and the origin of the ingredients of a product. The development of local food production has multiple benefits - economic, environmental, health and social. By using short supply chains, local producers can benefit greater share of product added value. The aim of the paper is to determine how adequate cooperation between farmers and consumers, forms of marketing engagement, and possible producer association influence the development of effective short supply chains at the local level. The purpose of the paper is to show that the organizations of short supply chains at the local level are an element of encouraging stronger development of competitive and efficient local agricultural production. A survey was conducted on a sample of farmers in the Koprivnica-Križevci and Međimurje counties in order to gain insight into the opinions and views of farmers about the agricultural production they are dealing with and the ways of distribution and marketing of their products. The target group of respondents consisted of a total of 110 farmers. The research on the agri-food sector of the Koprivnica-Križevci and Međimurje counties, based on the obtained data, shows local peculiarities and potentials for the development of short supply chains. The opinions and views of farmers regarding the development of short supply chains show that such development is inseparable from the characteristics of local agricultural production and the capacity of the local community.

Keywords: short supply chains, agriculture, local food production, local food, marketing and distribution of locally produced food

INTRODUCTION

Locally produced food integrates all processes from production, processing, distribution and consumption at the micro level, while stimulating the development of sustainable local economies and creating a strong link between farms and local consumers. Local agriculture supports the economy of the place, since farmland around cities is an ideal place for production, and city markets are ideal for the sale of local, locally produced food. There are various movements around the world promoting local food and alternative forms of food production, distribution and consumption. They actually connect producers and consumers, strengthen local agricultural systems and agricultural markets, and build better links between rural and urban areas (*Casolani*, 2015). The positive effects of consuming local food can be measured: socially, environmentally and economically.

Local agriculture is the production of agricultural and food products for the purpose of selling them in an area that is „reasonably" close to the farm where they were produced. There is no single definition of a term local area. While various sources confirm that the term means a relatively small geographical area, there is no consensus on distances, which can range from 20 to 100 km from the place of production (*European Comission*, 2013). Local can still be interpreted in two ways: firstly, defined by a market radius of approximately 50 km, and secondly, it can be linked to a region, eg in Croatia it could be an area of a county. In any case, it is characteristic of local food to be produced in an area that is known, and where consumers and producers meet directly (*Vincek and Ernoić*, 2016). In most cases, it is the consumer who actually decides whether or not a product is from a local area.

Some of the benefits of locally produced food and its placement through direct sales channels are: it is produced in a „known" area, and production is safe because the consumer „knows" a food producer. Food transport is reduced and the food supply chain is shortened. Consumers and producers are working closely together, consumers are learning from producers about concrete food production (*Mancini et al.*, 2019). This creates a sense of community and trust. Short supply chains mean reducing the number of intermediaries to the extent possible to deliver the final product to the consumer. The use of short supply chains strengthens the local economy (domestic producers), which enables the sustainability of farming and the sustainability of small businesses, crafts and farms (*Dani*, 2015). Food of higher quality, freshness and nutritional value are ensured, which contributes to increased food security, especially when it comes to the procurement of food in public institutions (schools, kindergartens, student food restaurants…).

In addition, the production and consumption of local food ensures job conservation. Imported food, on the other hand, has generally been long-traveled, long-stored, chemically treated, repackaged and over-labeled, indicating an unreliable origin. Likewise, imports strengthen the foreign economy, not the national economy, especially the local economy.

Short supply chain means a supply chain involving a limited number of economic operators committed to cooperation, local economic development and close geographical and social relations between producers, processors and consumers (*Feenstra and Hardesty*, 2016). Despite a broad understanding of local food networks and short supply chains, there is no single definition applicable to all EU countries. Therefore, the key determinants of short supply chains would be: shorter distance between producer and consumer, maximum of one mediator, liaison with the local area, mutual trust of buyers and producers and more intensive communication between producers and consumers, monitoring of product origin and active involvement of local intermediaries and others stakeholders.

The short supply chain, therefore, becomes a concrete place where multiple players - not just the producer and the consumer, interact in the spirit of agri-food management, where the act of buying is transformed into an act of economic, social and environmental value (*Fabbrizzi et al.*, 2014). Short supply chains accomplish the goals of sustainable agriculture by reducing transport costs and, consequently, CO2 emissions. In addition, biodiversity is promoted.

The strategic importance of short supply chains, and the production and consumption of local food can be measured by achieving benefits for farmers, developing skills for farmers, job satisfaction and adopting sustainable farming practices, increasing income for farmers involved in short supply chains, local development, community wellbeing and environmental

protection, job creation, the economic impact of short supply chains in the local economy (*Singh et al.*, 2018). By choosing a short supply chain, the consumer doesn't seek only out certain product characteristics, but also wants to participate in a „social event" that includes the principles of environmental and social sustainability.

Local food systems are the production, processing, trade and consumption of food that takes place in a relatively small geographical area (*Bloom and Hinrichs*, 2011; *Kovačević*, 2005).

Farmers from the area of the surveyed counties sell about 50% of their products through direct sales channels. About 7% of total production is sold via home delivery and about 5% at trade shows.

Joint direct selling involves some form of formal or informal cooperation. Partnerships involve various forms of collaboration between a number of manufacturers, customers, the public sector and organizations, which encourages the creation of a strategic approach and brings numerous benefits to the entire local area. In this way, the possibility of promoting rural development through the redistribution of value along the food supply chain and the sale of products of origin, geographical origin and organic and ecological products is also realized (*Todorovic, et al.*, 2018).

In the two northern Croatian counties, small agricultural enterprises have problems with marketing their products. So, the question is how to develop an efficient system of placement of locally produced food through short supply chains?

The way to create a competitive strategy for small family farms is to build regional and local agri-food systems (*Berti and Mulligan*, 2016). Can be achived the competitiveness of small farms through the development of innovative short supply chains? Can short local and regional food supply chains, as innovative organizational forms, bridge the „structural gaps" in the agri-food market between small producers and consumers?

Recently, there has been increasing interest in seeking alternatives to shortening the food supply chains, which would allow producers and consumers to connect more directly and localize food systems. Alternative local food chains are certainly part of rural / local development (*Peneva and Kazakova*, 2015). The question is how to stimulate and facilitate their growth to contribute to rural vitality and sustainable agriculture. The goal is to develop new alternative forms of agricultural local food supply chains, combined with production practices, rural tourism, traditional food production and local community / economy development.

MATERIAL AND METHODS

A survey was conducted on a sample of farmers in the Koprivnica-Križevci and Međimurje counties in order to gain insight into the opinions and views of farmers about the agricultural production they are dealing with and the ways of distribution and marketing of their products. The target group of respondents consisted of a total of 110 farmers.

The basic criteria for selecting respondents were agricultural production, residency status, typical work engagement and the assumption that there were no large discrepancies between respondents.

During the summer months of 2017, a survey was conducted on a sample of agricultural producers in the Koprivnica-Križevci and Međimurje counties in order to gain insight into the opinions and views of farmers about the agricultural production they engage in and the ways in which their products are distributed.

Due to incomplete data in the survey, 12 responses were excluded from the further analysis. Therefore, the total number of relevant respondents was 98, dealing with various types of agricultural production such as animal husbandry (18), cheese production (6), fruit production (29), vegetables (41), honey and medicinal plants (12).

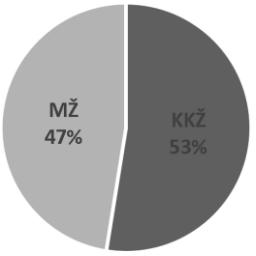
The questionnaire included a total of 38 mostly closed-ended questions.

RESULTS AND DISCUSSION

Almost equal number of respondents came from Koprivnica-Križevci (KKŽ, 52 respondents) and Međimurje County (MŽ, 46 respondents), which fulfilled the criterion of proportional representation of respondents necessary for the current analysis of the agricultural situation in both counties. (*Figure 1*).

Figure 1.

Number of respondents per county



The farmers in the sample are mostly male (63%) and to a lesser extent, they are female (37%), with an average of 45 years of age and 20 years of work experience in farming. The youngest farmers are in the beekeepers group and they are on average 31 years old. and cheesemakers are on average 38 years old. The oldest farmers are fruit growers with an average age of 53 years.

Farmers are engaged in agriculture mainly in a mixed type of agriculture enterprise (55%), that is, the type of enterprise (farm) where at least one family member is employed outside agriculture sector. About 45% of respondents live and work in a sole agriculture enterprise where the family memebers live exclusively from agriculture.

The character of the market with respect to the area (*Figure 2*) on which the product placement takes place has also been investigated. Farmers most often market products on the local market (55%) and one third (29)% on the regional market. Very few farmers market their products on the national (14%) and foreign markets (2%).

The local market (*Figure 3*) covers the area within a radius of up to 50 km, representing the market of neighboring gravitating towns and cities such as Đurđevac, Križevci, Koprivnica, Varaždin and Zagreb, which the farmers of Koprivnica-Križevci County are directed to. Čakovec, Prelog, Mursko Središće, Varaždin and Zagreb are towns which farmers of Međimurje County are directed to. It is interesting to note that the local market is most represented by livestock farmers (29%), followed by fruit growers (27%), beekeepers (23%) and in the smallest percentage by cheese producers (1%).

Figure 2:

Agri-food sales market

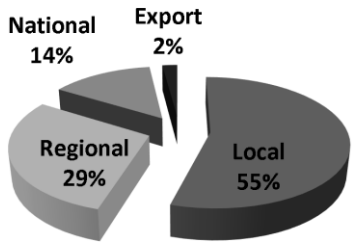
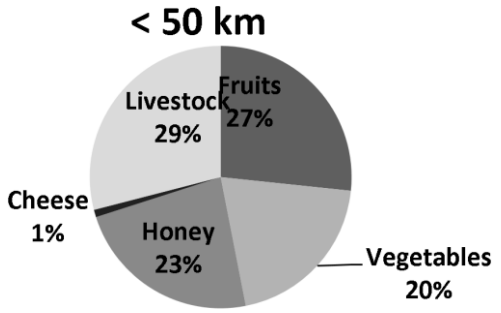


Figure 3

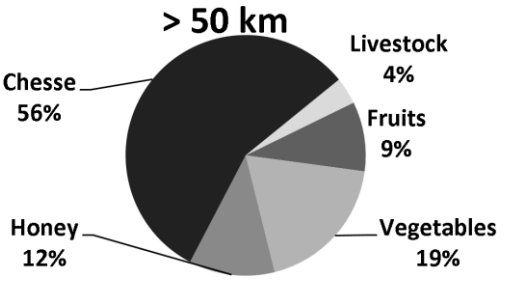
Local sales of agri-food products



The regional market (Figure 4) has a wider reach than the local market and implies a market area more than 50 km from the resident area, in the direction of neighboring cities, counties and beyond. The most present in the regional market are cheese farmers (56%), vegetable growers (19%), medarians (12), fruit growers (9%) and at least livestock farmers (4%).

Figure 4

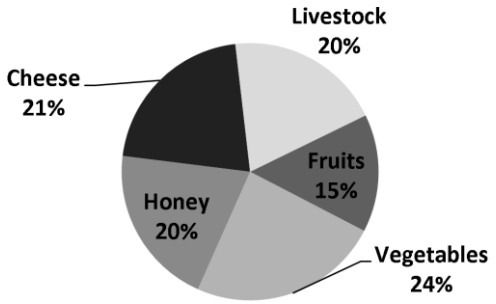
Regional sales of agri-food products



Vegetables (24%), cheesemakers (21%), livestock and honey producers (20%), and fruit growers (15%) sell their products to the greatest extent throughout the Republic of Croatia - national level (*Figure 5*).

Figure 5

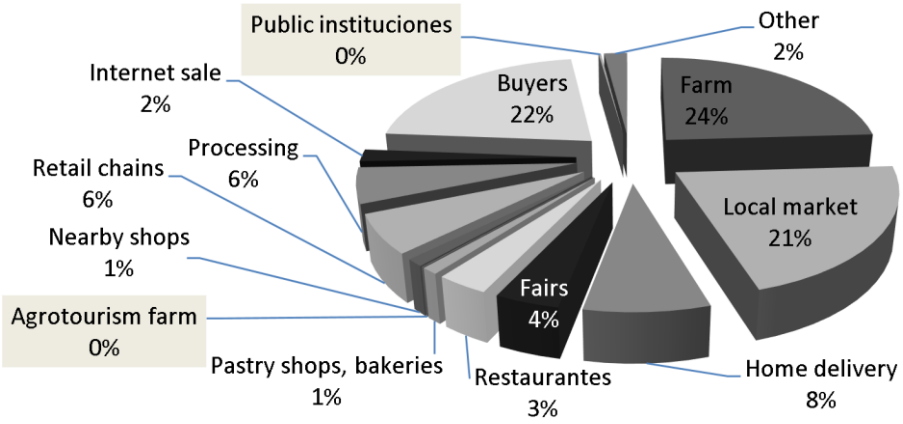
National sales of agri-food products



Furthermore, farmers sell their products through different sales channels (*Figure 6*), with the most represented channels being: at their farm (24%), buyers (22%) and the local market (21%). To a lesser extent, products are marketed via home delivery (8%), equally through retail chains and processing companies (6%), and at least through restaurants (3%), Internet sales (2%) and nearby stores (1%).

Figure 6

Where do you sell your products and how much does each channel contribute to total sales?



Agri-food products can be marketed as a primary agricultural product, as a raw material for processing or as a processed product, or as a fininal product. Farmers generally opted for placing their own products as a final product (*Table 1*), which they consider very cost-effective

(grade 4), and as a primary agricultural product (grade 3), which they consider cost-effective, and to a minimum extent as raw material for processing.

Table 1

Cost effectiveness of product placement

	Primary agricultural product	Raw material	Final product	Others*
Fruit grower KKŽ	3,1	2,0	3,9	5
Fruit grower MŽ	3,0	1,9	4,0	
Vegetable growers KKŽ	4,0	3,1	3,1	
Vegetable growers MŽ	2,8	2,6	3,1	
Beekeeper KKŽ	3,5	5,0	0,0	5,0
Beekeeper MŽ	4,3	2,0	2,0	
Cheesemaker KKŽ	1,0	1,3	5,0	
cheesemaker MŽ	3,0	3,2	3,5	
TOTAL	**3,2**	**2,6**	**3,8**	**5,0**

* iced product (fruit), gift package, souvenir (honey)

Considering the type of production, beekeepers are most interested in placing their products as primary products and raw materials, while cheesemakers consider cheese as the final product best placed just in that form. Other suggestions for possible product placement are placements for tourism and promotional purposes.

There are many problems that farmers face when selling and marketing agricultural products and they are diverse. The farmers rated them as a very small problem (rating: 1), a small problem (rating: 2), a medium-sized problem (rating: 3), a larger problem (rating: 4) and the biggest problem (rating: 5). According to the estimation (*Table 2*), the farmers point out as the most important problem the market pressure of cheaper imported products, low selling prices of agri-food products, lack of necessary infrastructure such as warehouses, cold stores and so on.

In addition, farmers believe that there is no organized purchase and market, that the products are of unequal quality, consumer purchasing power is low, general insecurity is in force, the competent departments and services (Ministry of Agriculture, Inspection) are not working properly, the raw material is poor, there is a lack of confidence in the purchasers, there are problems in developing a business plan and applying for projects, and, finally, farmers believe that they are left to themselves.

The decisions weather consumers will buy an agri-food product is an important topic that needs to be analyzed and depends on a number of factors.

Farmers consider that there are several important factors dealing with purchase decision, namely quality and product characteristics (importance rating: 4.2), price (importance rating: 3.6), and to a lesser extent knowledge of the place and production process (importance rating:

3.3), product availability (importance rating: 3.3), product brand (importance rating: 3.0), packaging (importance rating: 2.8), and environmental management (importance rating: 2.7). With the aim of better marketing of agri-food products, farmers develop certain forms of cooperation with the consumers of their products, and the most common form of such cooperation is (*Table 3*) telephone ordering of certain products, updating of a permanent list of consumers, home delivery through orders and online sales.

Table 2

General types of sales and placement issues

TYPES OF SALES AND PLACEMENT PROBLEMS	SCORE
Market pressure of cheep import goods	**4,2**
Low selling prices	**4,1**
Inssuficient necessary infrastructure (warehouses, cold stores...)	**3,6**
Underdeveloped network of primary product purchasers	**3,4**
Inability or delay in payment	**2,9**
Fear of entering new markets	**2,7**
Lack of professional and specific knowledge in marketing and trade	**2,5**
Language barrier	**2,4**
Ignorance of modern forms of sales (on-line, e-marketing,...)	**2,3**
Other	**4,4**

Table 3

Forms of cooperation between farmers and consumers

FORMS OF COOPERATION BETWEEN FARMERS AND C(	N
Telephone orders	**64**
Permanent list of consumers	**43**
Home delivery via order	**31**
Internet sales	**20**

Agri-food products are mostly marketed under their own name, that is, the name of the family farm, and the most common way of promoting the product is through the word of mouth promotion of satisfied consumers, participation in fairs, through social networks (Facebbok, Twitter, etc.) and its own website. But still a significant proportion of farmers do not promote their products or do so. It can be concluded that farmers use the usual, accessible and cheaper ways of promotion (*Table 4*).

When they were asked about membership in a cluster, producer organization, association or cooperative, 32% of respondents answered positivly to memberships, mainly in farmers' associations.

Farmers estimate that their association brings some benefits, but they find it insufficient (*Table 5*).

Table 4

Product promotion method

PRODUCT PROMOTION METHOD	N
Word of mouth	**56**
Fairs	**49**
Social networks (Facebook, Instagram, Twitter...)	**31**
Web pages	**17**
I do not promote	**16**
TV appearance	**5**
Radio appearance	**4**
Print media	**3**
TV ads	**1**

Table 5

Impact of association on production factors

FACTORS OF AGRICULTURAL PRODUCTION	EVALUATION
Product placement	3,0
Reduction in promotion costs	3,0
Product processing	2,7
Reducing production costs	2,5
Production quantity and structure	2,5

In the opinion of the respondents, association has a medium effect on product placement and reduction of promotion costs (importance rating: 3), and somewhat more indirectly affects product processing (importance rating: 2.7) and the reduction of production costs and the quantity and structure of production (importance assessment: 2.5).

Generally, 69% of farmers believe that more organized cooperation between farmers and consumers could bring certain benefits for both subjects in the local markets (*Table 6*).

Farmers agree that the benefits are great, and farmers take a real-world view of the benefits and evaluate their benefits

CONCLUSIONS

From a farmer's point of view, there is a need for better organization and association. The short food supply chain is an important system for promoting a new food culture and sensitizing citizens to local and fresher food and for environmental sustainability. There are many existing short food supply chains, but they are unstructured and unorganized. The goal is to come up with an organized model.

Obstacles and constraints in the development of short food supply chains need to be identified. There are several categories / types of restrictions: restrictions due to the nature of the market; because of the size and nature of the production; restrictions on employment and

skills of farmers; institutional constraints; restrictions on food supply chain relationships; through certification of food products; policies and regulatory constraints; limitations on personal beliefs, etc.

Table 6

Benefits for producers and consumers

BENEFITS FOR PRODUCERS AND CONSUMERS	SCORE
Food origins	4,4
Opportunies for rural development programs	4,3
Small produces negotaiating power	4,3
Awareness of the importance of consuming local products	4,2
Making products and producters more reconnizable	4,2
Improvment of local infrastructure	4,1
Improved social interaction (consumers learn from the producers)	4,1
Job preservation	4,1
Reducing transport costs	4,0
Increased revenue throught higher product prices	3,9
Better food security	3,9
Better product quality	3,8
Coproduction - producers learn from each other	3,8
Supply diversification	3,8
Reduced competition between small producers	3,8
Chemically less treated foods	3,6
Better environemntal benefits	3,5
Graeter biodiversity and landscape diversity	3,4

Improvement proposals can be found (implemented) through producer collaborative efforts, alternative institutional interventions, supply chain reintegration and logistics innovation, creating distribution networks / hubs, making better use of regional food groups, developing opportunities to establish local supply chain centers, or expanding or re-activating functions of agricultural cooperatives.

So-called „food hubs" or distribution centers could play a major role in creating sustainable regional and local food systems. This is a form of organizational strategy for short supply chains (or supply chains), with the aim of redeveloping the local agricultural market. The role of distribution centers could be of great importance for sustainable local food systems.

The development of entrepreneurial and innovative infrastructure through local partnerships eg entrepreneurial incubators can also be one way of developing short food supply chains. Business incubation in rural areas, and increasingly in integrated urban-rural space, can take many forms and involve different stakeholders. In a more developed business and market environment, one can speak of food clusters, which can also be defined as agroparks; there are also talk about food enterprise zones, food parks, etc. (*Dani*, 2015).

For the development of efficient short supply chains, it is necessary to educate young producers, who in the medium and long term can become real carriers of agricultural production and rural development.

The local community should become an „active environment" where, in parallel with the globalization tendencies of industrialized agriculture and large international / national / local distribution chains, local / regional food systems will be developed characterized by high levels of added value, short supply chains and high levels of social and environmental awareness.

ACKNOWLEDGEMENT

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DEVELOPMENT OF A THROUGHFALL SENSING SYSTEM FOR AGROFORESTRY

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Abstract

Agroforestry systems have considerably increased leaf area compared to traditional agricultural technologies. The planted tree canopies not only intercept rain on the leaf surface, but the part of rain falling through is heavily modified. The net precipitation is redistributed unevenly in time and space. Manual throughfall integrator gauges cannot apply to explore the temporal and spatial distribution of the rain water. The rapid development of digital sensing technology enables to use of automatic data collectors to explore patterns in water income of agroforestry field. Because of the high number of the planned sampling points we try to find low-cost solutions. As a first step into the digital world, we installed new equipment in our riparian alder plot. We preferred to gain information on the temporal properties of throughfall. It is rather important in the case of riparian vegetation to explore its contribution in the flood development. This publication summarises the recent efforts in the throughfall measurement automatisation.

INTRODUCTION

Agroforestry systems have considerably increased leaf area compared to traditional agricultural technologies. Trees in the agroforestry systems gives not only wood but have several other positive effect like increasing biodiversity, decreasing erosion, moderated wind and shadow for the sensitive plants (*Gyuricza and Borovics*, 2018). The planted tree canopies have also effect on hydrological elements. They not only intercept rain on the leaf surface, but the part of rain falling through is heavily modified. The net precipitation is redistributed by the agroforestry systems unevenly in time and space. There are some regular patterns, where trees are planted among rows. *Figure 1a* shows an example in Fertőd (Győr-Moson-Sopron County, Western Hungary) berry plantation. *Figure 1b* is a good example for highly irregular spatial structure located in Kőszeg (Vas Count, Western Hungary) silvopasture.

Canopy interception is well studied in the case of forest stands. *Móricz et al.* (2009) give a detailed review of the relevant literature. In the case of seasonal crops interception there are not similarly reach literature but *Kozak et al.* (2007) emphasise that interception loss of rain and irrigation water affects crop yield. *Walkovszy* (1980) shows some results for Hungarian crop fields. *Ong et al.* (2014) underline that in agroforestry systems rainfall interception vary with site, tree species, and planting density. In this article we show the beginning steps of a tool development which aims to explore the temporal and spatial redistribution of net precipitation in agroforestry systems.

MATERIAL AND METHODS

In a development process it is worth to find a well instrumented test area. In our case a riparian forest ecosystem was choosen as a test area. This alder (*Alnus glutinosa*) dominated plot is part

of the Hidegvíz Valley Experimental Catchment (Sopron, Western Hungary see details in *Gribovszki et al.*, 2006). In the research area there are several plots instrumented by traditional sampling collectors troughs and funnels (*Figure 2*). This already available infrastructure forms the reference for the development works.

Figure 1

Agroforestry research plot in Fertőd (a) and in Kőszeg (b)

(a) (b)

Figure 2

A troughfall measurement trough (a), and funnel (b)

(a) (b)

There are two development directions. The first is based on large collector surface tipically trough and a large volume container for the intercepted throughfall. The volume is estimated with the help of the continously increasing level in the container. The second method uses the well known tipping-bucket fenomenon which is broadly applied in the precipitation measurement. The latter is applicable for detailed spatial measurement while the former is good for temporal investigations because the size of the surface collector.

The first method, the trough with the large container, represents the simpler solution with less development demand. The only technical problem with this solution is how to log the water level changes? In the research area vented pressure transducers are applied to measure water level fluctuation in a fine scale. The accuracy for vented pressure transducer readings are suitable for this measurement but the termal deviations are larger compared to a temperated groundwater well (*Gribovszki et al.*, 2012).

The second method seemed at the first time more simpler. There are uncountable amount of tipping-bucket gauges ready to use even with data collector. This commarcial gauges can be use for temporal measurement with low sampling points number. To explore the spatial redistribution of through falling water require huge amount of measurement points. *Bales et al.* (2011) suggest dozens of sampling sensors to measure undercanopy processes. The expenses of the suitable sensor networks pressed us to find a more economical solution to study spatial variability of throughfall. The advent of digital revolution makes more easier to develop custom low energy consumption embedded systems. To produce custom datalogger we chose ARM based microcontroller family, which includes all the necessary components for a logger integrated in one circuit. The physical compontents of throughfall sensor prototypes also easily fabricable with the help of 3D printing solutions.

RESULTS AND DISCUSSION

The first equipment, the trough with the large container, is already installed (*Figure 3*). To prevent disturbances by temperature changes and fluctuations in level caused by inflow pressure sensor is placed into a stilling tube (see Figure 3b at the end of the trough.

Figure 3

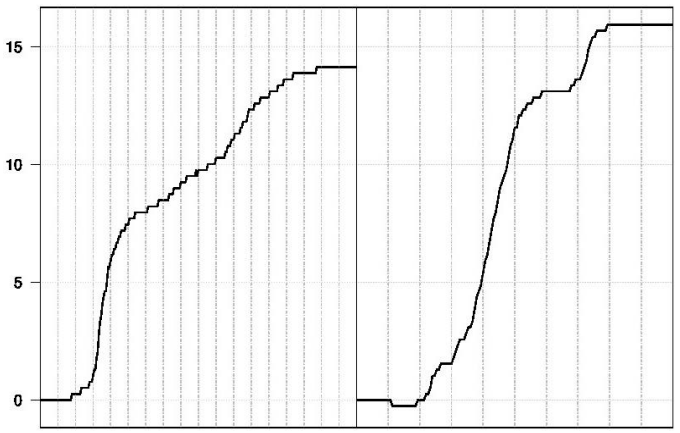
Overview of the automated measurement (a) and view from the end of the measurement trough (b)

(a) (b)

The collected data series shows some sign of under quantation even during lower intensities (*Figure 4a*). The temperature variation generated artifacts slightly affect measurement series (*Figure 4b*) but it is fortunateliy almost in the same magnitude as the quantation error.

Figure 4

Example time-series of throughfall [mm]



To increase the temporal sensitivity and the availability of the working throughfall gauge we construct the first test saple our own design of customisable tipping bucket to the end of the trough (*Figure 3b*). The 3D modell of the sensor is made with a parametriseable model to enable the easy changes (Figure 5 and 6a). The current sample is manufactured with the 3D printing technology. The electronical component of the system is under test.

Figure 5

3D modell of the bucket for the tipping bucket flow meter

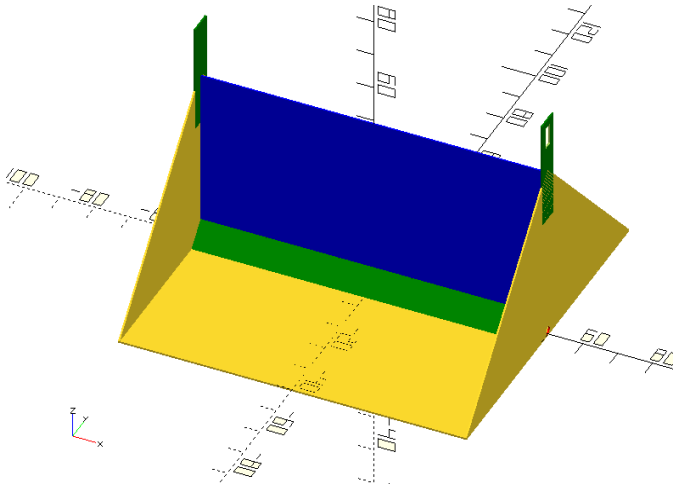
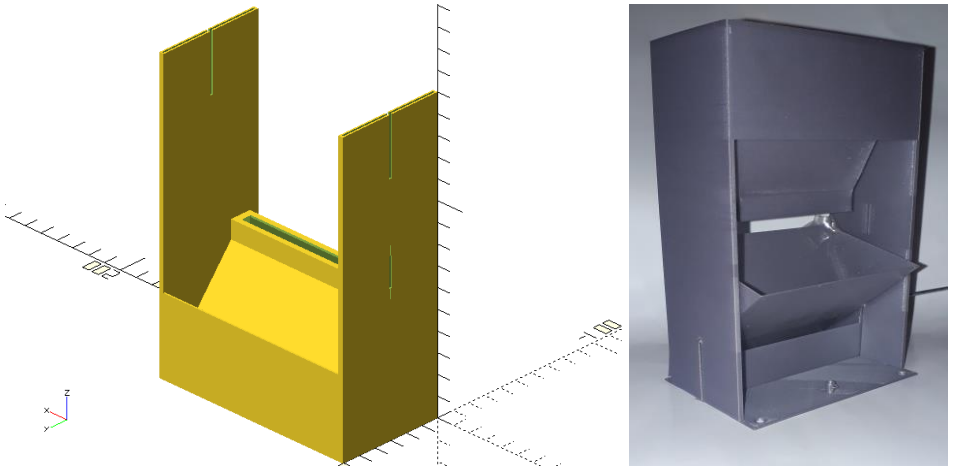


Figure 6

3D model of the support (a) and the printed and assembled equipment (b)



(a) (b)

CONCLUSIONS

In this publication we summarised the recent efforts in the throughfall measurement automatisation. With the combination of commercial sensors or easy to use microcontroller systems and 3D plotting techonologies it is achievable to build a low cost equipment to cover specific monitoring demands in the field of agroforestry research.

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AN OVERVIEW OF AGROFORESTRY FROM ANTIQUITY TO THE PRESENT DAY

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ABSTRACT

The practice of maintaining or integrating trees in the agricultural landscape has existed from ancient times around the world and has constituted the default practice in terms of land use management. It was only during the last centuries that farming and trees became dissociated as monocropping became more common, in an effort to intensify food production. The creation of modern agroforestry finds its origins in the solutions to development problems, its benefits are also recognized now in developed countries, and government support has grown accordingly.

DISCUSSION

Throughout the world, at one period or another in its history, it has been the practice to cultivate tree species and agricultural crops in intimate combination. The examples are numerous.

In Europe, the Spanish Dehesas, a system in which pasture (cattle, swine, sheep) is covered by scattered oaks, is said to have its origins dating back 4 500 years. In Germany, until the Middle Ages, farmers would start growing crops on small pieces of land they just cleared from trees. They would then have trees grow anew on the land, parallel to the crops grown. It was the general custom in Europe, at least until the Middle Ages, to clear-fell derelict forest, burn the slash, cultivate food crops for varying periods on the cleared areas, and plant or sow tree species before, along with, or after the sowing of the agricultural crop. This "farming system" is, of course, no longer popular in Europe. But it was still widely followed in Finland up to the end of the last century, and was being practised in a few areas in Germany as late as the 1920s (*King*, 1968).

In the Americas, numerous people during the pre-Columbian period practiced what is termed today as multi-story agriculture, whereby vertical space is maximized, as the farmers made an effort to mimic complex forest ecosystems, in order to enjoy their multiple benefits. In tropical America, many societies have traditionally simulated forest conditions in their farms in order to obtain the beneficial effects of forest structures. Farmers in Central America, for example, have long imitated the structure and species diversity of tropical forests by planting a variety of crops with different growth habits. Plots of no more than one-tenth of a hectare contained, on average, two dozen different species of plants each with a different form, together corresponding to the layered configuration of mixed tropical forests: coconut or papaya with a lower layer of bananas or citrus, a shrub layer of coffee or cacao, tall and low annuals such as maize, and finally a spreading ground cover of plants such as squash (*Wilken*, 1977).

In Asia, in the Indian peninsula, traditional homegardens have existed for millennia, while rulers have formally encouraged certain systems at specific periods. The Hanunoo of

the Philippines practised a complex and somewhat sophisticated type of shifting cultivation. In clearing the forest for agricultural use, they deliberately left certain selected trees which, by the end of the rice-growing season, would "provide a partial canopy of new foliage" to prevent excessive exposure to the sun "at a time when moisture is more important than sunlight for the maturing grain". Nor was this all. Trees were an indispensable part of the Hanunoo farming system and were either planted or conserved from the original forests to provide food, medicines, construction wood and cosmetics, in addition to their protective services (*Conklin*, 1953).

The situation was little different in Africa. In southern Nigeria, yams, maize, pumpkins and beans were typically grown together under a cover of scattered trees (*Forde*, 1937). In Zambia, in addition to the main crop in the homestead, there were traditionally numerous subsidiary crops that were grown in mixture with tree species (*Anon.*, 1938). Indeed, the Yoruba of western Nigeria, who have long practised an intensive system of mixed herbaceous, shrub and tree cropping, explain that the system is a means of conserving human energy by making full use of the limited space laboriously won from the dense forest. They compare the method to a multistoreyed building in a congested area in which expansion must perforce be vertical rather than horizontal. They also claim that it is an inexpensive means of combating erosion and leaching, and of maintaining soil fertility (*Ojo*, 1966). As they picturesquely described it, "the plants eat and drink, as it were, not from one table, but from many tables under the same sky" (*Henry*, 1949).

These examples indicate the wide geographical coverage of the system and its early origins. What is more important perhaps, they clearly point to the fact that the earliest practitioners of what has now become known as agroforestry perceived food production as the system's raison d'être. Trees were an integral part of a farming system. They were kept on established farmland to support agriculture. The ultimate objective was not tree production but food production. (*Steppler and Nair*, 1987).

There are plenty of other examples of how people would combine the ecological functions of species of trees and plants in order to provide themselves with various goods and services.

The term agroforestry was coined in the late 1970s, reflecting a significant change in agricultural development. During this period, the rural poor gained more attention from the international development community. Moreover, the environmental and social side effects of the high input agriculture induced by the Green Revolution, which brought tremendous increase in yields of cereal crops, were starting to be felt.

FAO therefore redirected its thrust and assistance in the direction of the rural poor. Its new policies, while not abandoning the traditional areas of forestry development, emphasized the importance of forestry for rural development, the benefits which could accrue to both the farmer and the nation if greater attention was paid to the beneficial effects of trees and forests on food and agricultural production, and advised land managers in the tropics to "eschew the false dichotomy between agriculture and forestry" (*King*, 1979). They also stressed the necessity of devising systems which would provide food and fuel and yet conserve the environment. (*FAO*, 2013).

As a result of this change in policy, FAO prepared a seminal paper "Forestry for Rural Development" (*FAO*, 1976) and, with funding from the Swedish International Development

Authority (SID A), organized a series of seminars and workshops on the subject in all the tropical regions of the world, and formulated and implemented a number of rural forestry projects throughout the developing world. In these projects, as with the World Bank's social forestry projects, agroforestry plays a pivotal role (see Spears, this volume). FAO also utilized the Eighth World Forestry Congress, which was held in Jakarta, Indonesia in 1978, to focus the attention of the world's leading foresters on the important topic of agroforestry. The central theme of the Congress was "Forests for People", and a special section was devoted to "Forestry for Rural Communities". (*Steppler and Nair*, 1987)

In this context, many stakeholders started to look at alternatives, such as intercropping and integrated farming, involving trees and animals. The creation of the International Centre of Research on Agroforestry (ICRAF) was an indication of the international development community's recognition of agrofoerstry as an important land use practice deserving intensified research. With these research efforts, modern agroforestry can use science to improve already well-established local traditions. (*Vityi et al.*, 2014)

Agroforestry is increasingly recognized as a beneficial land use practice and is thus becoming more widespread. The government of the Philippines was among the first to support agroforestry as a viable strategy for rural development. More recently, in 2014, the government of India adopted a National Agroforestry Policy. Such institutionalization in developing countries demonstrate their commitment to support wider adoption of agroforestry.

Although the creation of modern agroforestry finds its origins in the solutions to development problems, its benefits are also recognized now in developed countries, and government support has grown accordingly. Here are some examples of this.

In the United States, after a long period of sporadic interest, notably during the 1930's Dust Bowl, the USDA Interagency Working Group on Agroforestry in 1996 took on the issue of institutionalization. Its work and subsequent follow-up reports led to the adoption of the 2011-2016 Strategic Framework, which seeks to (1) increase use of agroforestry by landowners and communities, (2) advance the understanding of, and tools for, applying agroforestry and (3) incorporate agroforestry into an all-lands approach to conservation and economic development.

In 2001, in Europe, tree-based intercropping systems were accepted for access to funding support from the Common Agricultural Policy (CAP) of the European Union. In 2004, the European Commission launched Article 44 for support to agroforestry. In the new CAP of 2014, agroforestry is seen as a solution to enhance biodiversity on farms and also as a mean to improve forest areas and rural development. It therefore provides funding for establishment and maintenance agroforestry practices to this effect.

Australia and New Zealand are also recognizing the diverse benefits of agroforestry, or farm forestry. Through their respective programs, Landcare and the Sustainable Farming Fund, growing trees on farms is seen as a way to gear agricultural practices towards a more sustainable path, notably with agroforestry projects. (*FAO*, 2013)

Today, agroforestry is taught as a part of forestry and agriculture degree courses in many universities in both the developing and developed world; and specific degrees in agroforestry are already offered in a few. Today, instead of agroforestry being merely the handmaiden of forestry, the system is being more and more utilized as an agricultural system, particularly for

small-scale farmers. Today, the potential of agroforestry for soil conservation is generally accepted. Indeed, agroforestry is fast becoming recognized as a system which is capable of yielding both wood and food and at the same time of conserving and rehabilitating ecosystems.

Hungary is a traditionally agricultural country, therefore the traditional agroforestry technologies (windbreaks, shelter-belts, hedgerows, small-scale orchards and vineyards, wooded meadows, grazed forest and wood pastures had been applied in large scale in the past centuries. With the aim to increase the domestic agricultural productivity and wood production basis, and to decrease the national wood import dependency, a large-scale state-financed research project on protective wood lands started in the early sixties, led by the University of Forestry and Timber Industry.

The aim of the research were to identify the ecosystem services and the effects on agricultural productivity of protective woodlands, so as to justify their positive effects observed or measured only fragmented up to that time. As a result of that multi-annual research and development activity the area of forest belts increased further until the 80's. From the early nineties the positive trend of increasing area of protective forest belts first stopped, then reversed. As the outcome of the privatization, the landscape of the Great Plain had undergone a structural transformation, resulting in more diversified land use, a lot of small parcels together with new large estates. (*Vityi et al.*, 2014)

University of Sopron has several research areas: meteorological, hydrological and soil-related aspects of agro-forestry. Our group deals with the soil part in detail.

Our experimental area is Dejtár, a small settlement in Nógrád county, 13 km from Balassagyarmat. The experimental plantation is located to the east of the settlement, at an earlier nursery site. The examined area lies in the Cserhát countryside in a forest landscape, and within the Ipoly basin landscape. A brief description is as follows:

Over the last few years, the area has been used as an energetic "populus x americana" plantation, with several soil preparation and soil improvement interventions. It was harvested in 2016.

During the project, we will carry out several measurements. We apply soil water exploration, soil moisture and meteorological data, we also measure yields, nutrient composition and water absorption. The soil moisture is determined by automatic TDR probes at several depths. This parameter can be one of the most important interfaces for hydrological modeling when subsequent data analysis is performed. At the same time, soil temperature and matrix potential (pore pressure) are also planned.

As regards the soil, we expect positive effects, such as a more balanced nutrient, in particular the nitrogen economy, with decreasing nitrogen depletion. We expect a reduction in soil erosion due to the reduction of the wind strength of the trees and the soil binding ability of the frostbite. We expect to improve the carbon storage capacity of the soils.

HYPOTHESIS

Without compromising the agrarian sector that would bring significant economic benefits to the national economy, there are probably large areas available in Hungary, where agro-forestry can be an alternative that can be both economically and ecologically competitive

with today's traditional agricultural practices. In order to be able to provide quantifiable data, we must first evaluate the operation of agro-forestry systems in domestic conditions.

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WOOD MODIFICATION RELATED RESEARCH AT THE UNIVERSITY OF SOPRON

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ABSTRACT

Wood is recognized as the most important of the renewable base materials with the added advantage of being recyclable and CO_2-neutral. But wood is a biodegradable material. Many traditional protection treatments currently exist to prevent these deteriorations, but often they are based on toxic materials. The aim is to get better performance from the wood, resulting in improvements in dimensional stability, decay resistance, weathering resistance, etc. Wood modification in different ways dates back from decades at the University of Sopron (Simonyi Károly Faculty of Engineering, Wood Sciences and Applied Arts, Institute of Wood Science). Wood modification processes indicate continuously new challenges. During the last years special attention was given to heat treatment processes in different media, acetylation, compression perpendicular and parallel to the grain and some impregnation processes. The application possibility of nanoscale materials in wood industry has been also investigated, using TiO_2, ZnO, CeO_2 and Fe_3O_2 nanoparticles, among others. Mechanical modifications (compression processes) affect mostly the physical-mechanical properties of wood.

INTRODUCTION

Wood is recognised as the most important of the renewable base materials with the added advantage of being recyclable and CO_2-neutral. But wood is a biodegradable material. Many traditional protection treatments currently exist to prevent these deteriorations, but often they are based on toxic materials. The aim is to get better performance from the wood, resulting in improvements in dimensional stability, decay resistance, weathering resistance, etc. Wood modification in different ways dates back from decades at the University of Sopron (Simonyi Károly Faculty of Engineering, Wood Sciences and Applied Arts, Institute of Wood Science). Wood modification processes indicate continuously new challenges. During the last years special attention was given to heat treatment processes in different media, acetylation, densification perpendicular and parallel to the grain and some impregnation processes. The application possibility of nanoscale materials in wood industry was also investigated.

Heat treatment in gaseous atmospheres

The institute possesses a programmable heat treatment chamber in which it is possible the treatment of maximum 60 cm long samples. In this electric heated, supplied with ventilators and control panels equipment it is executable a heat treatment in normal atmospherical air. Due to the elaborated schedules and experience the good quality of heat treated wood is secured. In 2010 a combined heat treatment-steaming equipment with 0,5 m^3 capacity were purchased. This autoclave is suitable for heat treatments up to 250 °C temperature in vacuum, inert gases

and steam. Investigated wood species so far: oak, turkey oak, black locust, poplar, hornbeam, beech, maple, pine and spruce. As a result of the treatments durability was improved remarkably and swelling decreased as well. By means of heat treatments exotic and homogeneous colour can be achieved in whole cross-section of the wood. This property was very useful by producing of flooring elements from the material heat treated (*Figure 1*). Beside of the favourable properties the bending, tensile (20-40%) and impact bending strength (30-70%) was decreased considerably. However, hardness and compressing strength increased slightly.

Figure 1

Flooring elements with heat treated oak, turkey oak, beech and ash top-layer (left to right)

Heat treatment in different fluids

Efficiency of heat treatment processes depends on the rate and regularity of the heat growth in the wood, and on the reducing of oxidative processes in the interest of avoid unreasonable decomposition. Heat treatment in vegetable oils can be a solution for these problems. Wood was heat treated in rapeseed-, linseed- and sunflower oil at 160-200 °C (*Figure 2*). Swelling properties decreased 20-60% and strength decreased less than by heat treatment in a gaseous atmosphere. Colour changes were similar than by heat treatments in a gaseous atmosphere. Further advantage of a heat treatment in vegetable oils is the short treatment time (by a 25 mm thick poplar board, up to 6 hours including drying). However, it has to be noted, that for example by black locust, which has a practically impermeable structure, longer treatment times are needed to avoid cracks and deformations (*Bak and Németh*, 2012). With applying paraffin as heat treatment medium instead of vegetable oils, similar results can be achieved as well as moisture uptake decreased further because of the thin paraffin layer on the surface (*Németh et al.*, 2012).

Thermo-higro-mechanical (THM) treatment of wood

In terms of each product often only one property is important to be suitable for the requirements. In terms of poplar woods indoor use surface hardness is the property which limits the utilization. The goal in this case was to produce a material with low density and high surface hardness. With THM treatment (*Figure 3*) – using heat, steam and compressing

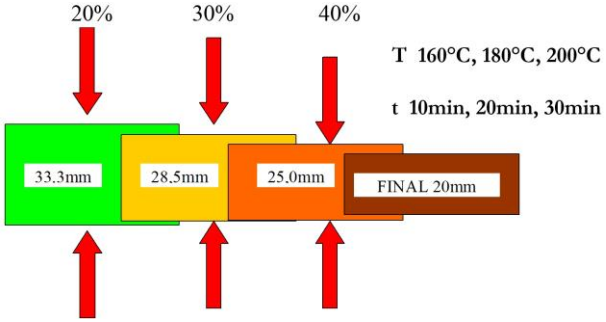
on wood – hardness of poplar wood can be increased from the very low 10 N/mm^2 to 22 N/mm^2. With 30% compression of poplar wood hardness increases 120% and reaches hardness of maple wood, which is a popular wood species of flooring element construction. Beside of the improved surface hardness wood colour became brown in 2-3 mm depth (*Ábrahám et al.*, 2010).

Figure 2

Colour change of poplar wood due to different heat treatment schedules in linseed oil

Figure 3

Parameters of the different THM process schedules



Acetylation of wood

One of the most common chemical modification processes is acetylation, which changes –OH groups in wood to acetyl-groups. Our first investigations were focussing on black locust (*Robinia pseudoacacia* L.) and poplar (Populus × euramericana cv. Pannonia). The swelling of poplar wood decreased by 70%, beside that the mechanical properties remained unchanged. Black locust cannot be effectively treated due to the small penetration deepness caused by its tyloses. However, as veneer or flake, good result can be achieved (e.g. production of weather resistant panels). Treated material typically loses colour but with appropriate surface finishing it can be brightened up. Acetylated wood has pungent smell for a long time (evaporation of acetic acid), furthermore by the application of hinges increased corrosion have to be taken into account.

As a next step hornbeam (*Carpinus betulus* L.) wood was acetylated in cooperation with Accsys Technologies (the Netherlands) (*Fodor et al.*, 2017; *Dömény et al.*, 2015). The results are promising, as the equilibrium moisture content and fibre saturation point decreased by 58% and 33% respectively, beside a slight increase in the density (4-15%, depending on the moisture content state). As a result of that, shrinkage decreased remarkably as well. The decrease was ~80% in radial and tangential directions, and ~60% in longitudinal direction. Weight loss by decaying fungi decreased by 95-98% as a result of acetylation, this means that the weight loss by three types of fungal decay was below 1%.

Usually acetylation has a slight effect on wood colour as well, which can be darkening and lightening as well. It depends usually on the initial colour and the WPG, that means light coloured woods became slightly darker, while dark coloured woods, slightly lighter. Similar results were found for acetylated hornbeam as well, as a slight darkening was observed as a result of acetylation (*Figure 4*).

Figure 4

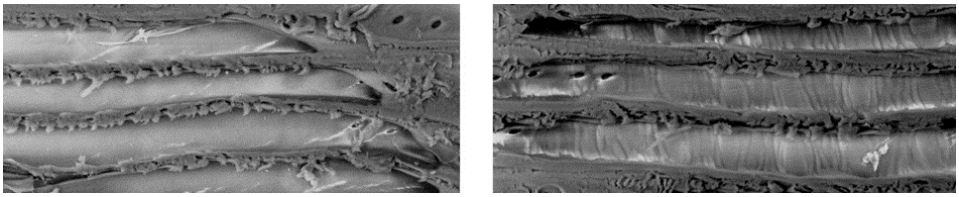
Colour change as a result of acetylation on hornbeam wood (left: untreated; right: acetylated)

Compression of wood parallel to its grain

The longitudinal compression results easier and in smaller radius bendable wood compared to the steaming process. The method can be used mostly for high density hardwoods (*Báder and Németh*, 2017). Another advantage is that longitudinally compressed wood can be kept cold for longer time in bendable state, therefore it is storable. This material can be used primarily in interior design and in the furniture industry. During the modification process the normally smooth cell walls deforming, buckle and finally seem like a half-closed concertina on the microscope images (*Figure 5*). Therefore this method can be called "pleating" (*Báder et al.*, 2019). The pleating and also the bending needs high quality hardwood raw material. Before the compression procedure the wood has to be plasticized, practically with steaming. The compression ratio is 15-25% of the original length. The sample can be held compressed for a while, this period is called fixation. Fixation also increases the pliability of the wood. After longitudinal compression and fixation, the shortening of the samples increases.

Figure 5

SEM images of the oak wood's fibres in case of a control sample (left), and a longitudinally compressed sample (right)



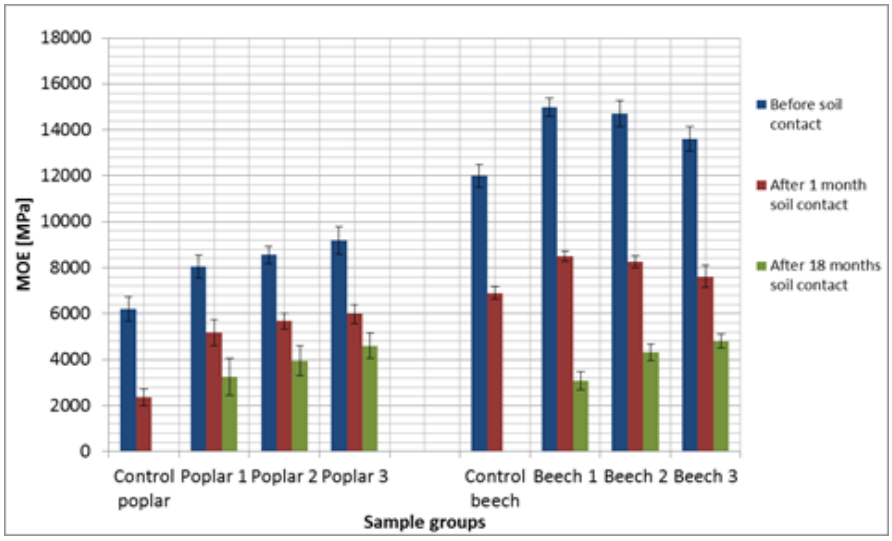
Magnification: 1000×

Other wood modification processes

In addition to the modification processes above, some other processes were investigated too. First of all, impregnation processes with beeswax or nanoparticles can be highlighted. Both treatments has the goal to improve fungal resistance of wood and improved dimensional stability (*Bak and Németh*, 2018). Zinc-nanoparticles improved durability very effective because already very low concentrations resulted in significant resistance against decay. Better results could be achieved by using zinc-borate compared to zinc oxide (*Németh et al.*, 2015). Impregnation with beeswax has a positive result that the process decreases moisture uptake of wood significantly (10-40%) and it increases the durability in short term applications, thus it can be a natural based preservative for wood without any chemicals (*Figure 6*) (*Németh et al.*, 2015).

Figure 6

MOE of poplar and beech samples (control and with 3 different DPS) in the investigation periods



CONCLUSIONS

At the University of Sopron (Institute of Wood Science) important research activity were executed during the last 30 years in terms of wood modification. In course of that, effects of numerous modification processes were investigated on wood. The main topic were investigation of different heat treatments (heat treatment in different gaseous atmospheres or liquids and with compressing), but in terms of acetylation and in development of environmental friendly wood preservatives (beeswax, nano-zinc particles) too.

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ECO-HYDROLOGY OF A FOREST AND A NEIGHBORING WET MEADOW A RIPARIAN AGRO-FORESTRY SYSTEM

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ABSTRACT

Eco-hydrology of a complex agro-forestry system consist of hydrophyte forests and wet meadows are very important question in changing climate. These ecosystems generally form riparian protection zones along streams reducing flood risk and enhancing water quality. In this study a riparian alder forest and a neighboring meadow eco-hydrolgy was analyzed in Hidegvíz-valley experimental catchment. The aim of the conducted experiment was to compare different surface cover type hydrological and botanical characteristics. The research has started in the 2018-2019 hydrological year. Throughout the botanical investigation, a list of the representative plant species has been composed from the experimental plots (an alder forest and a neighboring grassland) in each vegetation period. For classifications of the habitats the Á-NÉR categorization was used, which is a hungarian classification system for habitats. The hydrological research was focused on three important factors: precipitation, groundwater levels and soil moisture values. The preliminary results of this complex study were presented in this paper.

INTRODUCTION

Streamside vegetation types, such as hydrophyte forests and wet meadows, are important ecosystems. There were multiple studies about these complex systems, i. e. in the United States, China, and also in Hungary.

Castelli et al. (2000) examined the temporal and spatial relationships between hydrologic gradients, vegetation, and soils in two central Nevada riparian meadows in order to identify plant species and environmental variables that can serve as indicators of water-table status. Species diversity and aerial cover, ground-cover composition, depth to water-table, and soil morphological and physical properties were measured along hydrologic gradients within two riparian meadow complexes. Vegetation types were classified into four ecosystems using TWINSPAN method (*Hill*, 1979) with cluster, and multivariate discriminant analyses (*Castelli et al.*, 2000).

In the Last Chance watershed (northern Sierra Nevada, California) *Loheide and Gorelick* (2007) studied the effects of logging, overgrazing, and road/railroad construction. These acions caused stream incision, which resulted in drainage of riparian meadow and a succession from native wet meadow vegetation to sagebrush and dryland grasses. The hydrologic behavior of the characteristic research plots were simulated with a finite element model of variably saturated groundwater flow (*Loheide and Gorelick*, 2007).

In China, *Zhang et al.* (2018) examined a desert riparian ecosystem in the lower reaches of the Heihe River (arid part of Northwest China) to determine quantitative relationships among groundwater depth, soil and vegetation. The research showed that groundwater depth significantly increased with increased distance from the river, and soil and vegetation

characteristics showed a significant trend with increasing groundwater depth. They also found that with increasing groundwater depth, soil water content, soil total nitrogen, soil total carbon, soil available phosphorus and soil available potassium decreased, while the soil bulk density and soil carbon:nitrogen (C:N) ratio increased (*Zhang et al.*, 2018).

In 2016, Móricz studied the groundwater uptake of vegetation in discharge and recharge regions of the Hungarian Great Plain. A poplar (Populus tremula) plantation and an adjacent corn field plot were surveyed in a local discharge area, while a black locust (Robinia pseudoacacia) plantation and an neighboring corn field plot were also analyzed in a recharge area. The water table under the poplar plantation displayed a night-time recovery in the discharge region, indicating significant groundwater supply (*Móricz et al.*, 2016).

All of above mentioned studies showed that groundwater level in the riparian zone has the most important impact of the vegetation type.

In this study a riparian alder forest and an adjacent wet meadow eco-hydrolgy was analyzed in Hidegvíz-valley experimental catchment (west Hungary).

MATHERIAL AND METHODS

The Hidegvíz-valley experimental catchment is located in Győr-Moson-Sopron county (Hungary). The research area can be found in a valley bottom, with mostly sandy soils The climate is semi humid with 8,5 - 9,2 Celsius mean temperature and with 700 - 750 mm annual precipitation (430 mm in growing season) (Dövényi et al. 2010).

The measurements were taken in a walley cross section nearby the outlet of the experimental catchment (*Figure 1*).

Figure 1

The sampling area in the Hidegvíz-valley

The brown line indicates the stream, the lilac is the road, the red one is the elder garden and the green is the edge of the forest. Yellow dots represent the soil moisture measurement plots.

Surface soil moisture were measured on six point in each vegetation type with a TDR device. Meteorologoical data (air temperature and precipitation) was collected by a nearby meterological station. Groundwater levels were measured in the elder garden and at the forest edge.

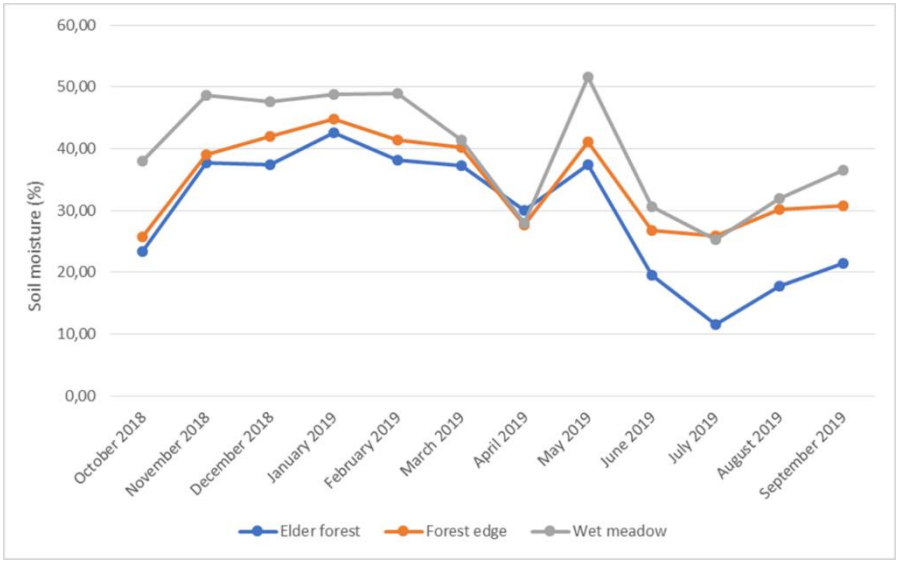
The botanical research was based on the Braun-Blanquet method (which is adequate, if the sampling area is smaller than 100 ha) with three experimental plots in each vegetation type (*Bartha et al.*, 2011). For the classification a hungarian system called Á-NÉR (*Bölöni et al.*, 2011) was used.

RESULTS AND DISCUSSION

Hydrological results showed that different vegetation had significantly different soil moisture (SM). Wet meadow SM is always the highest, and elder forest is the smallest. The only exeption was in May, the month with extreamly high rainfall amount (*Figure 2*).

Figure 2

Soil moisture measured by the TDR in the observed year



All the hydrological data was used to calculate the annual water balance. We calculated it using the following equation:

$$\boldsymbol{P - INT - (PET - INT) = dS - ETgw} \quad (1)$$

Where P is precitipation, INT is interception, PET is potential evapotranspiration, dS is change in the storage, ETgw is groundwater inflow. The PET-INT means the transpirantion (all parameters in mm).

Montly water balance graphs show that the elder forest had higher interception rate and needed more groundwater supply (*Figure 3* and *Figure 4*).

Figure 3

Water balance of the elder woodland during one year

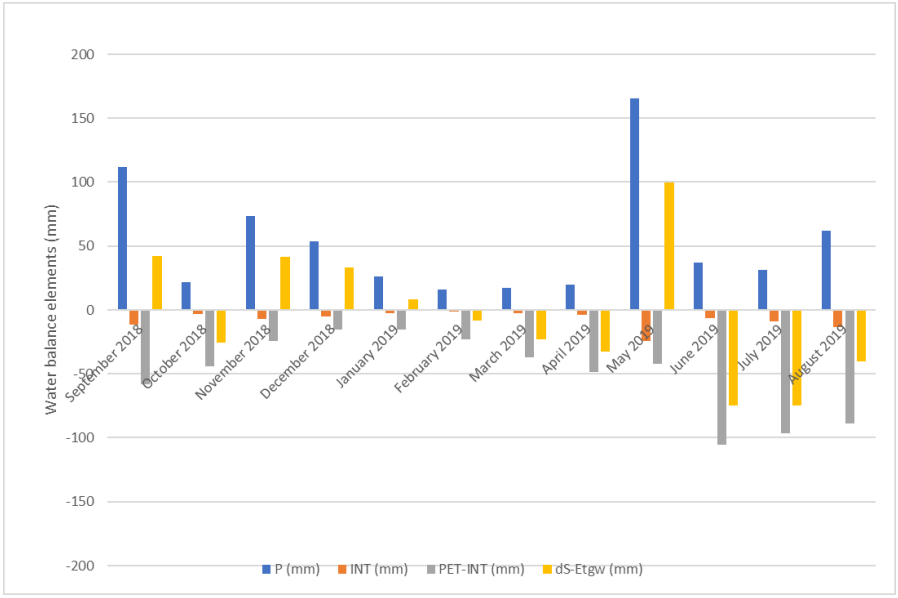
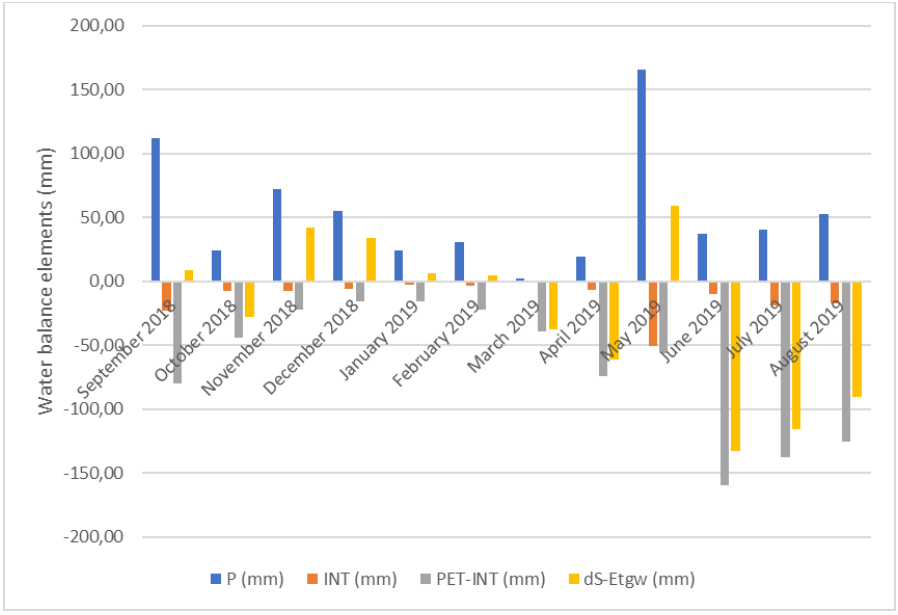


Figure 4

Water balance of the wet meadow during one year



The classification of the botanical study was based on the Á-NÉR system, showed that the elder woodland defined as a riverine ash-elder woodland, and the grassland was defined as an uncharacteristic mesic grassland. Most of the plants preferred wet or semi-wet habitats (i.e. common elder (*Alnus glutinosa*) and purple loosestrife (*Lythrum salicaria*), but in the meadow there were dry spots. Here we found herbs that usually growing in arid habitats (i. e. wild carrot (*Daucus carota*) and common yarrow (*Achillea millefolium*).

CONCLUSIONS

Results from the hydrological and the botanical research showed that there is a strong correlation between the water balance and the vegetation. The plants' ecological needs follow the hydrological changes. We also learned that these habitats have patterns with wet and dry spot and typical herbs show this varierty.

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ECOTOXICOLOGICAL EVALUATION OF TRACE ELEMENT SUPPLEMENTATION ON ANAEROBIC DIGESTION

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ABSTRACT

The aim of this study was to evaluate the effects of trace element supplementation on semi-continuous anaerobic digestion of sugar beet pressed pulp. Furthermore we have investigated the phytotoxicity of anaerobic sludge via an ecotoxicological test for white mustard (Sinapis alba). Three parallel reactors were run in all cases of non-supplemented (without trace element supplementation), supplemented (2 µL $L^{-1}d^{-1}$ of trace element solution) and supplemented + Fe (2 µL $L^{-1}d^{-1}$ of trace element solution + 82 µL$L^{-1}d^{-1}$ of Fe(III)-chloride 40% aqueous solution – technical grade). The acute toxicity test was applied according to the Slovakian standard of STN 83 8303:1999. Three parallel tests were applied in all dilution rates (dilution of 10, 50, 100 and 200 x) of non-supplemented, supplemented and supplemented + Fe sludges, respectively. Results showed that average values of specific methane yields were 11.0 and 11.7% higher in the supplemented and supplemented plus iron trials compared to the non-supplemented trial, respectively. In the root elongation test of white mustard, the highest stimulation rate (-59.41%) was observed for the 10-fold dilution in the treatment with trace element and iron supplementation.

INTRODUCTION

Usage of sugar beet pressed pulp (SBPP) in anaerobic digestion is one way to utilize sugar production's waste (*Tukacs-Hájos et al.*, 2014). The obtained renewable energy can be applied for heat or electricity production, but there is a secondary derivative, the fermented sludge, which has a great potential in the application on agricultural and forestry fields for fertilisation (*Govasmark et al.*, 2011; *Demirel et al.*, 2013; *Dong et al.*, 2013). By this complex use we can nearly reach a waste-free technology.

The digester effluents could provide the essential nutrients for plant growth when used as organic fertilisers (*Achiba et al.,* 2010). Since sludges are complex mixtures of different substances, speciation of toxic materials would be expected to increase or reduce toxicity (*Gomez et al.*, 2001; *García-Delgado et al.*, 2007; *Tu et al.*, 2012). Effluents used for irrigation water may cause a risk of decreasing crop production due to high salinity (*Ullman and Mukhtar*, 2007).

Optimal anaerobic digestion can be reached by addition of different trace elements based on to microbial requirements (*Zhang and Jahng*, 2012; *Qiang et al.*, 2013). The most commonly studied elements are iron, cobalt and nickel (*Choong et al.*, 2014). Apart from the positive impact on methane production, the accumulated heavy metals in the sludge could have adverse effects

on the soil ecosystem (*Walter et al.*, 2006; *Salazar et al.*, 2012). This negative effect can be prevalent for soil flora and fauna (*Carbonell et al.*, 2009). The most critical point of view is the availability of microelements by plants from the soil, which could be affected by anaerobic digestion and lower mobility of metals from digested slurry (*Marcato et al.*, 2009; *Pagnanelli et al.*, 2009). *Zhu et al.* (2014) state that Cu, Zn, Mn, Ni and Cd may be grouped as toxic and active components in sludge. The different trace elements can appear in food chain systems through cultivated plants from contaminated soil (*Wahsha et al.*, 2014, *Le et al.*, 2015).

Information on the phytoavailability changes with trace element supplementation of anaerobic sludge are scarce. There are two main methods to assess bioavailability: chemical measurements in the soil matrix and biological measurements using organisms exposed to soil (*Walsh et al.*, 1991; *Harmsen*, 2007). To investigate the injurious effects, different acute and chronic ecotoxicological tests are applied in practise (*Rosa et al.*, 2007; *Roig et al.*, 2012; *Young et al.*, 2012). Lactuca sativa seed germination and root elongation inhibition tests are used for assessing the toxicity reduction from anaerobic digestion based on measuring main chemical operational parameters (*Young et al.*, 2012).

Main aims of this study were to investigate the improved methane yield by supplementation of trace elements and to evaluate the ecotoxicological effects on fermented sludge

MATERIAL AND METHODS

Anaerobic digestion

Biogas reactors

The anaerobic digesters were 1-L working volume bottles (2.5 L capacity threaded brown bottles, Merck, Germany). The digesters were incubated in a water bath (Memmert WNB 14 Basic, Memmert GmbH. & Co.) at a constant temperature of 38°C. The anaerobic digester inoculum was active, adapted to sugar beet pressed pulp substrate (HRT 20 days) obtained from a biogas plant (Sugar factory, Kaposvár, Hungary). The reactors were manually mixed three times per day and the produced biogas was collected by Tedlar® gas sampling bags; volume was measured with a Hamilton gas-tight syringe (Sigma Aldrich Co). Biogas and methane yields were recalculated to the standard conditions for pressure and temperature.

Experimental design

Sugar beet pressed pulp as substrate was applied in our semi-continuous lab-scale experiments. The organic loading rate was raised to 5.2 gVSL-1d-1 by day 19; subsequently, because of the high tVFA concentration in all trials (up to 10000 mg L-1), feeding was stopped for two days. After this, a moderate loading rate was performed from day 22 to day 44, with a maximum of 3.8 gVSL-1d-1; subsequently, the OLR remained stable until day 81.

Three parallel reactors were run in all cases of non-supplemented (without trace element supplementation), supplemented (2 µL L-1d-1 of trace element solution) and supplemented + Fe (2 µL L-1d-1 of trace element solution + 82 µLL-1d-1 of Fe(III)-chloride 40% aqueous solution – technical grade). The application of high doses of iron is explained by its detoxification effect on sulphide inhibition, as described by *Gonzalez-Silva et al.*, (2009).

The trace element supplement solution contained 1625 mg of zinc, 13640 mg of manganese, 93 mg of boron, 20000 mg of nickel, 600 mg of copper, 50000 mg of cobalt, 228 mg of

molybdenum and 113 mg of selenium in a special organic complex form per kg of solution (42.2% TS). Dosing of microelements was based on our former experiment (*Tukacs-Hájos et al.*, 2014).

Analytical methods

Sludge samples (10 mL) were taken for chemical analysis before feeding. Samples were centrifuged for 10 min at 3,420 RCF (EBA 21, A. Hettich Co, Germany). From the resulting supernatant, 5 mL were used for determination of titrated VFA (tVFA) levels (every 5th day), using a potentiometric pH meter (EuTech PC 510, Thermo Fisher Scientific), and calculated in acetic acid equivalents (*Rétfalvi et al.*, 2011).

The components of biogas were analysed using an Ecoprobe 5-IR (RS Dynamics Ltd, Czech Republic).

Determination of COD was carried out according to the Hungarian standard protocol (MSZ ISO 6060). Determination of ammonium and total phosphorus was carried out according to the Hungarian standard protocols MSZ ISO 7150-1 and MSZ 488/18-77, respectively (*Rétfalvi et al.*, 2015).

Ecotoxicological tests

Preparation of aqueous extracts

The quantities of original sludges were weighted, corresponding to 100 ± 0.1 g of dry matter, and 1 L of demineralised water was added. Subsequently, the samples were shaken for 6 hours. The extracts were then left for 18 hours to sediment and after sedimentation, solid phases were separated by filtration through a paper filter with a pore size of 3 ± 2 µm.

Root elongation test with white mustard

The acute toxicity test was applied according to the Slovakian standard of STN 83 8303:1999. The tested organism was white mustard (Sinapis alba), a member of the Brassicaceae family. The sorted white mustard seeds were ochre-yellow, with a size of 1.5 to 2.5 mm, and germination power was higher than 99%. Thirty seeds were placed uniformly into Petri dishes (diameter of 120 to 140 mm) and 10 mL of the prepared aqueous extracts were added.

Three parallel tests were applied in all dilution rates (dilution of 10, 50, 100 and 200 x) of non-supplemented, supplemented and supplemented + Fe sludges, respectively.

As diluent, water stock solutions of salts were prepared and also used for the control. The pH of the diluent water varied around 7.6-8.0.

Table 1.

Test conditions of white mustard root growth inhibition

Testing organism	*Sinapis alba*, ochre yellow, size 1.5–2 mm, germination > 99%, 30 seeds in Petri dish, 10 mL sample
Temperature	20 ± 1°C, incubator TS 606 CZ/2-Var (WTW, Germany)
Control	Reconstituted water
Exposition period	72 hours
Monitored response	Root growth inhibition compared to control, IC

The basis of inhibition/stimulation effect on root growth was the average length of root determined in the individual concentrations of sludge in comparison with the average root length in the control.

The inhibition–stimulation effect (IC%) on root growth was calculated using the following equation:

$$IC\% = \frac{L_k - L_v}{L_k}.100 \quad (1)$$

where:
Lv is the average length of root in the tested concentration of aqueous sludges in cm,
Lk is the average length of root in the control in cm.

Statistical analysis

The software package STATISTICA 10 (Version 10, StatSoft, Tulsa, OK, USA) was used for performing (analysis of variance) and single factor dispersion analysis to evaluate the results of the ecotoxicological tests. Graphical presentation of ANOVA and Duncan's test results was performed using 95% confidence intervals for average immobilisation and inhibition values for individual samples (*Hybská et al.*, 2017).

RESULTS AND DISCUSSION

Methane production

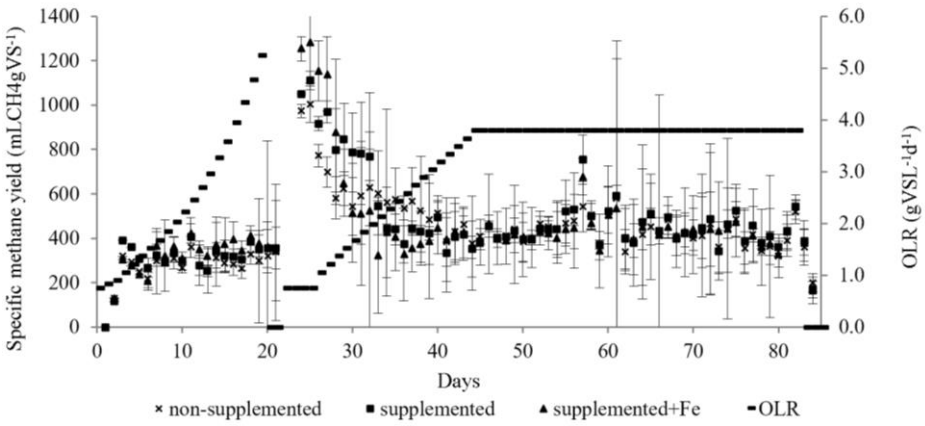
The effect of microelement supplementation was examined via methane production. The average values of SMY (403.8 ± 4.51^a mL CH_4 gVS^{-1} in case of non-supplemented, 448.3 ± 9.91b mL CH_4 gVS^{-1} in case of supplemented and 451.1 ± 9.16b mL CH_4 gVS^{-1} in case of supplemented+Fe trial, different letters indicate significant difference at $P \leq 0.05$) represent the 11.0% and 11.7% benefit effect of supplementations. This observation is in agreement with the findings of Wall et al. (2014). They reported an increase in SMY in the mono-digestion of grass-silage by 12% to 404 L CH_4 kg^{-1} VS by the effects of Co, Fe and Ni addition.

Specific methane yields were balanced during the uploading stage, with average values being 285.2, 317.6 and 328.9 mL CH_4 g VS^{-1} for the non-supplemented, supplemented and supplemented + Fe trial, respectively (*Figure 1*). Values of the average SMY values of supplemented and supplemented + Fe compared to non-supplemented increased by 12.6 and 23.0% during the drastic overloading period (day 12-19). The most significant effect of microelement supplementation on SMY was recognised during the reloading stage. In the first seven days of this period, SMY values increased by 22.2 and 32.3% and then decreased by 6.5 and 29.3% in the supplemented fermenters. During the stable run at moderate OLR levels, the effects of microelement supplementation on SMY rates were lower (5.8 and 1.8%, respectively).

The methane content of biogas was not significantly influenced by microelement supplementation. Average methane values and ranges of daily biogas production were 53.95 (51.68-56.74%), 54.19 (51.66-58.32%) and 53.49% (50.36-58.69%) for the non-supplemented, supplemented and supplemented + Fe trial, respectively.

Figure 1

Alteration of specific methane yields of non-supplemented, supplemented and supplemented + Fe trials during the experiment



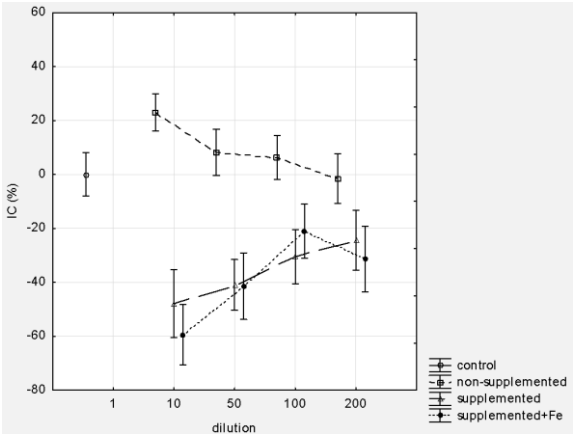
Root elongation test with white mustard

The preliminary test was negative as root growth inhibition was less than 30% and stimulation was lower than 75% compared to the control; therefore, further tests were not necessary (STN 83 8303:1999).

Decreased inhibitory effect could be determined in the non-supplemented treatment with increasing dilution rates (*Figure 2*). The highest stimulating rate (-59.41%) was found for a 10-fold dilution in the supplemented + Fe trial. Iron completion had no significant effect on IC% values.

Figure 2

Effects of dilution rates of anaerobic sludge on root growth of white mustard (0-100 IC%: inhibition, 0-100 IC%: stimulation)



CONCLUSIONS

This paper has highlighted the importance of trace element supplementation for anaerobic digestion of SBPP. In addition, we investigated the ecotoxicological effects of sludges on root elongation (white mustard). Based on the average values of SMY, supplementation (supplemented and supplemented + iron) increased the values by 11.0 and 11.7% compared to the non-supplemented control trial. The methane content of the produced biogas was not significantly influenced by microelement supplementation. This means that anaerobic digestion with trace element supplementation is more stable and flexible. Ecotoxicological assessment of anaerobic sludges is extremely important to determine application possibilities that could adversely affect forestry and agriculture. The applied tests were appropriate indicators to determine the differences of inhibition-stimulation effects. In the white mustard root elongation test, the highest stimulation rate (-59.41%) was found for the 10-fold dilution in the supplemented + iron trial.

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MICROCLIMATIC CONDITIONS OF A FORESTED HILL IN SOPRON

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ABSTRACT

The microclimatic conditions of agroforestry systems can largely differ from forested or agricultural areas. Our aim is to quantify the microclimatic processes in these systems. In our case study we analyzed the impact of orography (primarily aspect) on the diurnal cycle of temperature and relative humidity. In the Harkai-hill (close to the city Sopron), mobile devices were installed on the northern and southern slope of the hill. Results shows that in daytime, the southern slope is by up to 5 °C warmer than the northern slope. In nighttime, temperature were higher in the northern slope for all days. The temperature differences can be partly explained by the diurnal cycle of the relative humidity. Other explanation can be that in daytime the southern slope warms up more intense than the northern slope. Therefore in nighttime (no incoming solar radiation) the cooling of the southern slope is faster and more intense. In the growing season (foliated canopy) the temperature difference between the slopes was smaller than for leafless canopy, for both daytime and nighttime. To find out the exact reasons for this phenomenon, further research is essential concerning the weather patterns and the local wind conditions. However, measurements provide a good starting point to the assessment of the microclimatic conditions and potential benefits of agroforestry systems.
Keywords: agroforestry systems, microclimate, aspect, temperature, relative humidity

INTRODUCTION

Microclimate is the part of the atmosphere that is in direct contact with the ground. It extends from a few m2 to several hectares. They do not differ significantly from the macroclimate, but they influences strongly each other (*Péczely*, 1984, *Czelnai*, 1995, *Bartholy and Pongrácz*, 2013). The microclimate has many modifying factors. By changing the incident angle of the sun's rays, the orography increases or decreases the amount of irradiation. Therefore the hilltop, valley, north and south exposured slopes warm up differently. The vegetation also changes the microclimate by modifying the irradiation, but its effect changes dynamically, depending on the season and the vegetation stage of the plants (*Szász et al.*, 1997, *Foken*, 2008). Not only the vegetation cover, but also the type and species composition of the vegetation have an effect on the microclimate. These effects in a forest-covered area differs from that of an agricultural crop (*Papp and Gillay*, 1965, *Szász et al.*, 1997).

Forest trees create specific climatic conditions. Most of the radiation in a forest is absorbed by the canopy and only a small part is transmitted to the ground (*Papp and Gillay*, 1965, *Vig*, 1995, *Fokan* 2008). The heat radiated from the soil is trapped and held by the foliage. The trees at the forest edges also play an important role in retaining the wind (*Vig*, 1995, *Potter et al.*, 2013).

Like other agricultural crops, agroforestry systems affect also to the microclimate. In agroforestry systems, temperature, relative humidity, radiation conditions, wind speed have characteristic vertical and horizontal gradient patterns (*Szász et al.*, 1997). Agroforestry

systems can have a temperature-reducing, humidity-increasing effect (*Varga-Haszonits et al.*, 2000). This effect is highly dependent on the phenological characteristics of the plant species, the height of the vegetation, the soil characteristics (*Martius et al.*, 2004) and the cultivation technology (planting distance, row spacing, species composition, etc.). The temperature-reducing effect of shading is particularly emphasized regarding to climate change, as this phenomenon may be important in maintaining the health status of plants in the more arid conditions.

Therefore our aim was to quantify the microclimatic conditions of a forested hill, with special focus on the orographical effects (primarily aspect) on the diurnal temperature cycle, and how the temperature difference between the southern and the northern slope is influenced during the vegetation period and dormancy season.

MATERIAL AND METHODS

The measurements have been carried out in the Harkai-hill (*Figure 1*). The area is 2 km south of Sopron and is part of the Sopron Landscape Protection Area. The extent of plant cover of the Harkai-hill is nearly the same on both sides. On the south side, there are typically warm-tolerant, light-demanding species, such as downy oak (*Quercus pubescens*), wild pear (*Pyrus pyraster*), Adriatic fescue (*Himantoglossum adriaticum*), fragrant calf meadow (*Anthoxanthum odoratum*). In contrast, on the north side, less heat- and light-tolerant species appear, like sessile oak (*Quercus petraea*), in protected corners, and apricot bluebell (*Campanula persicifolia*). The Harkai-hill is a freestanding cone, which is far enough from the Sopron Mountains, therefore the microclimate conditions of the hill are not influenced by the mountains (*Figure 2*).

Figure 1

Case study area: Harkai-hill (close to the city Sopron)

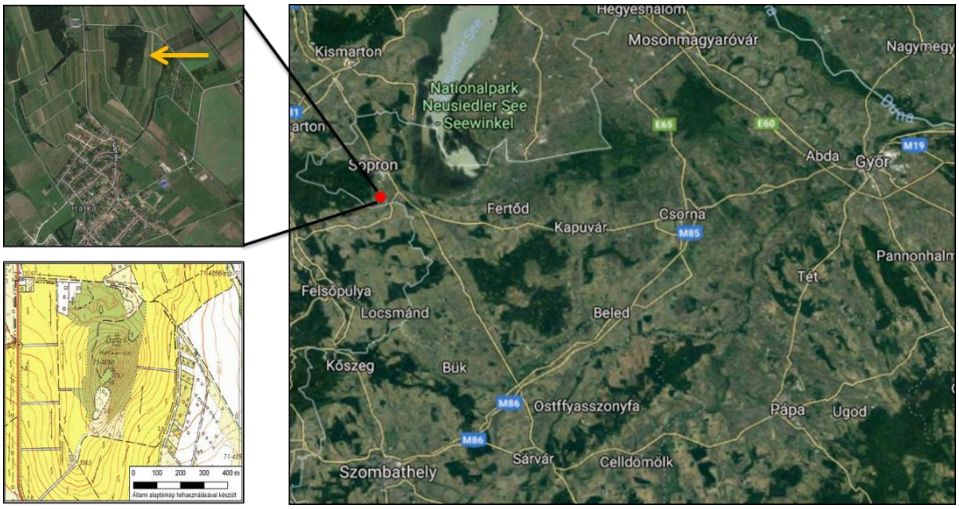
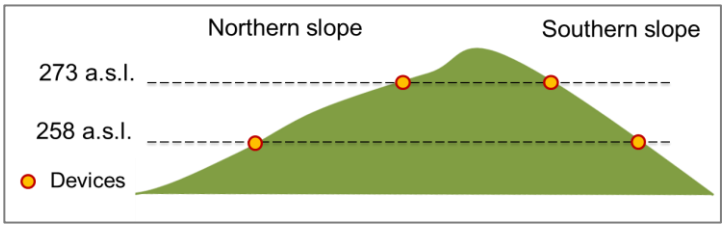


Figure 2

Schematic illustration of the installation of the devices



Voltcraft DL-121TH USB Data Loggers were installed on both the southern and northern slopes of the hill (*Figure 3*). Because of their small size and easy handling, these devices are optimal for our purpose. Temperature, relative humidity, and dew point data were collected in 10 minute intervals between April 1, 2018 and September 30, 2019. The daily and hourly average temperatures were calculated for the vegetation period and dormancy season, as well as for the warmest (July) and coldest (January) months.

Figure 3

Applied moble device

Furthermore, the mean and maximum temperature differences between the southern and northern slopes were determined. Finally, typical days were selected in the vegetation period and in the dormany season, for which the temperature difference of the two sides was analyzed in hourly time step.

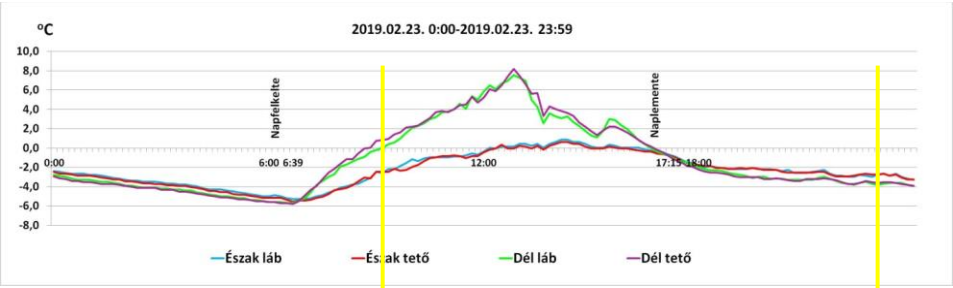
RESULTS AND DISCUSSION

In a relatively large part of the investigation period, the northern side seemed to be warmer at night, which is different from our previous expectations, so we analyzed the phenomenon for

a selected precipitation-free day. As shown in *Figure 4*, the northern side is warmer between sunset and sunrise, but the temperature difference does not exceed 1 °C. During the day, the southern slope is warmer by 6-7 °C than the northern slope. While the temperature difference between the slopes varies strongly during the day, at night the difference is constant.

Figure 4

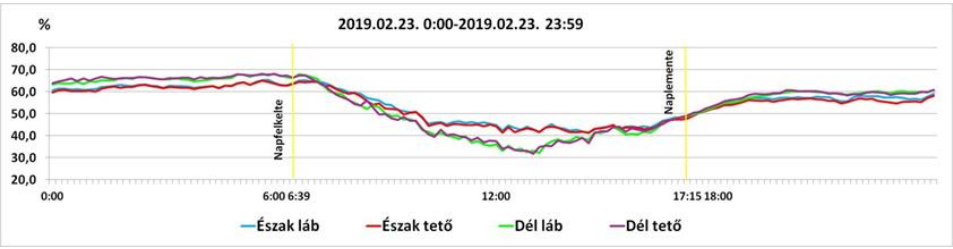
Diurnal temperature cycle on the southern and northern slope for a characteristic day



The temperature equilibrium between the two sides is at sunrise and sunset (Figure 4). Close to sunrise, it is getting colder as the soil stops to emit radiation. As the sun rises above the horizon, both the northern and southern sides begin to warm and the southern slope becomes warmer. The temperature reaches its maximum at about noon in the leafless period and slightly after 1 pm in the foliated state. In the afternoon, as the radiation is getting less intense, the southern side cools faster than the northern side. This is partly due to differences in relative humidity (*Figure 5*). In daytime, the southern side dries faster, its relative humidity is lower than that of the north side, and therefore starts cooling (the dry air dew point is lower). At sunset, the temperature difference between the two sides disappears. After that, the south side will continue to cool faster, that results in higher nighttime temperatures on the northern slope.

Figure 5

Diurnal cycle of relative humidity for a characteristic day



For characteristic days in the dormancy season and vegetation period, the magnitude of the effect of vegetation on the temperature difference between the southern and northern slopes was analyzed. The difference in temperature between the two sides of the hill in the

leafless state is greater than in the foliated state, both at daytime and nighttime. In the dormancy season on a rainless day at noon, the southern slope can be warmer by up to 5 °C than the northern slope (*Figure 6*). In the vegetation period, this value was up to 4 °C (*Figure 8*). At night the northern slope was warmer by 1-2 °C. This is also consistent with the relative humidity difference between the two sides, the warmer side was consistently the drier and the cooler side the wetter (*Figure 7, Figure 8, Figure 9*).

Figure 6

Characteristic diurnal cycle of temperature (T; left) and the difference (ΔT) between the southern slope and the northern slope (right): leafless canopy

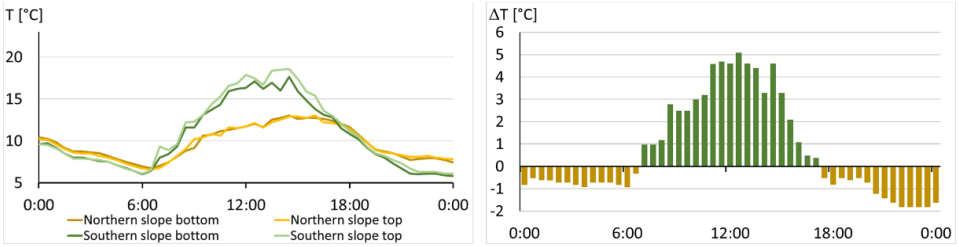


Figure 7

Characteristic diurnal cycle of relative humidity (RH; left) and the difference (ΔRH) between the southern slope and the northern slope (right): leafless canopy

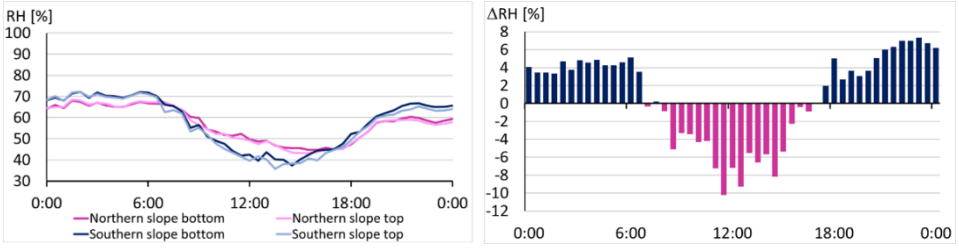


Figure 8

Characteristic diurnal cycle of temperature (T; left) and the difference (ΔT) between the southern slope and the northern slope (right): foliated canopy

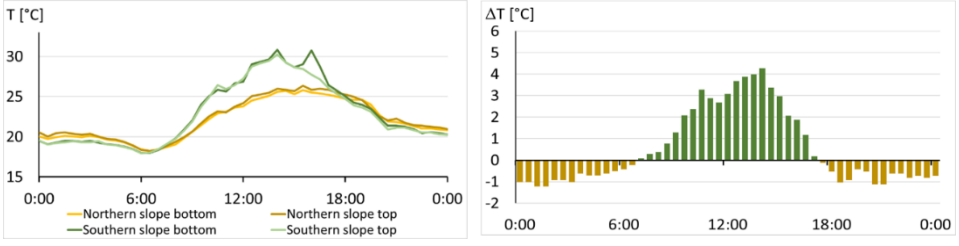
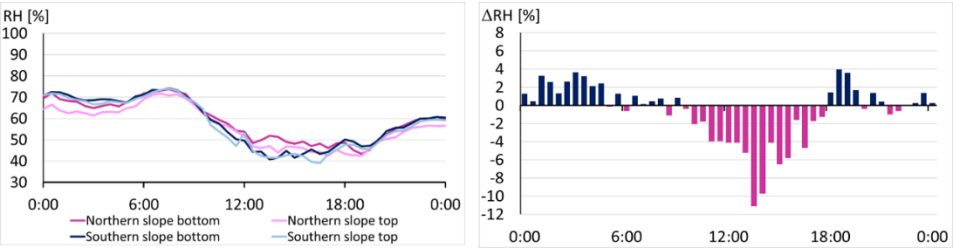


Figure 9

Characteristic diurnal cycle of relative humidity (RH; left) and the difference (ΔRH) between the southern slope and the northern slope (right): foliated canopy



CONCLUSIONS

Or study aimed to quantify the orographical effects (primarily aspect) on the diurnal temperature cycle of a forested hill and how the temperature difference between the southern and the northern slope is influenced during the vegetation period and dormancy season. The main findings are:

- For leafless canopy in daytime, the southern slope was up to 5 °C warmer than the northern slope. In nighttime the northern slope was characterized by higher temperatures (by up to 2 °C).
- In foliated canopy the temperature difference between the slopes was smaller than for leafless canopy, for both daytime and nighttime.
- The temperature differences can be partly explained by the diurnal cycle of the relative humidity, however, more research is essential.

Despite calibration correction, the uncertainties of the applied mobile devices can cause some uncertainties in the measurements. Thererfore we draw conclusions on the temperature difference between the slopes rather than on the measured absolute values. Longer time series on multiple sites are essential to better understand the processes, and to draw more reliable conclusions. However, the measurements are of practical importance from a forestry point of view. Information on the climatic conditions of a hillside or mountainside can help foresters to reforest the area with the tree species that prefer the existing conditions. From the point of view of agroforestry, information on the climatic and microclimatic conditions can support the selection of plant species that are able to survive the expected climatic change. Furthermore, it helps to propose agroforestry systems that have the most favorable microclimatic effects.

ACKNOWLEDGEMENT

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A SHORT REVIEW OF THE BENEFITS OF AGROFORESTRY SYSTEMS

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ABSTRACT

Agroforestry requires a different view both upon agricultural management and forest management. While these traditional managements separate most of their activities from each other, the agroforestry aims to integrate forests into agricultural systems. The agroforestry is a dynamic, ecology based natural resource management system which increases yield and simultaneously provides social, economic and environmental benefits. These factors play a key role in maintaining biodiversity, preserving habitats and their respective species. Several factors which must be analyzed in order to effectively manage an agroforestry system. The soil fertility and health, the water percolation, retention and runoff, biodiversity and carbon/nutrient circulation, etc. The soil test measures the pH level, porosity, the level of major, secondary and minor nutrients, the presence of possible contaminants. The biodiversity could be measured by identifying the plant and animal species in the area. A properly used agroforestry system also provides better protection from biotical and abiotical damage sources and results in an area of high social, environmental value. If the tree species and the planting system are well-chosen, the benefits of agroforestry can be directly increased by the crops of trees and later by their wood.

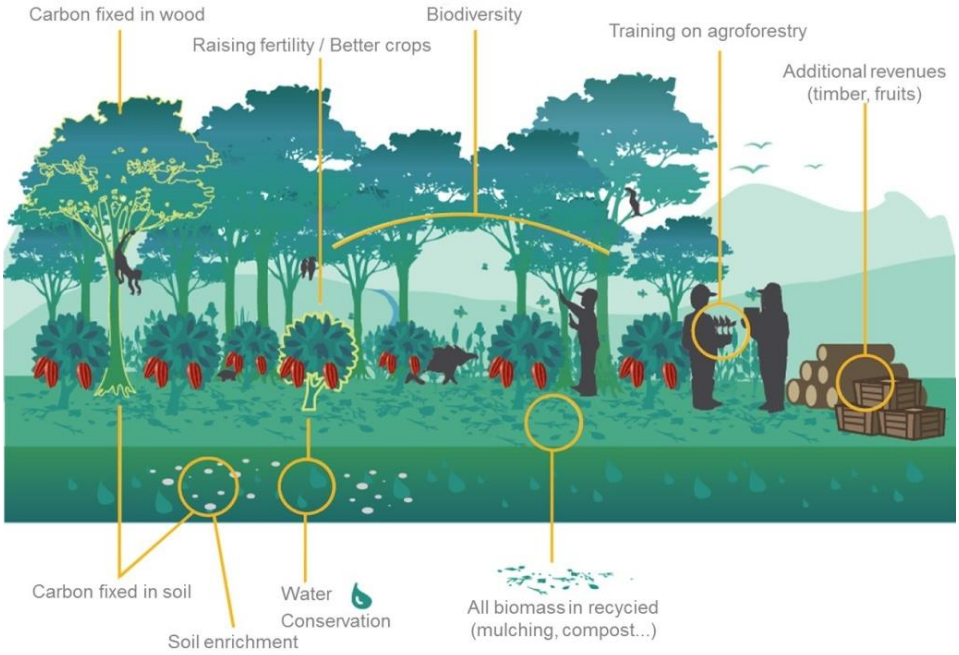
INTRODUCTION

The word 'agroforestry' was used in 1977 for the first instance, in order to define a combined system of forestry and agriculture: *"A collective name for land-use systems in which woody perennials (trees, shrubs, etc.) are grown in association with herbaceous plants (crops, pastures) or livestock, in a spatial arrangement, a rotation, or both; there are usually both ecological and economic interactions between the trees and other components of the system"* (*Lundgren*, 1982).

Albeit the definition is from the recent times, the practice of integrating trees into agriculture has been done for thousands of years (*Smith*, 2010). The agroforestry aims to build a link between forestry and agriculture into one integrated system, which has both socio-economic and environmental goals (*Figure 1*). Environmental benefits include increased biodiversity, lower chances of soil degradation, cleaner water supplies and higher amount of carbon sequestration (*Brown et al.*, 2018). These factors mean that is possible to improve the food production whilst lessen the costs on the environment (*Burgess and Rosati*, 2018). On the economical side, agroforestry offers more stable agricultural systems, with increased yield of crops and overall more consistent incomes (*Brown et al.*, 2018).

Figure 1

Schematic Illustration of an Agroforestry System



Source: https://www.purprojet.com/wp-content/uploads/2016/05/agroforestry2.png

AGROFORESTRY AS A REGENERATIVE AGRICULTURAL SYSTEM

Due its principles and methods, agroforestry can be classified as a regenerative agriculture system. Although there are several ways to define the regenerative agriculture, none of these are accepted uniformly (*Elevitch et al.*, 2018). A few examples are as follows: "*Practices that: (I) contribute to generating/building soils and soil fertility and health; (II) increase water percolation, water retention, and clean and safe water runoff; (III) increase biodiversity and ecosystem health and resiliency; and (IV) invert the carbon emissions of our current agriculture to one of remarkably significant carbon sequestration thereby cleansing the atmosphere of legacy levels of CO_2*" (*The Carbon Underground*, 2017). *LaCanne and Lundgren* (2018) has another phrasings: "*Unifying principles consistent across regenerative farming systems include: (1) abandoning tillage (or actively rebuilding soil communities following a tillage event); (2) eliminating spatio-temporal events of bare soil; (3) fostering plant diversity on the farm; and (4) integrating livestock and cropping operations on the land*" (Figure 2). Though the definitions may approach the subject from different perspectives, they share a reasonable amount of common themes. These common themes are: the soil fertility and protection, the protection of water supplies and its percolation, conservation and enhancement of biodiversity, maintaining a self-renewal, stable ecosystem and carbon sequestration (*Elevitch et al.*, 2018).

Figure 2

Silvoarable Agroforestry System with Barley and Poplar

Source: https://www.agroforestry.co.uk/wp-content/uploads/2018/05/silvoarable1.jpg

THE HISTORY AND BENEFITS OF AGROFORESTRY

As it was mentioned in the Introduciton, the predecessors of agroforestry systems were present in the last few thousand years, in the history of humanity. Based on the time period when they were created and used, the systems could be separated into two different groups: traditional and modern systems. The traditional systems include fruit tree systems, olive systems, shelterwoods and woodland grazing, pollards, pannage, dehesas, montados, hunting forests, hedgerows and timber tree systems (*Smith*, 2010).

The fruit tree systems were in use up until the 20th century. Nut and fruit silvorable systems were common in Central Europe. In some countries a few instances of fruit tree systems still remain. In Sicily 18,000 hectares of cereals or fodder paired with almond trees can be found. In the Aegean Islands and Crete cereals and fig trees are planted on 10,200 hectares. In northern Spain apple trees were planted in rows or in a scattered manner in croplands and meadows; these were called as *pomeradas* (*Smith*, 2010).

Olive plantations were present from pre-Roman times, where in alternate years wheat were intercropped with olive trees in order to increase the yield of olives for the next years. Even today, olive groves are present on 650,000 hectares in Greece. Either planted in scattered manner or in rows, olive trees and grapes vines are intercropped with vegetables, cereals or crops in both Greece and Spain (*Smith*, 2010).

Woodland grazing and shelterwoods offer a connection between livestock and the woodlands, these are among the oldest traditions of land usage. The shelterwoods of Northern Europe protected the sheep and cattle from the cold weather and in the Mediterranean regions sheltered the animals from the sun during summer. Another benefit of these mediterranean shelterwoods where that as the animals fed from the foliage between the trees, they reduced the chances of wildfires during hot summers (*Smith*, 2010).

Pollarding is the process of gathering tree branches in order to collect fodder for the livestock or wood for other uses. Pollarding was widely practised across Europe but fodder pollarding was especially common in the mountainous regions such as the Alps, Pyrenees or the Basque country. The leaf-bearing branches were cut in the summer period, dried and stored for the livestock for the winter months. The trees themselves were cut down in 2 to 6 years of rotation. Several species of decidous trees are suitable for pollarding: the most frequent are *Salix caprea* (goat willow), *Betula pubescens* (downy birch), *Betula pendula* (silver birch), *Fraxinus excelsior* (common ash) and *Ulmus glabra* (scots elm). Pollarding for wood material in Europe was universal as well, although this practice was often restricted to areas that met the special demands this method needed. An example for such special area is in England, an area named Epping Forest, where the pollarding for fuel materials were at an industrial scale. The forest itself consisted of different tree species, namely *Carpinus betulus* (hornbeam), *Fagus sylvatica* (common beech) and *Quercus robur* (pedunculate oak) (*Smith*, 2010) (*Figure 3*).

Figure 3

Pollarded Beech Trees in the Epping Forest, UK

Source: http://websterswildshots.com/wordpress/wp-content/uploads/2012/11/Pollarded-Beech-Epping.jpg

On the other hand in Italy, trees were planted in hedges for a similar purpose. The most common species were *Morus alba* (mulberry), *Salix viminalis* (common osier willow) and *Ulmus campestris* (elm) (*Smith*, 2010).

The modern systems as concept were introduced in end of the 1970s and were designed to find a balance between environmental conservation and yield increase. The following modern systems were developed: silvopastoral (livestock/pasture and trees), silvoarable (crops and trees) for timber, fuel and food production and systems for environmental reasons, for instance soil protection, shelterbelts and riparian buffer systems (*Smith*, 2010).

The distinct environmental benefits of the agroforestry systems are the bindind of carbon in wood, provides a moderate microclimate, reduces the risk of fire, soil degradation, nutrient leaching and an improved biodiversity, when compared to conventional systems of agriculture. Social benefits shall be studied more, as these systems could increase tourism, offer space for local events and these factors should be calculated and added to the monetary value of agroforestry systems (*Brown et al.*, 2018).

CONCLUSIONS

Although the concept of agroforestry was always present in the history of mankind, the demands of present times led to their decline. In the 20th century, the increasing mechanisation allowed the agricultural systems to become more intensive, favouring monocultures, which are easier to maintain than crop associations led to the decline of traditional agroforestry systems. However, in the 21th century, the ecological perpective became more relevant, which allowed agroforestry to be reinstated, studied and improved.

ACKNOWLEDGEMENT

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BRANDING OPPORTUNITIES FOR AGRO-FORESTRY PRODUCTS

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ABSTRACT

The aim of this study was to assess the main concerns of agro-forestry, and the consumer perception of agro-forestry products for promoting them products effectively. Indepth interviews with experts dealing with agro-forestry and a focus group interview were conducted in 2019. Experts found agro-forestry products useful for relieving the environment, which are multifunctional and less vulnerable. However, the legal conditions and the attitude need to be changed. Information, consultancy, education needed. Consumers were either not familiar with agro-forestry or did not care about it or believed „agro" and „forestry" were two separate concepts. Forest products were clearly considered healthy. They imagined the typical buyer as a 30+ old person, who has the material existence to be environmentally conscious. Universities and the chamber of agriculture play an essential role in branding on education level. More emphasis should be placed on the benefits and quality of agro-forestry products. PR articles, events, tasting, and road shows could bring awareness. Futhermore, environmentally conscious vloggers and influencers could encourage the young.

INTRODUCTION

In recent years, there are several scientific papers dealing with agroforestry which highlight that there are pros and cons of agro-forestry. According to *García de Jalón et al.* (2017), who asked the stakeholders in different EU countries, advantages include improved biodiversity and wildlife habitats, animal health and welfare, and landscape aesthetics. On the other hand, disadvantages include increased labour, complexity of work, management costs and administrative burden.

Agroforestry-based solutions for climate change mitigation and adaptation in Europe was evaluated by Hernández-Morcillo et al. (2018), and its role in the European common agricultural policy by Mosquera-Losada et al., 2018. In agriculture, there is a growing tension between ecological and economic benefits. Krummenacher et al. (2008) believe, agro-forestry is another way of achieving competitive production as a result of sustainable cultivation.

On the other side, there is a growing demand from consumers for forest-based products and services. Nowadays, the importance of natural lifestyle, organic products, green products (forest fruits, fungi, herbs, etc.) is reappraising. There is a growing demand for environmentally friendly products in all developed countries (Burrows and Sanness, 1998). Many traditional products, that were previously consumed only by low-income rural people, are now reappearing on the consumer market in the form of natural, environmentally friendly products (Meadley, 1989). There is also a growing demand for local products, natural cosmetics, and natural materials used in aromatherapy and bio-architecture.

Agroforestry-based solutions were evaluated for climate change mitigation, its role in the European common agricultural policy, however, marketing of agro-forestry (products) are rarely published or focus only on special sub-areas (Hankins, 2000).

Agro-forestry marketing is a specific part of marketing. Its primary purpose is to promote agro-forestry products and services to consumers. A number of methods have been developed to market the products. Both passive and active marketing appear in the industry. Market research and market analysis can be classified as passive, which later influences active marketing activities. Active marketing activities consists of product, sales, pricing and communication policy. Latter is in the focus of this paper, therefore this topic will be described in more detail.

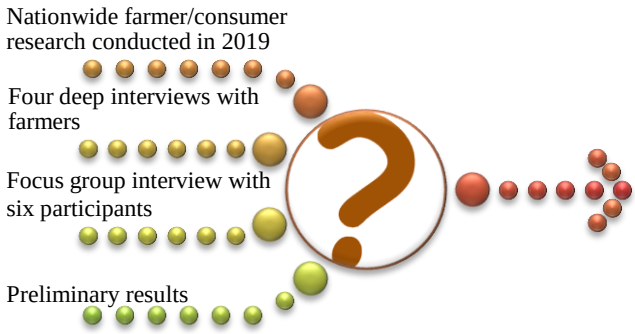
Communication policy refers to any activity that informs customers or potential customers about a product. We generally divide it into two large groups: advertising and public relations. Advertisements provide information about the company itself to potential consumers. Unlike other products, written and personal communication play a prominent role regarding agro-forest products. In the case of agro-forest products, instead of television and radio advertising, public relations play a promotional role. The objectives of the communication policy include improving the image of the sector not only at the corporate level but also at the level of agro-forest management (Hegedűs, 2007).

Material and methods

A nationwide research on the possibilities of promoting agro-forestry among the population was conducted in 2019 (*Figure 1*). Among non-probability sampling techniques, indepth interviews with four experts dealing with agro-forestry and a focus group interview with six participants were used for the data collection.

Figure 1

Design of the research



The indepth interview consisted of 15 semi-structured questions asking experts on their opinions and concerns regarding the differences of agro-forestry products compared to conventional products, specific benefits, difficulties and opportunities of their initiative, distribution of the products, funding and cooperation experiences and plans, judgment on motivational factors and on the future of agro-forestry in Hungary and internationally.

Focus group interviews started with the clarification of the concept of agro-forestry, followed by the benefits of these products, and product information. Futhermore, a situation analysis was

performed asking the participants to represent agro-forestry and conventional products while convincing each other why one is better than the other. Interviewees were also asked to describe the typical agroforestry consumer. The interview ended with discussing the means and ways of reaching the consumers; where and how to promote agro-forestry products effectively.

RESULTS AND DISCUSSION

Agro-forestry farmers' opinion - the results of deep interviews

Farmers find agro-forestry products useful for relieving the environment, however, the structure and operation of the system must be adapted to the environmental conditions, which requires constant attention and revision, while the reliability and universality of the accessible information is questionable. They also emphasise its multifunctional and less vulnerable features. This initiative gives the opportunity to utilize unused areas or less land, but the mechanical work is harder, therefore precise planning is required. They also face difficulties in particular with the ineffective legal system. Futhermore, lack of support for active agro-forestries makes maintenance complicated (usually there is support for getting started) – however, some stated that the system should work without support. They believe that agro-forestry could be more attractive by changing the legal-technical conditions (without unnecessary administration). Regarding the future of agro-forestry production, there may be a breakthrough, but it is necessary to change the attitude, besides the policy. In addition, information, consultancy, and education is needed. Since there are initiatives, they bevieve that good examples can boost agro-forestry production.

Consumers' opinion - the results of the focus group interview

Consumers are either not familiar with agro-forestry or did not care about it or believe „agro" and „forestry" are two separate concepts. On the other hand, forest products are clearly considered healthy. The situation analysis ended with the result that a product from agro-forestry grow in the nature, is much healthier, comes from a controlled, proven, high quality origin. It is palatable, "the southern slopes, the sunshine" can be felt on them. They imagined the typical buyer as a 30+ old person, who has the financial existence to be environmentally conscious. Promotion is target group-dependent, they suggested that the old can be reached via TV commercials and gastro shows, while the young through social media and influencers. Events (or joined events) would also have a significant impact.

CONCLUSIONS

Branding should be started on the education level. Universities and the chamber of agriculture play an essential role in it. Besides, more emphasis should be placed on the benefits and quality of agro-forestry products. PR articles, events, tasting, and road shows could bring awareness. Futhermore, environmentally conscious vloggers and influencers could encourage the young.

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ECOLOGICAL AND ECONOMIC ASPECTS OF AGROFORESTRY AS A SUSTAINABLE, ENVIRONMENTALLY FRIENDLY FARMING SYSTEM

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ABSTRACT

The efficiency of agricultural production has been increasing at accelerating rate since the beginning of the Industrial Revolution. The pace of mechanization, the scale of industrial production of chemicals, has increased so much in the last 50 years that we now produce food for more than 7 billion people. Agri-forestry systems have been established in recent years to protect the fertility of soils and their sustainable use as a natural resource. Intensive farming has increased the rate of resource exploitation beyond sustainability. There is a need for more extensive, environmentally friendly, sustainable cultivation technologies in agriculture and forestry. Ecological advantages of agroforestry systems are following: preservation of microclimate, reduction of soil erosion, habitat preservation, connection of fragmented habitats as ecological corridor, reduction of pesticide use, high carbon storage effect, maintenance of extensive animal husbandry, to provide habitat for protected species occurring in the Carpathian Basin, such as wildlife conservation and increasing species, population and landscape diversity. Recognizing these benefits, support for the implementation of agroforestry systems combined with arable crops, wooded pastures, wooded meadows and grassland plantations is now an integral part of the EU's Common Agricultural Policy.

AGROFORESTRY

Agrogorestry was defined by the FAO (Food and Agriculture Organization) in 2015 as landusing systems and technologies where woody and perennial plants (trees, shrubs, palms, bamboos, etc.) are intentionally used on the same land farming unit like agricultural plants and / or animals, in any spatial or temporal order. Two main types of agriculture on one agricultural land are the "silvopastoral" systems, which typically integrate trees with pastures and domesticated animals, and "silvoarable" systems that integrate trees and cultivated plants. The combination of trees, animals and agricultural crops is sometimes called "agrosilvopastoral" systems (*Garcia de Jalón*, 2017).

Compared to monoculture, the efficiency of agroforestry systems is averagely 36% higher. In Europe, Spain currently has 4 million ha, Portugal 2 million ha and Greece 2 million ha agroforestal area which are the most important at EU level. In France until the year 2040, 500.000 hectares of agroforestaly systems are planned to establish. In regards of the Hungarian conditions, presence of wooded pasture, pasture forest, line spacing plantation and the significantly larger field protective forest belts are used to be determinative. Together the intensification of mechanization, growth of chemicals and the increase in the ownership of large-scale holdings led to the separation of forestry (wood-growing), agricultural crop production and animal husbandry. As a result, disappearance of traditional agroforestry

systems, professional knowledge and the experience of farmers have disappeared; landscape has changed and environmental problems appeared: soil erosion, wind erosion (deflationary damage), water pollution, significant carbon release, loss of biodiversity, narrowing habitats of the natural enemies of pests, while farmers have lost a significant amount of their alternative income (*Borovics et al.*, 2017).

IMPACT OF AGROFORESTRY

The number and age of trees in an agroforestry system can be very different. An energy tree plantation can be cut from 3 to 15 years old, while fruit or industrial wood producers have to sustain their plantation for decades. Agroforestal systems can therefore be extremely versatile. Trees and crops affect each other. Trees provide protection and reduce wind speed, thus protecting the soil from destruction. Trees standing near water collect nutrients and bind the pollutants ensuring better water quality. These areas are not regularly fertilized, thus less nitrogen is leached into the groundwater under the trees also reduced amount of greenhouse gas is released into the air. Wooded area also provides habitat and shelter due to the low level of disturbance and several bird and insect species find their live conditions within the trees. Livestock farming can also be involved in agroforestry. Grassy areas can be grazed by cattle, sheep or goats, enjoying the shade of the trees, while hens and geese also feel comfortable under the trees. The alleys influence the growth of neighboring arable crops, too. The strength of this effect depends on the height and distribution of the trees and the grown species.

Ecological benefits of agroforestry system:

- microclimate conservation,
- changing windspeed dynamics,
- reducing the effects of deflation,
- soil protection,
- conservation and creation of habitats,
- ensuring the connectivity of fragmented habitats as an ecological green corridor,
- reducing pesticide loads on the site,
- high carbon storage effect,
- the maintenance of extensive animal husbandry traditions,
- increase landscape mosaicism, diversity,
- Providing habitats for protected species occurring only in the Carpathian Basin, such as wildlife conservation and increasing species, population and landscape diversity (*Szalai and Dósa*, 2018).

LAND USE OPPORTUNITIES WITHIN THE AGROFORESTRY SYSTEM

Land Equivalency Ratio (LER): mixed 1 ha agricultural forestry = 0.8 ha agriculture + 0.6 ha in a separated forest systems. Thus, agroforestry mixed 1 hectare LER is equivalent to 1.4 hectare LER in a separated land-system (*Mead and Willey*, 1980). In other words, agro-forestry mixed 1 hectare LER is equivalent to 1.4 hectares LER separate land, which means that the farmers can produce the same or even higher yields of the woody or herbaceous crops with a smaller land-use.

Agroforestal systems classification due to management types can be as follows:

- Rows of woods in arable land (intermediate cultivation): Plantation in a wide row spacing under which annual or perennial arable crops are produced. Agricultural crops provide annual and trees provide a long run income.
- Wooded pastures: networked or grouped tree plantation, under which crop cultivation or grazing is performed. Afforestation provides favorable living conditions for livestock.
- Field hedges and shelter belts: Tree-line shrubs with well-enclosed tree structure and linear placement between individual agricultural fields. Its role is to protect agricultural fields from wind damage, thus ensuring a favorable microclimate.
- Tree groups: small-scale afforestation, which is less suitable for arable cultivation or is planted in areas that are not cultivated. They provide alternative land use opportunities (*Szalai and Dósa*, 2018).

A good example of the latter is the tree groups established in the agricultural areas on the border of Bősárkány. The *Picture 1* show that the herbaceous culture is unable to produce in stagnant water-covered areas, so that parts of the area can be used alternatively by planting a noble poplar trees in these areas. Furthermore, by abandoning arable cultivation in these areas, they also create habitat for the wildlife and game.

Forest-like shelter belts are well suited to ensuring protection of agricultural lands against erosion and deflation. Research over the past decades confirms the positive effects of these shelter belts on agricultural producitity and yields so as the quality of the environment. However, environmental problems have intensified as a result of the large-scale spread of large-scale monocultures and mechanization, the widespread chemical pesticides, in parallel, the decrease of the spatial extent of the Hungarian forest belts and shelter belt systems. Since the 1950s, forest belt systems have been planted in Hungary for approximately 2,500 km, of which 1,500 km in the Great Plain and 1,000 km in Transdanubia. The plantations lasted until the early 1960's and covered some 273,000 hectares. Later, for the reasons already mentioned, the area of forest-like belts began to decrease drastically (*Gál and Káldy*, 1977).

Picture 1

Alternative land use in inland areas

Photoes of the author

For the implementation of agroforestal systems combined with arable crops cultivation, wooded pastures, wooded hayfields, shelter belt afforestation within the framework of the call for proposals VP5-8.2.1-16 "Implementation of agroforestry systems" establishment and maintenance of grassland, new establishment and maintenance of wooded pasture or meadow in combination with grassland management and establishment and maintenance of field protectve woods or shelter belts (*PALYAZAT.gov.hu*, 2019).

CONCLUSIONS

Compared to monocultural farming system, agroforestry gives a wide-range of opportunities to the farmers, because agroforestal systems are diverse and variable. Several types can be created in a given landscape that elements are complement and help each other. For instance, a wooded fields, wooded pastures, meadows, meadows and waterfront forests-belt are situated next to each other, the latter protects the water from the pollution effects of agriculture and also the arable land from the destructive effects of water. In addition, trees play a wind shelter role in all types and protect the soil from erosion. Trees on the wooded pasture provide a better microclimate as well shade for animals and herbaceous plants.

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AGROFORESTRY INNOVATIONS IN HUNGARY AND EUROPE

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ABSTRACT

Intensive agricultural areas in Europe are confronted with environmental concerns at several points, such as soil erosion, high nitrate content in groundwater due to fertilizer use, and loss of biodiversity. These negative effects can be mitigated by trees planted in open areas. Combining agricultural land with tree plantations can be particularly beneficial for rural biodiversity, which may also increase soil fertility. Almost forgotten land use patterns are becoming more and more prominent and are becoming increasingly important as a result of conservation, landscape and climate protection efforts. Recognizing all of these, agroforestry has been included in the land use practices supported by the previous Common Agricultural Policy, and the current cycle has further expanded the range of supported agroforestry systems. As a result, linear tree plantings, shelterbelts, alley cropping systems and wood pastures are established through Europe. The research and network building activity connected to agroforestry was funded by FP7 and H2020 programs. The aim of this study is to give an overview on the goals and results of the most relevant agroforestry projects in Europe, and their Hungarian aspect.

INTRODUCTION

Agroforestry is a system of land use system, in which the continuously cultivated woody crops are consciously integrated into the agricultural crop or livestock activities on the same land (*Keserű* 2014, *Vityi–Marosvölgyi* 2014). Although the concept itself is still new in Hungary, the tradition of this activity dates back centuries and thousands of years in Europe, mainly in relation to grazing in wood pastures and tree plantations (*Keserű* 2014). In Hungary, tree plantations of farms, shading tree groups in pastures, and the plantation of shelterbelts meant integrated land use. Because of aerial pest control in large-scale farming, most of them was eliminated (*Vityi–Marosvölgyi* 2014).

Almost forgotten land use patterns are becoming more and more prominent and are becoming increasingly important as a result of conservation and landscape protection and climate protection efforts. These forms of land use include, for example, the creation of the above-mentioned wood pastures and shelterbelts in protected areas (*Halász et al.* 2015).

The UNEP IAASTD (United Nations Environment Program, International Assessment of Agri-cultural Knowledge, Science and Technology for Development) report defines agroforestry as a dynamic, ecologically-based natural resource utilization system that diversifies and increases yield through the integration of trees into agricultural areas. while delivering social, economic and environmental benefits to farmers.

Intensive agricultural areas in Europe are confronted with environmental concerns at several points, such as soil erosion, high nitrate content in groundwater due to fertilizer use, and loss of biodiversity. These negative effects can be mitigated by trees planted in open areas. Combining agricultural land with tree plantations can be particularly beneficial for rural

biodiversity, which may also increase soil fertility. In addition, farmers can achieve higher productivity in the areas and increase crop diversity (*Kay et al.* 2016).

The importance of agroforestry systems is that it can have a positive impact on the quality of farming in many ways. According to *Somogyi* (2014), these systems are significantly more efficient than monocultures, on average with 36%. With the appropriate technology, they have good rates of return, but also play an important environmental role, for example, according to *Moreno et al.* (2016), *Vityi–Marosvölgyi* (2014), *Westaway et al.* (2016):

- Carbon sequestration,
- Water and soil protection,
- Preserving biodiversity
- Landscape diversity that also influences recreational opportunities
- Shade and protection for livestock and wild animals in the area (*Haddaway et al.* 2016 and *Westaway et al.* 2016)
- Promotes keeping the population in place and expanding their earning opportunities (*Keserű* 2014, *Somogyi* 2014)
- expands the habitat of natural enemies of pests and pathogens,
- Beekeeping significance.

The importance of beekeeping is that naturally occurring trees and shrubs used in agroforestry can significantly prolong the natural feeding cycle of bees compared to traditional cultivated plant varieties and also provide protection (*Somogyi* 2014).
In addition to environmental benefits, the agro-forestry system has cultural and recreational value to the population and can often generate other types of income in addition to agricultural and forestry revenues (*European Parliament* 2013).

According to *Jones* (2012), certain land use techniques, such as agroforestry as multifunctional land use, can play a key role in preserving biodiversity both in tropical and temperate zones.

AGROFORESTRY PROJECTS IN EUROPE

AGFORWARD (AGroFORestry that Will Advance Rural Development) was a four-year research project funded by the European Union's Seventh Framework Programme for Research and Technological Development (FP7). Based on a preliminary review of literature and datasets describing agroforestry practices across Europe, it focused on the four farmer networks i.e. agroforestry of high nature and cultural value; agroforestry with high value trees such as fruit trees, olives, and chestnut; agroforestry for arable farms; and agroforestry for livestock farms (*den Herder et* al. 2015).

Based on the LUCAS database the total area under agroforestry in the EU27 was estimated to be 15.4 million ha which is equivalent to 3.6% of the territorial area or 8.8% of the utilised agricultural area. This is a larger estimate than the 10.6 million ha reported in the literature review. Livestock agroforestry is, by far, the dominant type of agroforestry in Europe accounting for 15.1 million ha. The area of silvoarable systems is estimated to be 358 thousand ha. The above totals include the grazing and intercropping of permanent crops (e.g. fruit trees and olives) (1.05 million ha) comprising 0.85 million ha of grazed systems and 0.22 million ha of intercropped systems (*den Herder et al* 2016).

Across the five regions and five management options, in terms of environmental benefits, the strongest relationships occurred in terms of lower inputs of pesticides and/or fertiliser. In terms of economic benefits, the strongest relationships were associated with lower labour costs, production of higher quality crops and timber, or lower business risk due to diversification. For social benefits, the strongest relationship was with increased knowledge and information on agroforestry. In terms of costs, the strongest relationships were with increased labour costs or increased competition between crops, trees, and animals. In terms of opportunities, the strongest relationships were with the availability of subsidies or higher employment. Lastly in terms of risks, the strongest relationships were with low market opportunities or lack of subsidies (*Rois Díaz et al.* 2017).

A consortium of 13 partners from 9 European countries, launch AFINET (AgroForestry Innovation NETworks), a thematic network aimed to foster the exchange and the knowledge transfer between scientists and practitioners in the agroforestry. The project acts at EU level in order to take up research results into practice and to promote innovative ideas to face challenges and resolve problems of practitioners. To achieve this objective AFINET uses an innovative methodology based on the creation of a European Interregional network, composed of "Regional Agroforestry Innovation Networks (RAINs)", and the creation of an European reservoir of scientific and practical knowledge of AF with an end-user friendly access (the "Knowledge Cloud"), where all the information collected and the materials created in the project will be published.

The main objective of the RAIN meetings was to support agroforestry innovations and knowledge transfer, starting from bottlenecks and problems experienced by practitioners. The most frequently mentioned bottlenecks were the lack of information on cost benefit analysis of (traditional) AF systems and the lack of information on appropriate species/varieties choice (combinations of animal, tree, and crop) for specific climate, soil conditions and land use in order to maximize the benefits of agroforestry (production, soil improvement, parasitic antagonists). The lack of practical guidelines, good practices and well-functioning pilots were also mentioned in almost all regions, for example, how to adequately protect (efficient and economic) seedlings or trees against domestic and wild animals in an efficient and economic way. Finally, also the need to get a better understanding of the demand, supply & marketing opportunities for AF products (e.g. fruits, nuts, new crops (e.g. hops), poplar wood) was seen as a priority.

Each of the partners combined the third meeting with providing information to the stakeholders through farmer testimonies and inspiring field trips. A total of 269 stakeholders, of which 102 practitioners (38%, see figure 1 for complete overview of stakeholder participation) were introduced to the concept of Operational Groups (OGs) by a local authority on the matter and by means of inspiring examples from agroforestry related OGs within the AFINET project region. At the same time, local stakeholders brainstormed on possibilities for future OGs tackling the agroforestry challenges within their region.

The AFINET Knowledge Cloud (KC) is an online source of all kind of information about agroforestry. It integrates and synthesizes existing pools of information. It includes knowledge coming from the Regional Agroforestry Innovation Networks (RAINs), innovative practices and experiences, regional, national and international project results, as well as grey and scientific literature. Agroforestry-related sources are available by using OpenAIRE search function integrated in the KC. In this way, the AFINET Knowledge Cloud will provide access to a wide range of AF-related information.

PRESENT AGROFORESTRY PRACTICES IN HUNGARY

Zöldág Lovasudvar is an abandoned and then renovated wood pasture. Nowadays, besides the supply of the animals, is used for recreation turism purposes. Trained horses and qualified coaches are waiting for those who want to ride. Riding camps are also organized for children in summer and the service building is suitable for organizing cultural and professional events. The sheeps are part of the only Hungarian Merino stock culture.

Valaha Tanya is a family farm on 12 hectares of land. The success of the farm is based on the combined application of agroforestry, permaculture and organic farming as well as the enthusiasm, technical and economic expertise of its owners. One difficulty they encountered in the development of their new farming activities was that previously the land was occupied by large fields of agricultural monocropping, and located in a hilly and windy area. Their land is still surrounded by big, intensively cultivated agricultural parcels. The installation of the green protective hedgerow around the area was one of the first steps in the development of the farm. Due to this, within 4 years there has been a significant decrease in wind pressure, and most probably in chemicals as well. To further reduce the exposure and thus water loss to evaporation, the area has been sectioned in blocks with tree and bush lines planted perpendicular to the prevailing wind direction. Each fruit trees species was planted in a row or block to facilitate pollination. Within the orchard, a separate block is made up of a parcel of 12 rose species and several varieties of berry (raspberries, blackberries, red currant, currant gooseberry, chokeberries, mountain ash, cornel, elderberry and blackthorn). Flower petals are used for colouring and flavouring syrups. This structure also facilitates the management of the farm. In each block, animals are fed for short periods after mowing, until the ripening of the fruits. In the south-facing area, the arrangement of crops in mixed parcels follows the contours. The area is dominated by orchards, but animal husbandry (goats, cattle for milk production, horses, donkeys and poultry) as well as vegetable and herb production are also carried out. Farm diversity is further enhanced by the recently planted wood pasture and forage areas, as well as the pine plantation with mixed species and multiple purposes. The orchard consists of commercial fruit and berry varieties as well as wild fruit species, approximately 1000 of each. The aim of this wide range of species and varieties is to increase biodiversity and to provide the flavour required for the main product of the farm: syrups.

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INITIAL HYDROLOGICAL INVESTIGATIONS IN A WOOD PASTURE AT KŐSZEG (HUNGARY)

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ABSTRACT

The Őrség National Park Directorate has an ongoing habitat reconstruction project at the Doroszlói-meadows (Kőszeg, Hungary). The aim is to reconstruct a wood pasture area and a marsh meadow and thereby to achieve a more complex biodiversity. To ensure and manage the water supply and retention in the area several interventions are planned. The hydrological investigations have started in April 2019. Four groundwater wells were installed for the selected points, where we monitor manually the groundwater levels and the surface soil moisture (in the surroundings of the wells) once a week. According to the initial results, the groundwater levels and the surface soil moisture values follow the seasonal trends: a decrease can be detected during the vegetation period. Useful results are expected with the hydrological comparisons of the different sites of the wood pasture area. Since we have started the examination before the interventions, the current results can be interpreted asthe results of the control period. Thus, later we would analyze the effects of the water supply and retention.

INTRODUCTION

The Őrség National Park Directorate (ŐNPI) is currently implementing a project (KEHOP-4.1.0-15-2015-00002) at the Doroszlói-meadows (Kőszeg, Hungary) which has an area of 70 hectares. The aim is to reconstruct a wood pasture area and a marsh meadow, and to achieve a more complex biodiversity by restoring the previously favorable natural conditions. Wood pasture is a habitat type consists of mosaics of trees, tree groups, shrubs and lawnsIts existence and survival are strongly linked to grazing and grazing management (*Bajomi*, 2014; *Gyuricza and Borovics*, 2018). Previously, the area was used for pasture, as meadow, then it was abandoned, resulted in a rapid spread of shrubs and weeds (Szakály, 2016). To ensure and manage the water supply and retention in the area several interventions are planned. The water control and the grazing with approx. 100 cattle ("magyar tarka") is expected to begin next year in the area.

In the framework of the EFOP-3.6.2-16-2017-00018 in the University of Sopron project we are conducting on-site hydrological investigations.

MATERIAL AND METHODS

On 4th of April 2019 we installed 4 groundwater monitoring wells at 4 selected points in the area. Into the drilled holes PVC pipes were inserted. The pipes are perforated and filtered to

ensure the entry of the groundwater (*Figure 1*). The coordinates and basic data of the wells are shown in *Table 1* and their location is shown in *Figure 2*.

Figure 1

The installation of a groundwater well.

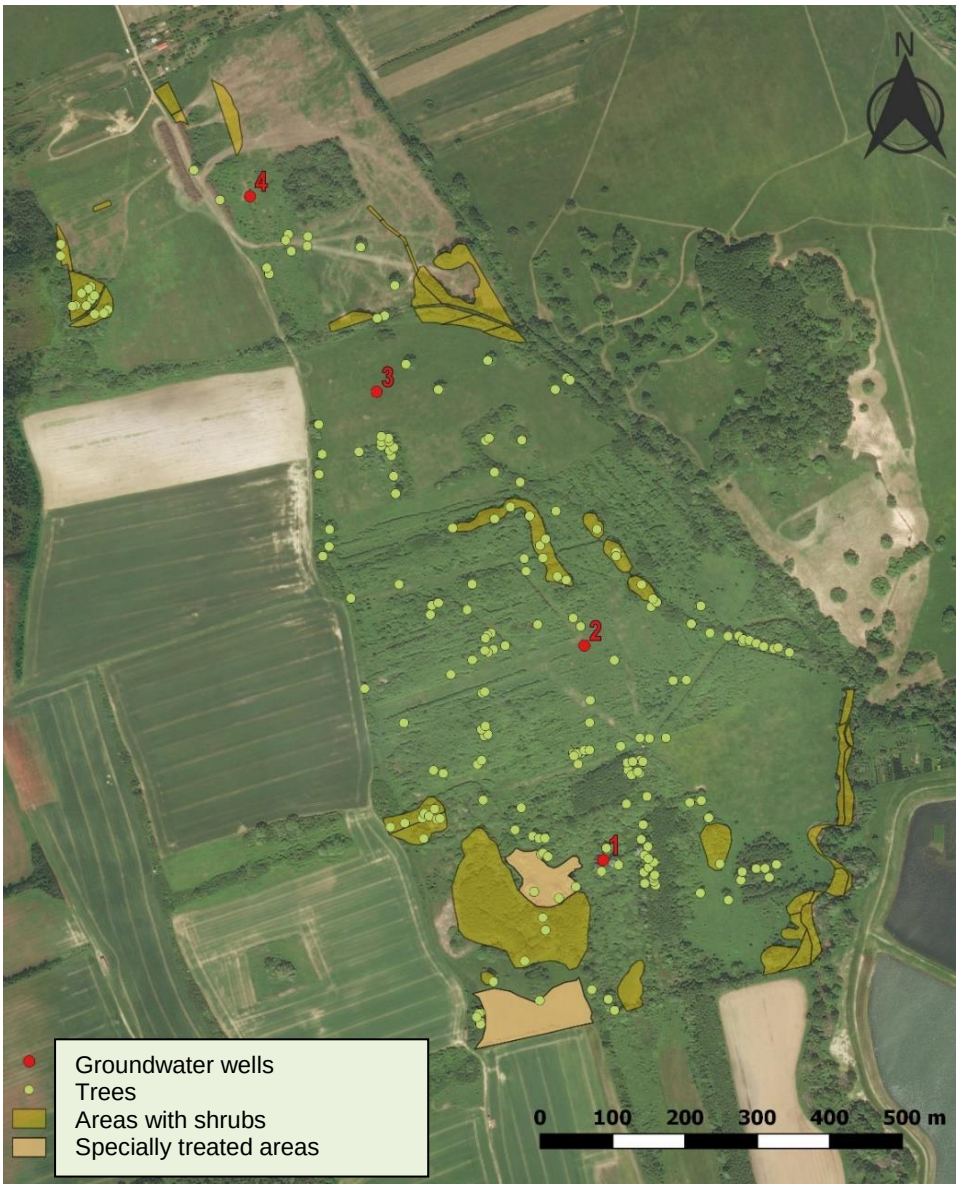
Table 1

The coordinates and basic data of the groundwater wells.

	Well 1.	Well 2.	Well 3.	Well 4.
Easting (HD72)	461776.996	461760.277	461484.549	461318.371
Northing (HD72)	227142.530	227438.573	227797.093	228071.588
Altitude of the edge (m.a.s.l.)	257.561	259.476	261.543	263.508
Edge-ground (cm)	58.0	16.0	44.0	15.0
Drilling depth (m)	2.5	2.8	3.9	4.0
K (µS/cm)	617	450	346	407
T (°C)	8.6	9.5	9.1	9.0

Figure 2

Location of the groundwater wells in the habitat reconstruction project area at the Doroszló-meadows



The slope of the area is North-Southeast. Well 1. is located in the southern part, which used to be a marsh (this area is still wetter than the others) and will be replenished during the dry period by a pipeline from the Tamás-channel (this watercourse is the eastern

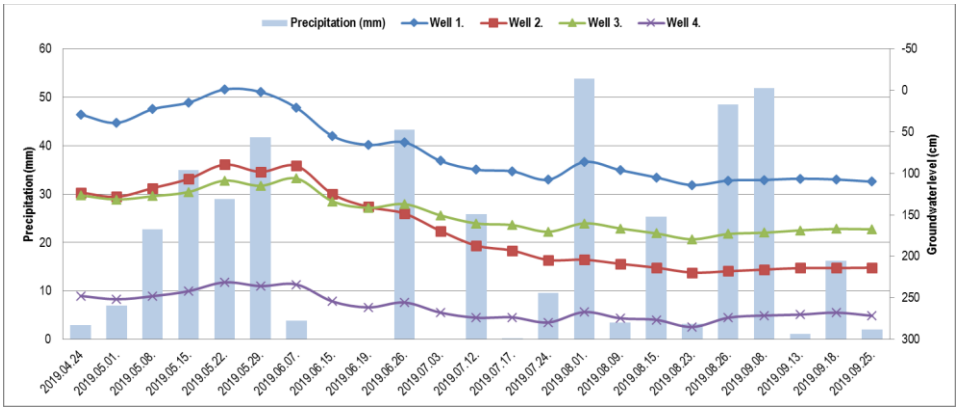
boundary of the area). Well 2. is located above the water supply of the planned pipeline. There will be an water management object to the Northwest from Well 3. that will recycle the water from a periodic stream (from the West). Well 4. will not receive any additional intervention water in the future, so this can be considered as a control well. At the installation of the wells, we collected soil samples from the borehole row (for laboratory tests) and measured surface soil moisture and groundwater conductivity measurements were performed at each test site. Furthermore, we measured infiltration factor at the Wells 1-3. and collected undisturbed soil samples at Well 1. Groundwater level and surface moisture measurements have been conducted on site on a weekly basis since the wells were installed. We use Dataqua measuring tape with led to detect the groundwater level, and Delta-T HH2 instrument to measure the surface soil moisture. In the case of the latter, 5-5 measurements are taken in the sorroundings of the wells.

RESULTS AND DISCUSSION

Figure 3 shows the changes in groundwater levels and precipitation. The water levels follow the seasonal change, the average groundwater level decreases during the vegetation period. Rising groundwater levels due to more rainfall occur only at water levels close to the surface (Well 1.).

Figure 3

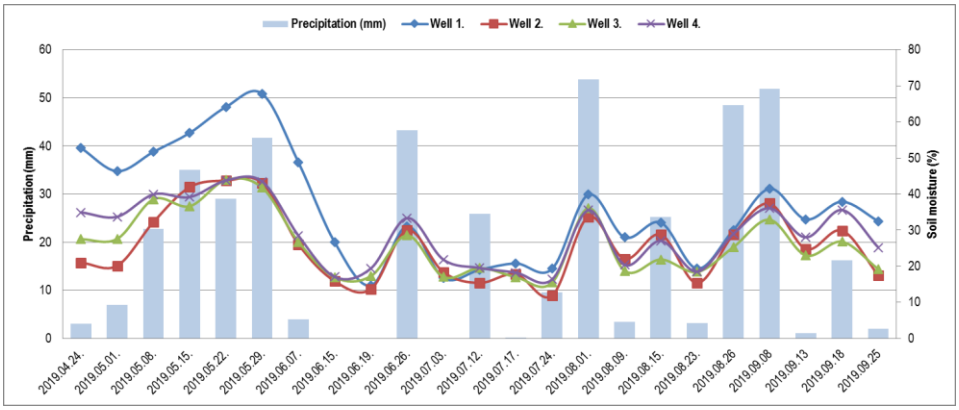
The changes in groundwater levels and the precipitation amounts.



The changes in surface soil moisture and precipitation are shown in Figure 4. The soil moisture values also follow the seasonal change. The effect of precipitation is mainly seen in wells 1 and 2.

Figure 4

The changes in surface soil moisture and the precipitation amounts.



CONCLUSIONS

We continue the weekly measurements. Since we have started the examination before the water management interventions and the grazing, the current results can be interpreted as the results of the control period. Thus, later we would analyze the effects of the water supply and retention.

ACKNOWLEDGEMENT

The research was supported by the EFOP-3.6.2-16-2017-00018 in the University of Sopron project.

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WOOD WELDING USING WATER STEAM AND PRESSURE

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ABSTRACT

Nowadays, environmentally conscious products and processes play a more and more central role. Wood industry also needs to evolve with expectations to remain a key player in the constantly changing market. Instead of some adhesives and some gluing tasks, wood constituents may be perfectly suitable. Wood is a cellulose fiber-reinforced lignin-hemicellulose matrix, where the lignin and the hemicelluloses are responsible for bonding the components. Applying lignin and hemicelluloses to bonding tasks would reduce the amount of chemicals that surround us. Lignin and hemicelluloses are thermoplastic components. The analysis of the degradation of lignin and hemicelluloses in the presence of heat and saturated / unsaturated water vapor (80-180 °C) is important as these components are not only heat-softenable but also heat-degradable. The purpose of this study is to determine whether the matrix materials of wood can be softened, so that the cellulosic fibers can be "welded" to cellulosic fibers of another softened wood surface. Then, after the matrix materials have solidified, are they able to form a proper bond between the components. Wood welding with steam and pressure seems to be a good way to solve the problem outlined above, so it is essential to study lignin and hemicelluloses to understand wood welding. If we could prove that welding is possible under industrial conditions, we could look at wood as a raw material in a quite different way, as well as wood welding technology.

INTRODUCTION

Wood is not a homogeneous material and most of its characteristic properties derive from this orthogonal anisotropic structure. In addition, the chemical components (cellulose, lignin, hemicelluloses) also have different chemical and physical properties. These differences give several advantages and disadvantages to the wood. Depending on the area of use, these characteristics are shaped in most suitable and possible way. This area is covered by wood modification, where wood welding is on the edge, because we want to change the composition and structure of the wood at the same time to create a bond with each other. The aim of the research is to better understand the behavior and potential of wood-building materials.

MATERIAL AND METHODS

The wood species used for wood welding are selected on the basis of the proportion of components. The amount of lignin and hemicelluloses is important in this case. Lignin is plasticized when sufficient temperature and water are present, while the hemicellulose bonds are loosened (*Boonstra et al.*, 2006). This is important because wood can be considered as a cellulose fiber-reinforced lignin matrix in which the link between the two components is provided by hemicellulose. Therefore, when these two components soften, the previously

bonded cellulosic fibers can move from one another. The extent of this process is influenced by the temperature and the amount of water present. There is one point where the degradation processes also start in the wood, which can worsen the end result. The goal is for both surfaces to plasticize and the free cellulosic fibers on the two surfaces to tangle with each other without degrading. The soft lignin matrix is then cooled and fixed in this position.

Previous methods have been based on friction welding in the metal and plastics industries, using heat from friction. Friction welding, both linear and rotary, has been experimented with at Biel University in Switzerland. In the linear system, two clamped surfaces are pressed against each other and then vibrated linearly. The sliding surfaces produce heat, which softens the lignin and burns the surface slightly, thereby degrading the base components, but the compressed surfaces nevertheless form bonds. The two specimens are pressed against each other at a pressure of 1.3 MPa and then oscillated at 100 Hz frequency and 3 mm amplitude. Contact surfaces are heated to 250 °C (*Ganne-Chédeville et al.*, 2008).

The other method involves friction welding by rotation. In this case, a slightly tapered hole must be made with a smaller diameter than the wood dowel to be welded. During drilling, the twisting movement and pressure aimed to the hole results in friction on the sheath thus the same plasticization process occurs as in the case of the linear one. The difference between the two methods is that in this case, the direction of the fibers is perpendicular to each other. In case of the experiments, an 8 cm long rod of 10 mm in diameter was rotated at 1165 rpm and 1515 rpm, while pressed to 15 mm deep hole of 8 mm in diameter. The smeared, burnt surfaces bonded eventually (*Ganne-Chédeville et al.*, 2005).

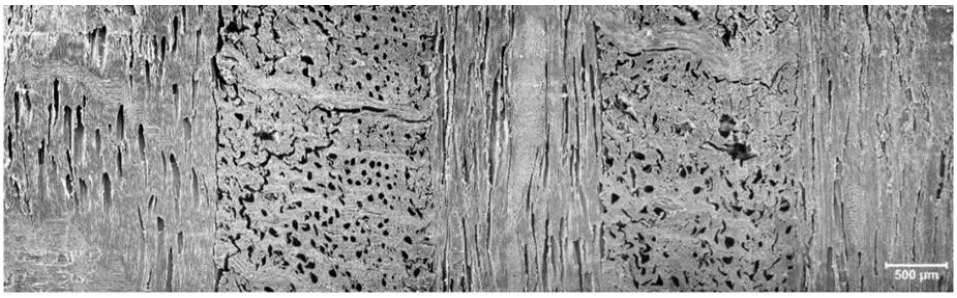
The third method is to press high temperature veneers together to form bonding between the surfaces, in case of both directions, perpendicular or parallel to the grain (*Cristescu*, 2006).

RESULTS AND DISCUSSION

Scanning electron microscopy (SEM) images show the changes in cell walls and wood structure (*Figure 1* and *Figure 2*).

Figure 1

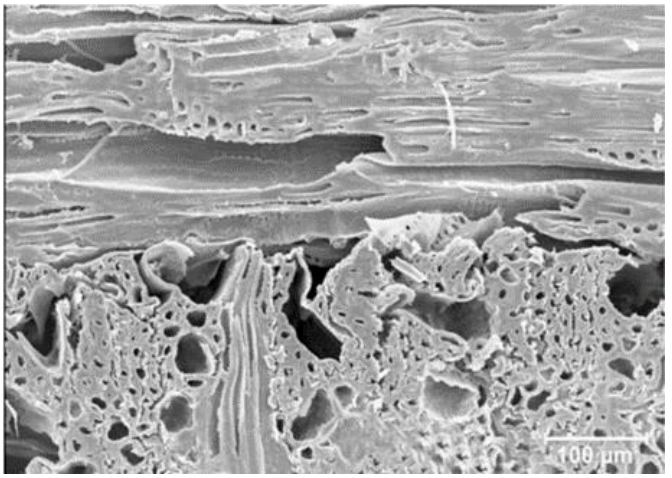
SEM Image of a Cross Section of Veneers with Perpendicual Grain Direction, Bonded with Linear Wood Welding (Magnification x35)



Source: *Cristescu* (2006)

Figure 2

Laminated Veneers Bonded with Perpendicular Grain Direction – Scanning Electron Microscopy Image of a Cross Section, 200x Magnification



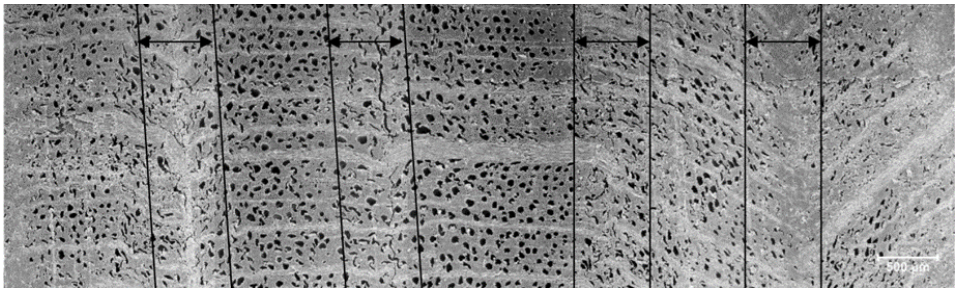
Source: *Cristescu* (2006)

Plywood was produced by high temperature pressing. The pictures show how the cell wall and cell structure of the wood is deformed. The two materials in contact can only form a bond on the surface, because the fibers perpendicular to each other carried the load obtained during pressing. The two surfaces were hardly connected thus only the lignin could adhere to the lignin on the other side.

When the fibers of the layers are parallel to each other, the treatment gives a different result (*Figure 3* and *Figure 4*).

Figure 3

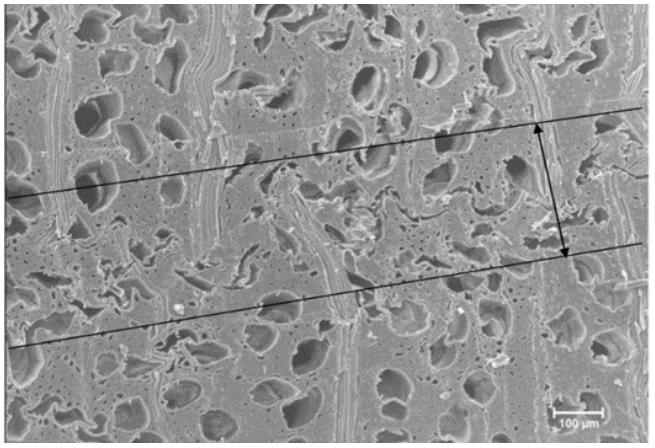
Laminated Veneers Bonded in Parallel Grain Direction - Scanning Electron Microscopy Image of the Cross Section, 35X Magnification



Bonding Zones are Marked with Arrows Between Straight Lines
Source: *Cristescu* (2006)

Figure 4

Laminated Veneers Bonded in Parallel Grain Direction – SEM Image of a Cross Section, 200X Magnification



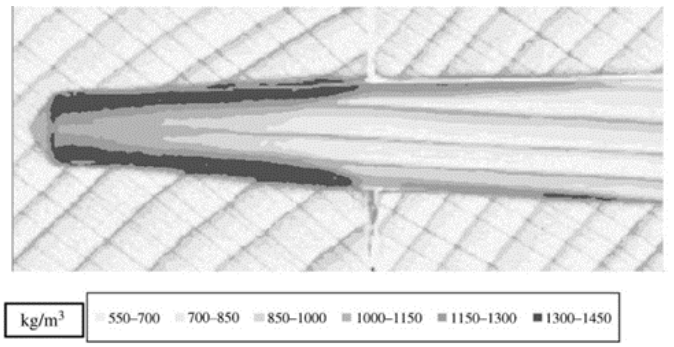
The Bonding Line is Situated Between the Straight Lines
Source: *Cristescu* (2006)

Compared to the transverse veneer arrangement, it can be seen that the parallel fibers of the two surfaces are entangled in a relatively thick band, allowing for a stronger bond between the two veneers. However, there is no transversal strengthening, so the resulting product will be brittle in one direction with more heterogeneous properties.

X-ray microdensitometry images of rotary welding show a much higher density on the surface, where although the two materials are degraded, but have a good bond strength, which cannot be evaluated using non-destructive method (Figure 5).

Figure 5

X-ray Microdensitometry Map in kg/m^3 of a Rotation-welded Beech Dowel as Inserted in a Beech Wood Subtrate

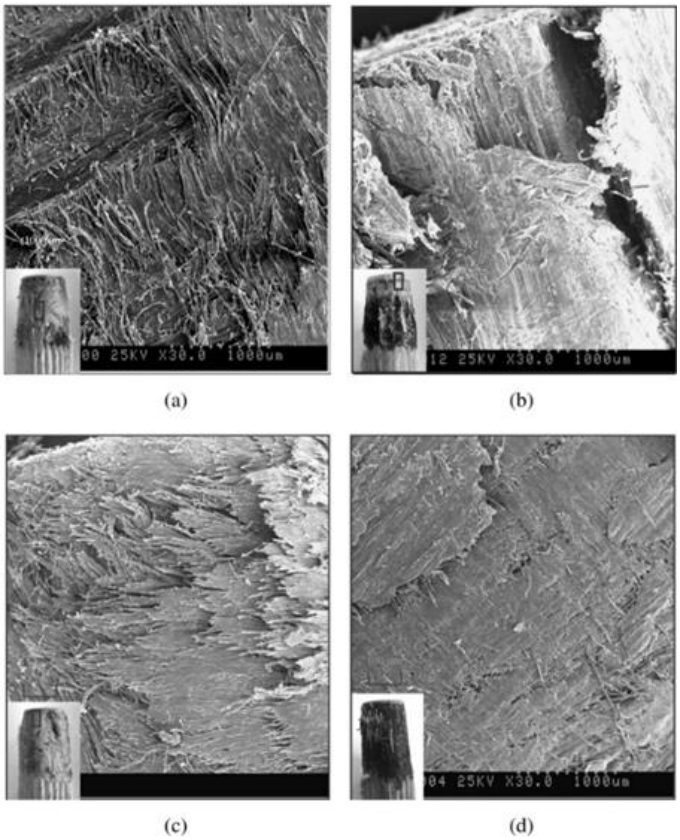


Source: *Ganne-Chédeville* (2005)

This method is the best in the industry so far, because even a CNC machine can do the rotation and there is the possibility of making non-visible joints. The disadvantage of the process is that the bonding strength is weakened on the contact of water. In this case, water contact is eliminated because the welding takes place in a closed structure, which protects it. The other advantage is that the welded dowel is only subjected to shear stress rather than a tensile force parallel to the dowel, so the purpose of the bond is to prevent the dowel from slipping (*Figure 6*).

Figure 6

Scanning Electron Microscopy (x30) Micrographs of the Surfaces of Different Tested Dowels After Extraction from the Substrate



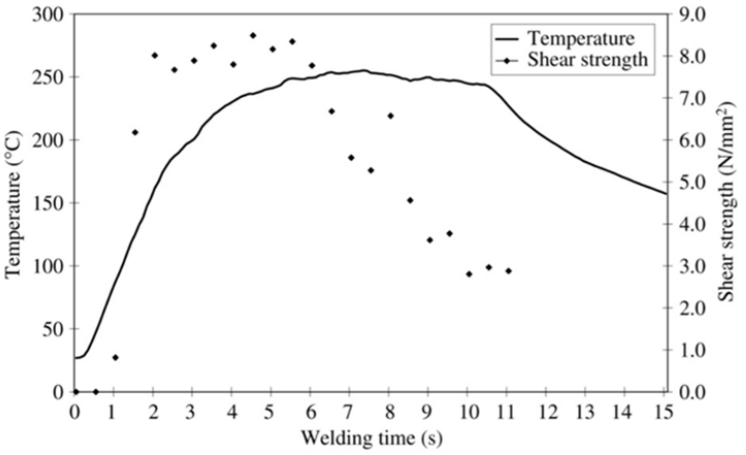
All Dowels are Pretreated with Ethylene Glycol. (a) Pine Substrate, Dowel Inserted Perpendicular to the Wood Grain. (b) Pine Substrate, Dowel Inserted in Wood End Grain. (c) Beech Substrate, Dowel Inserted in Wood End Grain (d) Beech Substrate, Dowel Inserted in Wood End Grain
Source: *Ganne-Chédeville* (2005)

Figure 7 shows the temperature and shear strength of a linear vibration weld as a function of weld time. The frequency used for welding is 100 Hz, the amplitude is 3mm. It shows that the

shear strength reaches its maximum value at 220 °C within 3 seconds. This can be explained by the fact that at 220 °C the degradation of the hemicelluloses starts more intensively and is unable to form such bonds as earlier between the lignin and the cellulose fibers.

Figure 7

Temperature and Shear Strength of the Samples as a Function of the Welding Time



Source: *Ganne-Chédeville* (2005)

A major disadvantage of the mentioned methods is that the contact surfaces are burned by high frictional heat and, if these parts are exposed to water, their bond strength is suddenly and significantly reduced. This is because when the bond is formed, the materials present are degraded and the remaining material forms the bonding surface, but this is a fraction of the cohesive strength of the wood. So the problem is that the wood burns, and it burns because nothing prevents the water in the wood from escaping as steam at 220 °C. Since the Thonet technology, it has been known that lignin and hemicellulose in wood can be plasticized, and this requires two things: sufficient temperature and the presence of water in the wood. The parts of the Thonet furniture were just steamed and still made the wood amazingly flexible until it cooled down and stayed in place. Degradation takes place in wood at a relatively low degree up to 220 °C in a humid environment. Thus, if we were to heat the wood while keeping it moist, it would not burn, but the lignin and the hemicellulose could soften sufficiently. Keeping water in the wood at this temperature is quite difficult, but if water is added from the outside in a saturated or dry vapor formula, both the temperature and the water content of the wood can be adjusted. With these two parameters, the plasticization of the wood can be adjusted to be as complete as possible without significant degradation. The surfaces thus softened must be roughened to facilitate the adherence of the cellulosic fibers. Moving the two materials in a circular motion at low pressure causes the cellulosic fibers protruding from the surface to become entangled, and the samples are pressed together until they cool down. Subsequently, since the wood does not burn during the formation of the bond, it is believed that the bond formed is more resistant to water.

Based on the above, wood as a cellulosic fiber reinforced lignin matrix in which the hemicellulose provides the connection between the two components, wood may be able to exhibit the behavior typical of composites and the wood welding process seems feasible. Research has shown that this type of experiment is worth working on, because the bonds that are formed can provide sufficient wood bonding strength in the industry.

CONCLUSIONS

Knowledge and analysis of research in the field of wood welding is extremely important if one is to develop a technology in this field. The results and sub-results of these research and processes can be used as guidelines for the design of new technologies. Wood welding technology is an environmentally friendly option, which is extremely important in today's world, so it is worth pursuing research in this area. Relevant references are used from scientific publications and professional experience of researchers. Perhaps the most important conclusion that can be drawn is that not only the presence of pressure and heat, but also the presence and amount of water plays an important role in the welding process. This is a line of research that should be explored in the future to achieve a better bonding strength of wood.

ACKNOWLEDGEMENT

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THE ANATOMY OF WOOD BENDING
A SHORT OVERVIEW

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ABSTRACT

This study focuses on the anatomy of wood, covering its main constituents, the tracheids, the parenchymas, the wood fibers, the wood rays and the possible resin canals. Of course, the role of cellulose, lignin and hemicelluloses is also an important issue. After reviewing the various microscopic features of the cells (pits, vessel perforations, etc.), the structure of the cell wall is presented. The role of the middle lamella and the primary cell wall is negligible in the subject matter of this study, the secondary cell wall deserves much more attention as it is mainly responsible both for the strength and the anisotropy of the wood. That is, due to changes in its moisture content, the wood behaves differently in its three major anatomical directions. Following the description of a commonly used light microscope specimen preparation procedure, the longitudinal compression (aka. pleating) of the wood is described. In all cases, the wood has to be plasticized practically with steaming previously to its compression in a heated press, so that the lignin-hemicellulose components can soften. Due to pleating, the properties of wood change more or less, e.g. the modulus of elasticity is reduced significantly, these properties are briefly described as well. After describing a short-term longitudinal compression, the conclusions can be drawn regarding the changes in the microscopic structure of the wood and some specific wood properties as a result of the treatment, which makes the material well pliable.

THE ANATOMY OF WOOD

The knowledge of the microscopic characteristics of wood is an important part of the wood industry, as different wood species characteristics and wood defects can be deduced to the microscopic level, and can be explained and understood by the cellular structure and the structure of each cell. The species' characteristics greatly influence the range of its uses.

Basically, the wood species can be divided into two major groups: coniferous and deciduous. Coniferous can be further divided into resinous and non-resinous species. Deciduous species could be classified as hard or soft, but in this case, it is more interesting to divide them by ring or diffuse-porous species. This means that pores or vessels – which are responsible for moisture and nutrient transport, and will be presented later - gradually decrease in size going from earlywood to latewood, within an annual ring (diffuse-porous species) or the pores of small and large diameter can be easily separated by a thin line (ring-porous species) (*Figure 1*). There are also species of minor importance for the wood industry, which are transitions between ring and diffuse-porous species. These are e.g. various fruit trees, but their presentation is outside the main subject of the article.

The structure of coniferous species is simpler: it consists only of tracheids, parenchyma and possibly resin canals. The main part of the wood structure is made up of tracheids, which transport water, store and provide structural support. Between these long cells with pointed

ends are the pits which provide nutrient transport. Ray parenchyma cells are predominantly present in pith rays, axial parenchyma cells occur in small quantities around resin canals, sometimes dispersed, but in case of some species, they are completely absent. Parenchyma cells are shorter, they are often of the same length and width, and have rounded ends, even when elongated. Their proportion is 1-2%, so their mechanical role is negligible. By separating the clustered parenchyma cells, cavities are formed where resin is formed, these cavities are called resin canals. The parenchymal cells which surround the resin canals are called epithelial cells which secrete resin (*Figure 2*). Resin canals can occur not only longitudinally but also along the pith rays (*Butterfield et al.*, 1997).

Figure 1

Cross Section of a Diffuse-porous Lime Wood (*Tilia*) (Left) and a Ring-porous Oak Wood (*Quercus*) (Right).

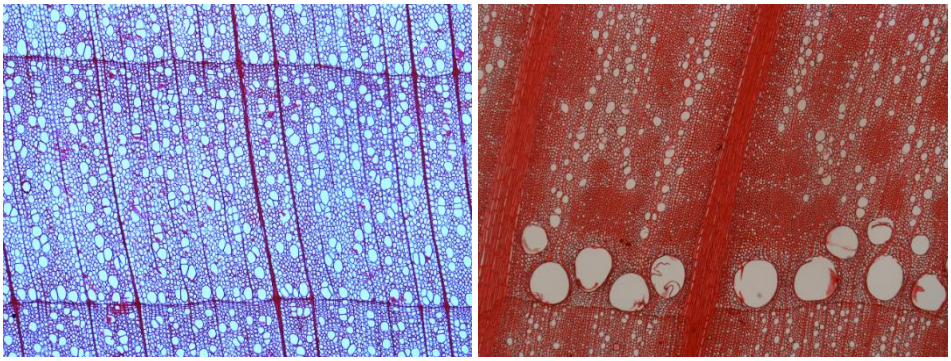
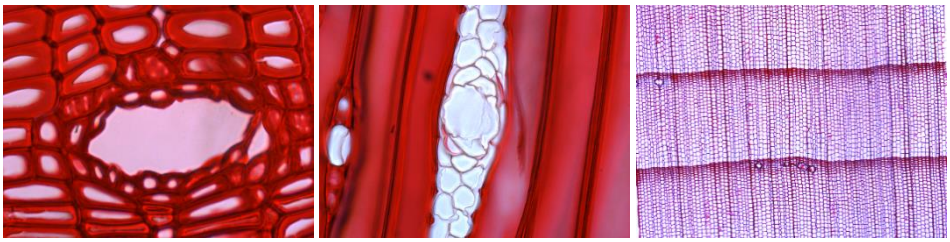


Figure 2

Resin Canals in Different Wood Species: Douglas Fir (*Pseudotsuga menzisii*), X60 (Left) Scots Pine (*Pinus sylvestris*), X40 (Middle), Spruce (*Picea abies*), X4 (Right)



Tracheids make up 90-95% of conifers, with an average length of 3-5 mm and a thickness of 10-30 μm. They are divided into three parts according to functionality: earlywood and latewood tracheids and, in some species, transversal tracheids. Earlywood tracheids make up earlywood, they have larger cavities, rounded ends, thin walls and shorter length. Typically, regular circular bordered pits provide transport between them. They do the

larger part of the moisture transport. The latewood tracheids, which make up latewood, have smaller cross section, thicker walls, bigger length and pointed ends. Their pits are smaller and have more of a slit shape than a circular one. Their role is to provide structural support. Transverse tracheids can occur in certain coniferous species, forming pith rays along with ray parenchyma cells. Their function is to ensure transversal transport within the xylem, while their structural importance is negligible. They may be located in the middle or on edges of the pith, or they can be completely absent.

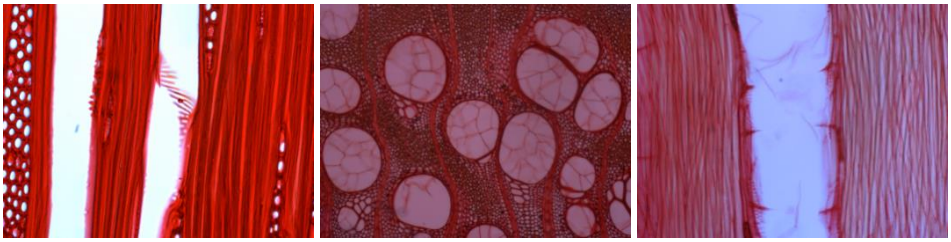
The structure of deciduous species is more complex, containing vessels (trachea), which are primarily responsible for water transport. They have tracheids, parenchymas, and a high proportion of wood fibers, which are primarily responsible for solidification. Their pith rays can be single, or in small groups, or so-called medullary ray, the ray flecks of which are clearly visible to the naked eye.

The vessels or tracheae, with their large diameters of up to 400µm, are very distinct from the rest of the xylem. They are responsible for water transport, consist of several vessel elements (cells), between which the cell wall can be partially or completely disappeared. Earlywood vessel elements are bigger and shorter, latewood vessel elements are thinner and longer (*Butterfield et al.*, 1997). In case of ring-porous species, the thick-walled earlywood tracheae are arranged in circles, and their earlywood and latewood rings are easy to be distinguished. On the other hand, in case of diffuse-porous species, the vessels are located individually, in small groups or in so-called vessel bands or rows. In case of some species, like walnut, cherry, plum, etc. a transition between these two types can be observed, like semi-diffuse-porous, where the size of vessels gradually decrease, or semi-ring-porous, where the vessels are of the same size, but are arranged in rings in the earlywood (*Molnár et al.*, 2007). Different perforation plates and the spiral thickening of the cell wall can help in microscopic identification of various wood species.

During the formation of heartwood, vessel occlusion can occur with deposits such as tyloses (*Figure 3*), and others like gums, oils and resins. The clogging of vessels prevents the flow of material (water and air) and therefore provides a degree of protection for the wood. In addition, tyloses may have a thick, hard wall, which also gives protection against fungi, but may also make certain woodworking technologies difficult, such as drying, gluing, saturating, and tool abrasion.

Figure 3

Scalariform Perforation Plate (*Fagus sylvatica*), X40 (Left); Tyloses (*Robinia pseudoacacia*), X40 (Middle); Simple Perforation Plate (*Ulmus*), X40 (Right)



The tracheids of deciduous species differ slightly from those of conifers. They also transport water and solidify, but the pits membranes remain uniform in thickness and do not develop the torus-membrane structure typical of conifers. Because of this, they are only able to transport water more slowly and have no perforation plate.

Wood fibers make up most of the xylem of deciduous species, which are thick-walled, small-hole, sharp-edged cells. Simple pits cover their thick cell walls. Their primary role is to solidify the xylem, while their water transporting capacity is negligible. They become woody in short time. Their average length is shorter than conifer tracheids, which are about 1-2 mm long. They give the strength of a certain wood, but species with a higher proportion of wood fibers are not always harder, but rather the mechanical properties of wood depend on the thickness of the cell wall of fibers.

The proportion of parenchymal cells in deciduous species may vary from 1-10% depending on the species. They are the longest living cells in the xylem, and therefore play an important role during the formation of heartwood. In the living tree, they are also responsible for the reaction processes during tree damage.

Their arrangement can be around vessels, around vessels in patches, bands, along annual rings, or in a scattered arrangement. Their cell walls are typically thin and therefore easy to compress.

The pith ray is perpendicular to the longitudinal direction of the stem and can be one or more cell wide. The pith ray of deciduous species is composed only of parenchyma cells, which usually have the same size within a tree species. In the case of a homogeneous pith ray, all cells are in horizontal position, giving a uniform appearance. In a heterogeneous pith ray, some of the cells are in horizontal position and the other in vertical position. The role of pith ray is the transverse transport of material within the xylem and the storage of nutrients. Thicker pith rays may be the starting points for cracks during wood drying. Many tree species with wide pith rays are harder to work with.

The structure and constituents of wood cells

There are three main components in the wood: cellulose, lignin and hemicellulose. Cellulose, hemicellulose and lignin are the three most important constituents of wood in case of longitudinal wood compression and bending, so only these will be described in more detail. These three components work just like iron and concrete in reinforced concrete, cellulose symbolizes steel wires because it is a crystalline long chain molecule with high tensile strength and lignin like cement binds together the cellulose fibers. Hemicellulose ensures the proper connection between these two major elements.

Cellulose accounts for 40-55% of the xylem. A β-D-glucose molecule chain $(C_6H_{10}O_5)_n$ where n is the degree of polymerization, which is at least 1000-1200 but it can reach 8000. Cellulose is well resistant to water and most solvents (*Molnár*, 1999). Lignin is a complex aromatic compound whose structure may differ slightly among tree species. No crystallization, nor cross-linking occur, it has amorphous structure. It binds celluloses together within the xylem, thus significantly increasing the compression strength. However, when combined with heat and humidity, it softens to some extent, this way wood can be better shaped by steaming.

The cells of a tree can be divided into the middle lamella, cell wall and lumen. The lumen is obviously empty, the primary purpose of it is water transport. The middle lamella is

an adhesive-like layer between each cell, consisting of pectin and lignin. The cell wall can be further divided into a primary cell wall, a secondary cell wall, and a tertiary cell wall. The thickest is the secondary cell wall, in which the S2 layer is the thickest, which is why its properties are most relevant when looking at the wood-water connection or the mechanical properties of wood. In the S2 cell wall layer, so-called microfibrils composed of cellulosic fibers are arranged parallel to each other but at an angle of about 10 ° to the longitudinal axis of the cell. This gives the anisotropy of the wood, both in case of mechanical properties and of shrinkage and swelling properties. There are 1 nm gaps between the microfibrils where water molecules can become wedged, tearing them apart. So, of course, the wood swells at higher extent perpendicular to the microfibrils while it swells less in longitudinal direction. This "wedged" water is the so-called bound water, which also causes dimensional changes in case of for example built-in wood due to air humidity. Bound water is chemically bonded to the wood in several layers, but the closer layers have a higher bonding energy, so the wood material always strives to achieve a uniform moisture distribution. When fiber saturation point is reached (about 30%), the cell wall is unable to absorb more water, this way water can accumulate in the lumen, but no chemical bonds are formed, so the size of the wood does not change. The moisture content (*MC*) can be determined by a number of methods, such as a spot-on electrode moisture meter, which calculates the *MC* of the wood by electrical resistance. Under laboratory conditions, the wet weight of the samples is measured and then dried at 103 ° C and the *MC* is determined from the two weights by the calculation:
$MC = (w_m - w_0) / w_0 * 100$, where w_m is the wet weight and w_0 is the dry weight.

Determination of wood species by microscope

The microscopic properties discussed above can be examined with a simple light microscope. The microscope used in this paper requires a thin specimen that is easy to illuminate, since only a translucent material can be examined with a light microscope. The microscope illuminates the sample from below with a bulb through a lens, and then through the magnifying lens above, the magnified image can be observed. The lenses are fixed and the sample itself must be moved to the focal point. The difficulty of the test begins with the preparation of the sample. The length of the test wood cubes should be of 1-2 cm and then soaked in water, or cooked, to make the material softer and to stretch the fibers. Then, a microtome (*Figure 4*) is used to cut samples from the cube in each of the 3 anatomical directions. The microtome consists of a thick, rigid, razor-sharp blade and a specimen holder. The advancement mechanism is adjustable in micrometer precision, allowing very thin slices of wood cube to be cut. The sample is removed from the blade with tweezers. The sections are colored. On the slide (which is a thin glass slide that will hold the sample), distilled water is dripped onto the slides, and another slide is pressed onto it to hold the sample.

Next comes the microscopic examination. Wood species are identified by their different characteristics. It is worthwhile to start the examination on the cross section, where it can be determined whether it is conifer or deciduous wood species. In case of conifers, resin can be examined if it is present or absent. In the case of deciduous species, it is possible to determine whether it is ring-porous or diffuse-porous, how wide are the annular rings, the pith rays, examine the parenchyma cells, the presence of tyloses, etc. Based on these, the list of possible tree species can be significantly narrowed. After that, it is worth switching to the tangential

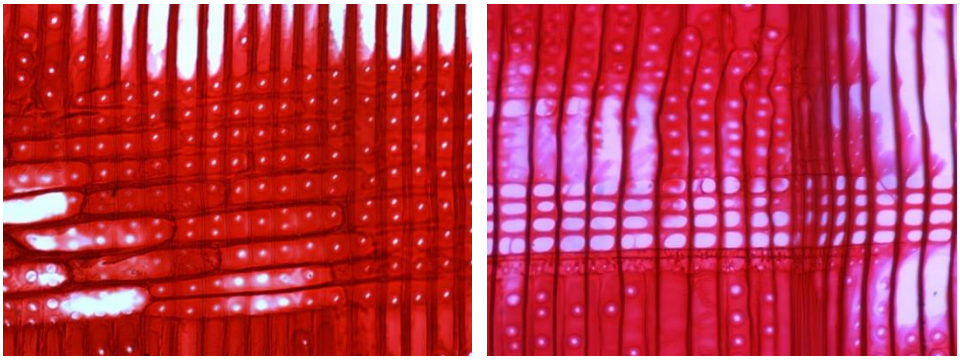
section, where the pitting, cell wall thickenings, pith rays can be examined, and the cross-fields in case of conifers. Cross-field is the intersection of pith rays and longitudinal cells, where the pitting can be observed: window-like, piceoid, cupressoid, taxodoid (*Figure 5*).

Figure 4

Microtome

Figure 5

Cross-fields: Cupressoid Pits in Juniper (Left) and Window-like Pits in Scots Pine (Right)



Wood bending

Wood can be bent in several ways. A widespread solution is a structure consisting of laminated and glued elements (eg. plywood), in case of which many thin layers are essentially bent together and then glued together. Here, however, the wood does not remain in the desired shape by itself, but the shear stress created by the adhesive connecting the layers holds the layers in that shape, which is also subjected to tensile and compressive stresses. However, where the wood really holds its shape, is the steamed and bent, and also the compressed solid wood.

When steaming, the wood must be placed in a closed space at a temperature of at least 80°C. The easiest way to do this is to boil water under the wood, taking care not to let the

wood get into the water, which could dissolve the extracts from the wood and saturate the lumen. Mentioned earlier, the lignin and hemicelluloses soften and, while in this warm and wet state, can be well formed and bent. During bending, the lignin softened in the middle lamella allows the high cellulosic tissue to move from one another. After the layers have moved, the material retains its shape when it cools. At the same time, compressive stresses develop on the inside of the arc, while tensile stresses on the outside, which can cause cracks in the wood. A further disadvantage of bending by steaming is that it cannot be further modified after cooling.

The other, more advantegous technology is longitudinal compression, which also requires first plasticizing the wood by steaming. The softened material is typically compressed in the longitudinal direction by 20% and then kept in a compressed state for a while (Báder and Németh, 2018). Unfortunately, from a technological point of view, it is not that simple. Not all wood species can be compressed well, and only flawless, straight-grain material can be used. During compression, the wood with oblique or diagonal grain may easily break, making the material unusable and destroying the machine. Aesthetic and mechanical defects may occur around knots due to different fiber directions (*Figure 6*). During compression, the wood must be supported from the side against bending. A sheath is required for compression, which should not be too tight, since the frictional force that would occur would affect the degree of compression in the longitudinal direction, and the unevenly compressed wood would be inhomogenous. If the outside of the wood material were to release heat when contacted with a metal support at room temperature, the middle plate would harden again, so the wood could not be compressed. For this reason, the laboratory uses a sheath with heated wall and adjustable dimensions. Also, the exact starting size is important because if the material hangs from the sample holder, it can easily split.

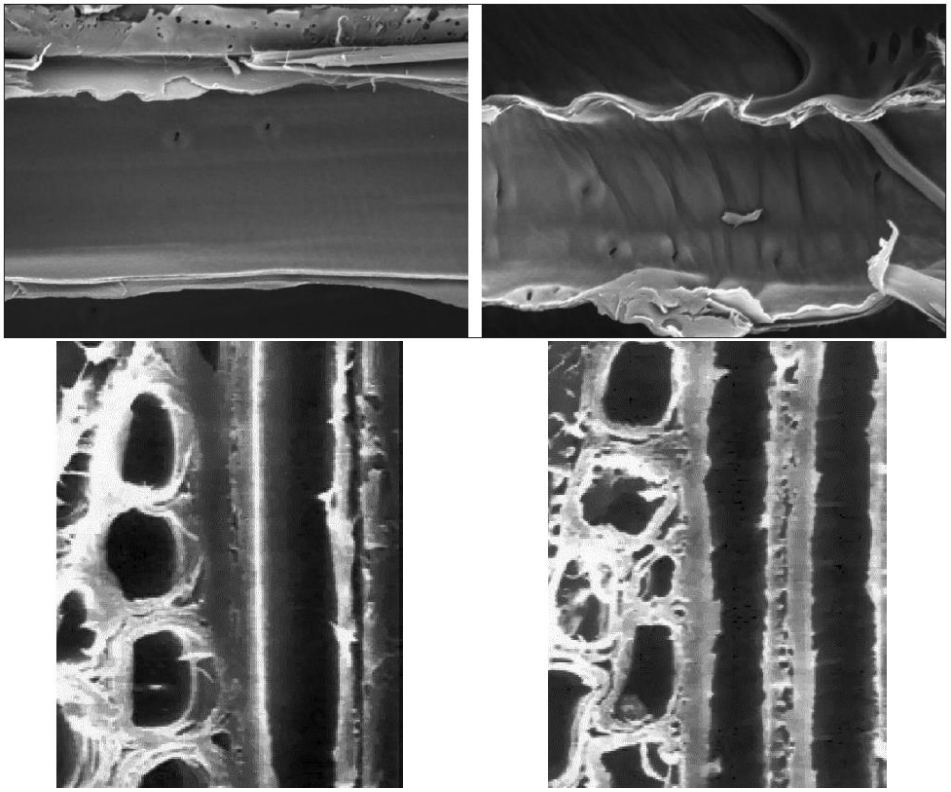
Figure 6

Spike Knot in Compressed Wood (Left) and Splitting Caused by Oblique Grain (right)

Not only in case bending, but also during compression, the softened middle lamella allows the cells to move. At the same time, the cell wall is crumpled (*Figure 7*), adding some new properties to the wood. The modulus of elasticity drastically decreases, while the static mechanical properties (eg. bending) decrease, but at the same time the wood becomes more flexible. The energy absorbed during the fracture under dynamic load is significantly increased. The material thus obtained becomes easily bendable because, when bent, the fibers are not stretched and compressed, but the crumpled cell wall is straightened or crumpled further. This type of load is more bearable for the wood material (*Báder*, 2015).

Figure 7

Wood Cells Before (Left) and After (Right) Longitudinal Compression



Source: *Báder*, 2015

Not only the mechanical properties of the material, but also its hygroscopic properties change as a result of the treatment. As a result of higher humidity, it undergoes the same process as in case of untreated wood, but due to the crumpled fibrous structure its longitudinal growth is significantly higher. As a result of this, when exposed to moisture, the longitudinally compressed wood tends to return to its original shape. These bent materials are used primarily

in furniture and interior design products. Due to the changed mechanical properties it is not suitable for building structures.

CONCLUSIONS

The first half of this article introduces the basics of wood anatomy to the reader, beginning with an overview of the cell types that make up the wood. Conifers and deciduous species are distinguished by different cell types and characteristics. Based on the arrangement of the vessels, deciduous species are divided into ring-porous and diffuse-porous species. Next, the preparation method of light microscopy and the characteristics of these specimens are discussed. After presenting the cells and their examination, the cell wall and its three major elements, lignin, cellulose and hemicellulose, were presented in more detail. This makes wood bending easier to understand. There are two basic types of wood bending, plywood bending and compression with steaming. The article discusses the bending of compressed and steamed wood, the effects of steaming and longitudinal compression on the anatomy of wood. During steaming, the lignin softens, allowing the cells to move, allowing the wood to be shaped and bent. The compression technology is based on this, only in this case, the steamed wood is not bent immediately after steaming, but is first compressed longitudinally, which causes the cell structure to crumple. As a result, the wood becomes even easier to bend and more flexible, even at room temperature. However, the mechanical properties as well as its hygroscopicity changes. In this way, it is advisable to keep it in indoor climate close to constant humidity.

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ARTHROPOD AND FUNGUS COMMUNITIES ON DIFFERENT POPLAR TAXA

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ABSTRACT

The Populus genus includes key species with both ecological and economic significance. They play an important role in natural ecosystems and biomass production. Agroforestry frequently uses poplar species. Cultivating poplar trees with another herbaceous plant or plants in the same area provides a more complex habitat that can support a wider variety of fauna. Furthermore, in landscape management, poplar species are frequently planted as a windbreak around agricultural fields to protect against wind erosion. Our aim was to determine the arthropod and fungi communities living on young poplar trees and to detect those harmful pests, which can cause damage both on poplar trees and on herbaceous plants. We have examined four Populus taxa, the majority of which belonged to the Aegerios section. Our trial was carried out in a plantation. The insect association was investigated twice in the growing season, for three years. We determined the harmful pest in technology terms. The chewers were the most frequent and species-rich functional group. The majority of observed beetles were oligophagous, while the bulk of Lepidoptera species were polyphagous. Poplars have a rich aphid community. The suckers can spread viruses so this type of harmful pest can have a vector roll in agroforestry, as well. The rust species were the commonest fungi on examined poplar taxa. Rust fungi on poplar are able to infect two different plant hosts in different stages of its life cycle so we have to pay attention to this fact when we design the list of companion plants.
Keywords. Polyphagous, *Helicoverpa armigera*, soil insects, rust species, soil-borne fungi

INTRODUCTION

Agroforestry has been practised all over the world for centuries, however its importance has been changing from country to country and from timet to time. This cultivation system has several positive effects as growing trees with different herbaceous plants in the same area provides a more complex habitat that can support a wider variety of fauna (Harvey, 2007; *Jose*, 2009; *Shibu*, 2012; *AFAF*, 2017). Furthermore, this cultivating method increases organic carbon in the soil (*Naveen et al.*, 2009; *Parakash and Lodhiyal*, 2009; *Rizvi et al.*, 2011), decreases soil erosion (*Escobar et al.*, 2002; *Schultz et al.*, 2004; *Eynard et al.*, 2005; *Legout et al.*, 2005), improves productivity of some kinds of plantations (*Noble et al.*, 1998) and diversifies of farm incomes (*Seobi et al.* 2005).

The *Populus* genus includes keystone species with both ecological and economic significances. They play an important role in natural ecosystems and biomass production, in the temperate area of the Northern Hemisphere. *Populus* is a fast growing tree species with easy and effective vegetative and generative propagation (*Philippe and Bohlmann*, 2007). Its soil enrichment quality is fine. *Whithman et al.* (1996) mention poplar species as the most productive member of the riparian communities. Its oxygen producing ability is – in connection with its vigour and intensive growth – one of the best regarding the trees species in the temperate climate (*Schmidt*, 2003).

Some *Populus* species like a founder species providing nutrition and habitat for several invertebrates linking to food chains (*Shuster et al.*, 2006; *Bailey et al.*, 2006), making microbiologicaly connections, and linking intimately to ecological recycling (*Schweitzer et al.*, 2008) under wetland conditions.

Poplar plantations provide inexpensive hardwood timber to prepare plywood, paper pulp, fiber board, veneer, fine paper, sports goods, matches, boxes and pallets for instance. With this objective 10-12-year old trees can be harvested in Hungary. Poplar is also used as an energy crop for biomass, growing in a short rotation coppice system from two to five years. In addition, in landscape management, poplar species are frequently planted as a windbreak around agricultural fields to protect against wind erosion. This type of use can get an important role in agroforestry, as well.

Due to the mentioned facts agroforestry frequently uses poplar species worldwide (*Chandra et. al.*, 2001; *Fang et. al.*, 2005). However every country has its own tree species use (*Newman*, 1997). All poplar clones and sorts have a specific herbivore and xylophagus insects as well as pathogen assemblage.

There have been numerous studies with insects living on poplar trees, however there were only a few to examine the complete insect community in an artificial poplar habitat. *Floate and Whitham* (1995) examined different hybrid poplars in their natural habitat and in a nursery. They observed different connected insects community in these two habitats. That is the reason why the poplar insect and fungus community should be examined in different habitats.

Our aim was to determine the arthropod and fungi communities living on young poplar trees in our country and to detect the harmful pests that can cause damage both on poplar trees and on intercrop plants endangering the successfulness of agroforestry cultivation.

MATERIAL AND METHODS

Our trial was carried out in a plantation in Somogy county. The forest site conditions were the same in every plot.

We examined four *Populus* taxa (Monviso, AF-2, Kopeczky and *P. canescens*) the majority of which belonged to the Aigeiros section. Only one clone originated from Leuce section.

The trees were 2 years old in the first year of examination. Two hundreds trees were randomly chosen from each taxa to examine the infestation of arthropods and infection of pathogens. The insect association and pathogens have been investigated twice (beginning of July and September) in the growing season, for three years. The damage caused by the insects was categorized in seven groups: chewers, skeletonisers, leaf miners, leaf rollers, gall makers, suckers and sap feeders (aphids and leafhoppers) as well as xylophagous insects. The damage caused by pathogens was examined on the leaves and on the bark. The quantity of the missing and infected leaf surface was determined in percentage for chewers, skeletonisers, and pathogens. The number of mines, galls, rolls and damage caused by xylophagous insects and pathogens on the bark were counted, while sap suckers' damage was recorded by the scale of Banks. Basic statistical methods were used to estimate the damage and compare the dataset of different poplar clones. We analysed the differences among group means using Kruskal-Wallis nonparametric test.

RESULTS AND DISCUSSION

Relatively rich artropods and pathogens community were detected during the three-year long examination on young poplar: 83 arthropods species and 14 pathogens were identified.

The arthropod and fungus communities were different on four young poplar clones. However, the dominant insects and fungi species with plant protection importance were similar on the examined taxa. The most frequent chewer and skeletoniser species were *Chrysomela populi,* caterpillars of *Helicoverpa armigera, Orgyia antiqua* and *Acronycta rumicis* furthermore *Phratora* spp.. Two of them (*H. armigera, A. rumicis*) can endangered poplar and herbaceous plants, as well. *H. armigera* dominated from midsummer until October. Infestation of its first generation was always moderate, but the second one was exceptionally high. It seems that this species flies from the agricultural fields into plantations in midsummer. *O. antiqua* consumes deciduous trees, while *C. populi* and *Phratora* spp. chews and skeletonises leaves of poplars and willows. Significant differences were determined between the clones regarding the damage caused by chewers (p_1=0.0092; p_2=0.0310; p_3=0.0359) during the examined years. The groups of leaf miners, gall makers and aphids consist of dominantly monophagous species only some leaf miners occur on willow, too. The leaf rollers are mono-, or oligophagous species, while leafhoppers occurring on poplar are polyphagous species. There was not significant difference between the three Euramericana hybrids regarding the damage of leaf miners (p=0.312), rollers (0.754), gall makers (the infection was too low), sucker and sap feeders (p=0.274). The infection level of gall makers was lower, while sucker and sap feeders was higher on *P. canescens* than on the Euramericana hybrids.

Paranthrene tabaniformis and *Gypsonoma aceriana* like xylophagous insects frequently caused damage on all clones.

The most frequent fungus genus were: *Drepanopeziza, Melampsora,* and *Venturia.* The highest infection rate was caused by *Drepanopeziza* spp. in summer and *Melampsora* spp. in late summer and autumn on poplar trees. Regarding *Melampsora* spp. significant difference (p=0.004) was observed among the clones. The highest infection was found on *P. canescens*, while the lowest on AF-2 clones. *Mycosphaerella populi.* was also a frequent species, but it occurred only on AF-2 clones. Here mentioned species are mono-, or oligophagous, they infect poplar and might infect willow. They are important species in connection with determining the plant protection method in poplar. Considering the species, which can cause plant protection problems both on poplar and herbaceous plant the most dangerous were *Fusarium* spp., *Verticillium* spp. and *Botritys cinerea*, however their infection was not to serious on young stocks.

The majority of insects (67.5%) and fungi (57.1%) living on poplar are oligo- or monophagous (*Table 1*). This fact is in a great part due to the "bottom-up" control of poplar. From this viewpoint poplar is a proper species in an intercrop cultivation system.

Nevertheless, there are some type of polyphagous harmful pests, which can endanger the successfulness of cultivation. The frequent polyphagous lepidopteran species and some aphid species can cause damage both on tree and on intercrop, as well. Besides, soil insects (grubs, wireworms) may cause bigger plant protection problems both in poplar rows and herbaceous intercrops. Regarding the frequent pathogens, the different rust fungi can cause serious problems in this kind of agroforestry plantation in case of defined companion plants, because

rust species living on poplars have a herbaceous host, as well. The soil-borne type of fungi (*Verticillium*, *Fusarium*, and *Botritys* also dispose soil-borne dormant resting structure) endanger both the poplars and the other cultivated plants.

Table 1

Number of identified arthropods and pathogens on different hosts

Pest / Host	Poplar	Poplar and willow	Poplar and deciduous	Poplar and herbaceous
	Number of species			
Herbivore arthropods	37	16	15	9
Xylophagous insects	2	1	3	0
Pathogens	7	1	1	5

Note: *Every species were divided into one group, which characterises it the best.*

CONCLUSIONS

Agroforestry is an intensive cultivating system. Trees and intercrops require a different type of plant and forest protection method from agricultural field and natural forest. Under these conditions the trees do not behave like a forest tree. We have to follow the principle of integrated pest management, so we have to use agricultural protection method as proper crop combination; we have to pay attention to genetic background of tree and crop species, and only last resort we have to use plant protection material against harmful pests.

Chewing and skeletonising damage as well as the rust infection showed significant differences between the examined clones. Based on our findings 28.8% of occurring arthropods and fungi species can cause plant protection problem in both deciduous or herbaceous intercrops.

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MAJOR PHYSICAL AND MECHANICAL PROPERTIES OF SELECTED WOOD SPECIES

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ABSTRACT

Wood properties are the result of several influencing factors. Among these factors, one of the most importants is the moisture content (MC). In this study, the MC of wood was selected as a main factor which highly affects most properties of wood (density, strength, elasticity, shrinkage and swelling, etc.). The aim of this study is to determine the differences in tensile strength, bending strength, compressive strength and Brinell hardness between samples with 12% MC and samples with MC over the fiber-saturation point. This study deals with control samples came from conventional forests, which is the first step to be able to make a comparison with species grown in an agroforestry system. Agroforestry combines agricultural (cultivated plants) and forestry technologies (shrubs and trees) to create more diverse, productive, profitable, healthy, ecologically adequate, and sustainable systems. The properties of wood are influenced by the different nutrient uptake, the different illumination and wind, etc. All these conditions can cause highly different growing of trees, that affects their microstructural and macrostructural structure as well.

INTRODUCTION

The properties of wood are the result of several influencing factors. The structure of annual rings and the resulting inhomogeneity, the porosity, the moisture content (*MC*) and many other factors have great significance on its properties, and these can be never ignored. In this study, the *MC* of wood was selected as main factor, which highly affects most properties of wood (density, strength, elasticity, surface treatment, pliability, decay-resistance, electrical and thermal properties, anisotropic properties, shrinkage and swelling, etc.).

Water can be found in wood in three states: liquid water (free water) and water vapor in cell lumens, water bound in cell walls (bound water), and crystallized water linked to the chemical components of wood. The fiber-saturation point (*FSP*) is the *MC*, when all the intermicellar and interfibrillar cavities of the cell wall are saturated with water, but no free water is found in the cell lumen (*Tiemann*, 1906). *FSP* is at about 30% *MC*, hangs on the wood species. Between the absolutely dry state and the *FSP*, both air and water can be found in the wood tissue. The mechanical properties of wood highly change, but over the *FSP* the mechanical properties of wood remain the same. Over *FSP*, free water is already present in the cell lumens and if the wood reaches its saturated state, no air remains in the lumens.

The aim of this study is to determine the differences of tensile strength, bending strength, compressive strength and Brinell hardness between 12% *MC* and *FSP*.

MATERIAL AND METHODS

During the described researches the mostly used Hungarian hardwood and softwood species had been selected: robinia (*Robinia pseudocacia*), sessile oak (*Quercus petraea*), beech (*Fagus sylvatica*), poplar (*Pupulus*), larch (*Larix decidua*) and spruce (*Picea abies*). The porosity of wood correlates well with its density:

- high density (>700 kg/m^3): robinia, beech
- medium density (550-700 kg/m^3): oak, larch
- low density (<550 kg/m^3): poplar, spruce (*Molnár*, 2004; *Molnár et al.*, 2016)

Another important factor is that the selected species include both diffuse-porous (beech, poplar) and ring-porous wood species (oak, robinia). Only faultless samples with narrow annual rings had been tested, thus with homogeneous structure.

Prior to the measurements, the samples had been prepared according to the standards, and the tests were conducted according to the standards as well. The samples were divided into two equal groups. The first group was put in a climate chamber at a temperature of 20 °C and a relative humidity of 65%, to have a *MC* of 12%. The other group was soaked into distillated water to have a *MC* over their *FSP*.

Tensile strength

The value of the tensile strength (σ_t) is given by the ratio of the highest load (F_{max}) and the area of the most highly loaded cross section (A) of the sample:

$$\sigma_t = \frac{F_{max}}{A} \quad (1)$$

In addition to the maximum tensile force, the shape of the fracture after the test predicts the quality of wood as well, by showing the rigidity of the sample. The samples were designed as described in the standard ISO13061-06, with a size of 20 × 20 × 300 mm.

Bending strength

For a three-point bending test of wood, the value of bending strength (σ_b) is calculated using the Navier-equation corrected by Tanaka (*Kovács*, 1979), as follows:

$$\sigma_b = \frac{F_{max}}{A} \quad (2)$$

The samples were produced as described in the standard ISO13061-03, with a size of 20 × 20 × 300 mm.

Compression strength

Compression strength (σ_c) is calculated using the following equation:

$$\sigma_c = \frac{F_{max}}{A} \quad (3)$$

In our tests, compressive strength parallel to the grain was investigated as described in ISO13061-17 standard.

Brinell-Mörath hardness

In 1900, Brinell expressed the hardness as the ratio of the load and the surface impressed by a 10 mm diameter steel ball. According to Mörath's amendment, very hard wood species are

exposed to 1000 N, semi-hard wood species are exposed to 500 N and very softs are exposed to 100 N force (F) (Vörös and Németh, 2018a; Vörös and Németh, 2018b), as it is shown in the hungarian standard MSZ6786/11-82. The Brinell-Mörath hardness (H_{BM}) is calculated by the next equation, using the depth of indentation (h), the diameter of the ball (D) and the diameter of the remaining impression of the ball (d):

$$H_{BM} = \frac{F}{D\pi h} = \frac{2F}{D\pi(D-\sqrt{D^2-d^2})} \quad (4)$$

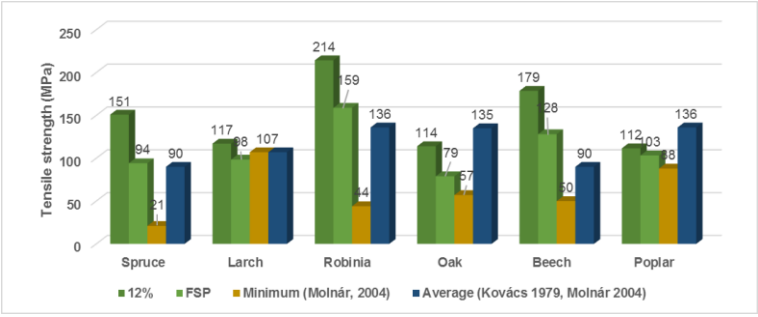
RESULTS AND DISCUSSION

Tensile strength

The mean values obtained for tensile strength are shown in *Figure 1* (dark green: air-dry, light green: over *FSP*). By comparison, air-dried minimum values (yellow) and averages (blue) are presented as separate columns, derived from the studies of *Molnár* (2004) and *Kovács* (1979).

Figure 1.

Changes in Tensile Strength Depending on the Moisture Content of Spruce, Larch, Robinia, Oak, Beech and Poplar



As shown in *Figure 1*, the tensile strengths at 12% *MC* are well above the average values, except for oak and poplar. However, considering the maximum values given by *Molnár* (2004), these protrusions cannot be considered as unique results. As an example, the tensile strength can be as high as 245 MPa for spruce and 180 MPa for beech and oak. For robinia, Molnár (2004) gives a maximum value of "only" 184 MPa, but this difference of 16% cannot be considered as a significant difference, as wood can have highly different mechanical-physical properties due to their diverse tissue structure even in one species.

The loss of strength due to the increasing *MC* is 56.8 MPa (38%) for spruce, 18.6 MPa (16%) for larch, 55.5 MPa (26%) for robinia, 35.1 MPa (31%) for oak, 50.6 MPa (28%) for beech and 8.3 MPa (7%) for poplar. It should be noted that the relative standard deviation of the results over *FSP* was slightly higher (~31%) compared to the results of air-dry samples (~ 26%).

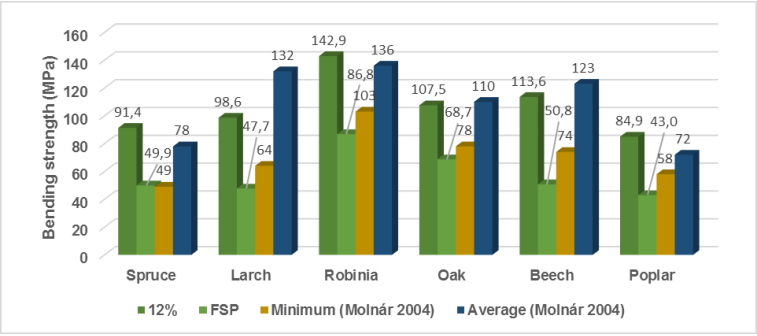
Bending strength

The results of the 3-point bending strength tests are shown in *Figure 2*. With increasing *MC* between 12% and FSP, bending strength decreases by 41.4 MPa (45%) for spruce, 51 MPa

(52%) for larch, 56.1 MPa (39%) for robinia, 38.8 (36%) for oak, 62.8 MPa (55%) for beech and 42 MPa (49%) for poplar.

Figure 2

Changes in Bending Strength Depending on the Moisture Content of Spruce, Larch, Robinia, Oak, Beech and Poplar



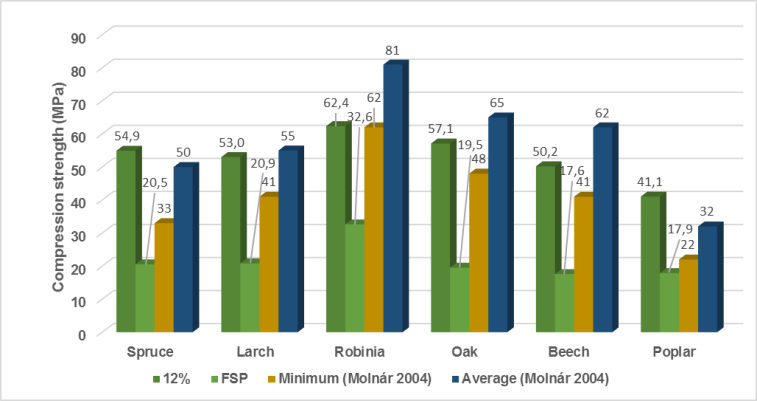
The results of spruce, robinia and poplar exceed the mean values, while the results of larch is much lower compared to the results of *Molnár* (2004). The average results are much higher compared to the minimum-values in the literature. The reason in this case is mainly the high difference in the anatomy within each species.

Compression strength

The results of the compression tests and the comparative values of the literature can be seen in *Figure 3*.

Figure 3

Changes in Compression Strength Depending on the Moisture Content of Spruce, Larch, Robinia, Oak, Beech and Poplar



The compressive strength showed a significant reduction of averagely 60% with the change in *MC* between 12% and *FSP*. The compressive strength of spruce and poplar samples exceed the average values, while the remaining wood species remain below. The minimum values given by *Molnár* (2004) has always been achieved.

Brinell-Mörath hardness

The hardness of the wood species was tested in all three anatomical directions which are shown in *Figure 4-6*.

Figure 4

Changes of Brinell-Mörath Hardness in Longitudinal Direction, Depending on the Moisture Content of Spruce, Larch, Robinia, Oak, Beech and Poplar

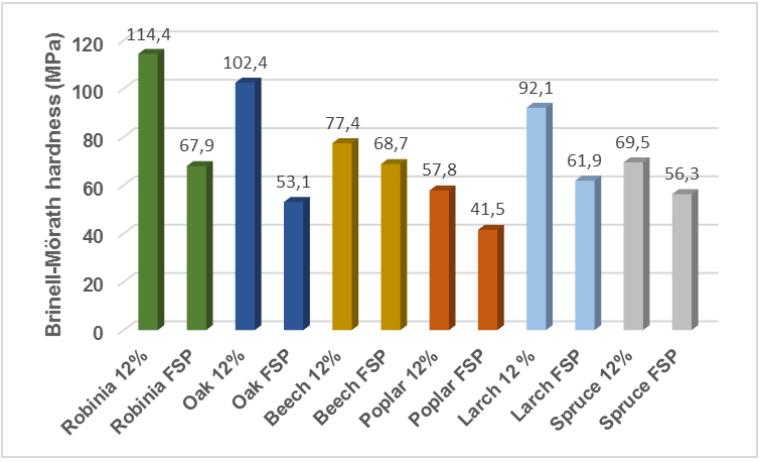


Figure 5

Changes of Brinell-Mörath Hardness in Tangential Direction, Depending on the Moisture Content of Spruce, Larch, Robinia, Oak, Beech and Poplar

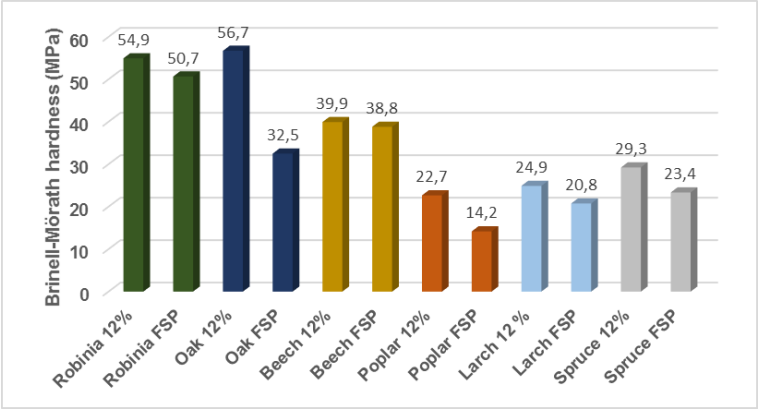
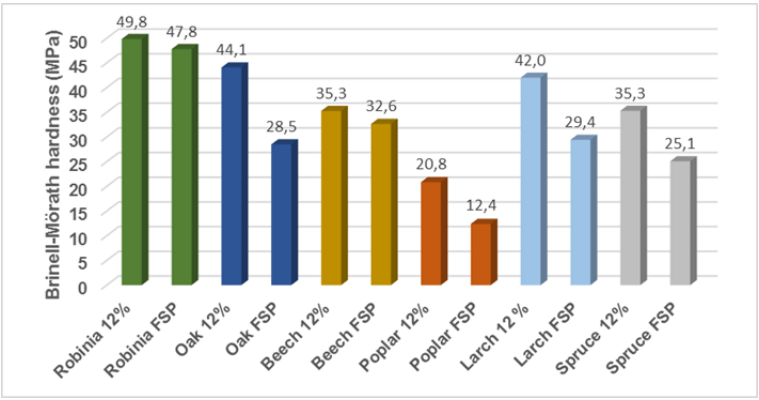


Figure 6

Changes of Brinell-Mörath Hardness in Radial Direction,
Depending on the Moisture Content of Spruce, Larch, Robinia, Oak, Beech and Poplar



In order to be the high amount of data easier comparable, the degree of hardness reduction is presented in *Table 1*.

Table 1

Reduction of Brinell-Mörath Hardness in Different Anatomical Directions
Between 12% Moisture Content and the Fiber Saturation Point
of Different Wood Species

Direction	Wood species					
	Robinia	Oak	Beech	Poplar	Larch	Spruce
Longitudinal	41%	48%	11%	28%	33%	19%
Radial	4%	35%	7%	41%	30%	29%
Tangential	8%	43%	3%	37%	17%	20%

The reduction of hardness of the wood species in their three anatomical directions is quite different. The most significant change occurred in the fiber direction of the ring-porous species (robinia and oak). In the tangential and radial direction of robinia almost no change occurred by the change in *MC*, but for oak this change was high, averagely 39%. For diffuse-porous species, the reduction of this property of beech is very low. However, poplar has a high decrease in hardness, moreover its radial decrease is higher than the decrease in its fiber direction. Both poplar and oak have huge cell lumens, which can absorb much more water compared to the other species. For softwoods, spruce shows a similar tendency to poplar in its hardness reduction resulted by the increase of *MC*. The change of this property of larch, the decrease in radial direction approaches the result in fiber direction, but the tangential hardness-change is significantly lower compared ti its other directions.

CONCLUSIONS

As a conclusion, both tensile strength, bending strength, compressive strength and hardness of the air-dry samples closely correlate with the data from the literature. This confirms the correctness of the performed measurements which is necessary, to be the results comparable using other moisture content. The examined properties consequently decreased with increasing moisture content for all six wood species, but the ratio of changes was various, depending both on the measurement method and on the species. The selected species representing different groups of wood species, thus, these different groups have become better comparable.

ACKNOWLEDGEMENT

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RELATIONSHIP BETWEEN WOOD PROPERTIES AND THE MICROSTRUCTURE OF CELLS

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ABSTRACT

Agroforestry combines agricultural (cultivated plants) and forestry technologies (shrubs and trees) to create more diverse, productive, profitable, healthy, ecologically adequate and sustainable systems. The properties of wood are influenced by the different nutrient uptake, the different illumination and wind, etc. All these conditions can cause highly different growing of trees, that affects their microstructural and macrostructural structure as well. This study deals with control samples came from conventional forests, which is the first step to be able to make a comparison with species grown in an agroforestry system. The amount and the position of wood fibers and rays considerably influence the physical and mechanical properties of wood. These properties are primarily affected by the fibers. The walls of cells are built up of layers. The cell wall layers are characterized by the differences in the positioning of the microfibrils. The thickest and physically and mechanically mostly significant is the S2 layer. The microfibril angle in the S2 layer is an important determinant of the quality of tree, wood and fiber. Relation can be found between microfibril angle and stiffness, shrinkage, pulp and paper properties and other factors, such as hemicellulose content. All these parameters have significant effects on the macroscopical view of wood, as well.

INTRODUCTION

Agroforestry is a land use management system in which trees or shrubs are grown around or among crops or pastureland. It combines shrubs and trees in agricultural and forestry technologies to create more diverse, productive, profitable, healthy, ecologically sound, and sustainable land-use systems. Agrisilvicultural systems (*Figure 1*) are a combination of crops and trees, such as alley cropping or homegardens. Silvopastoral systems combine forestry and grazing of domesticated animals on pastures, rangelands or on-farm. The three elements, namely trees, animals and crops, can be integrated in what are called agrosylvopastoral systems and are illustrated by homegardens involving animals as well as scattered trees on croplands used for grazing after harvests (*Gyuricza and Borovics*, 2018; *FAO*, 2015; *www.wikipedia.org*).

The properties of wood will be influenced for example by the line-width or by the changed nutrient uptake, the change light effects and wind. All of them can cause, that the trees grow elseways, that way can give rise to microstructural, hereby macrostructural alterations in the wood substance/woody tissue.

Figure 2 shows some by agroforestry changed factors and their possible effects. The early wood and the late wood both together means the annuel growth of trees. The rate of them, and the annuel ring width depend on the above listed factors. If the trees are growing on a hilly terrain, their structure will be deformed. As an example of this phenomena called reaction wood is shown (by hardwood they are called tension wood, by softwood compression wood). It is very unfavorable by drying, production, painting and for phisycal and mechanikal

properties. It is can be caused by extended wind- or snow, too. For us it is interesting, because as on the round of a forest grown trees, the in the extendid line width grown trees can be touched, too. The extended line – width can be a reason for the further engender knots. Knots are the left places of chipped branches. If there are a big place to grow, trees will have more branches. It is unprofitable by producing, the wood products industry likes brunchfree trunks.

We have to carry out measurements to get acquainted with the exact differences between the regular- and the agroforestry and with the influence-factors.

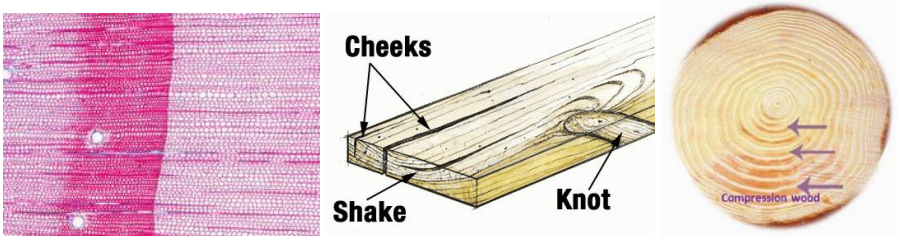
Figure 1

Agrisilvicultural system

Source: https://yggdra.be/wp-content/uploads/2017/09/alleycropping-in-france.jpg

Figure 2.

Annual ring (a) knot (b) and reaction wood by softwood (c)



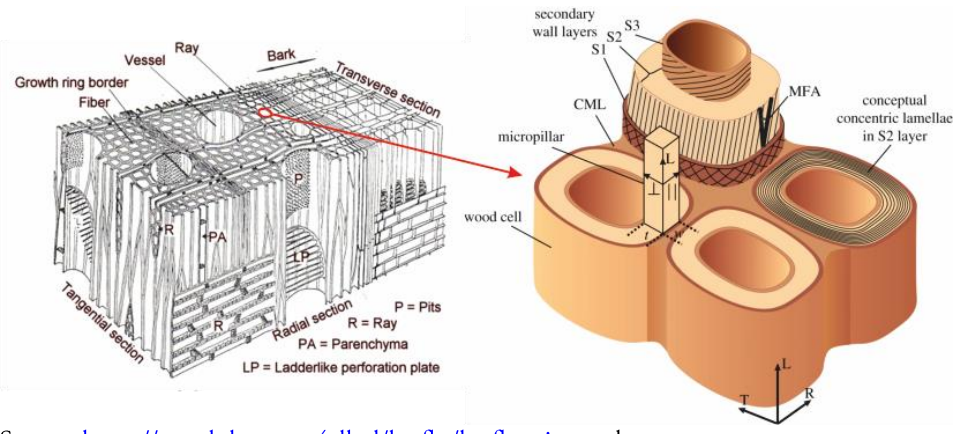
Source: *Isaac-Renton* (2017: p. 36), https://o.quizlet.com/y3akriLhkuT53DyvlH5K1Q.jpg and *Hanegraaf* (2018: p. 15)

The structure of the cell wall in wood

At first we have to get acquainted with the microscopical structure of wood (*Figure 3*). The wood vessels, which run longitudinal through the trunk transporting water. The vertical dark lines in the figure 3 are rays. They are series of thin walled cells, running radially to the outside in the transverse section. One of the functions of the rays is the transporting of nutrients in horizontal direction. The physical and mechanical properties considerably depend on the amount and the position of the rays.

Figure 3

The microscopical structure of wood and cell wall



Source: https://steurh.home.xs4all.nl/loofht/loofhen.jpg and https://www.researchgate.net/profile/Konstantins_Jefimovs/publication/261139845/figure/fig1/AS:667194094538756@1536082876518/Schematic-of-cell-wall-layers-within-cellular-structure-of-wood-The-S2-micropillar-and.png

These are the main cell types of wood, but they vary in wood species, wood types (ringporous, diffuse porous hardwoods and softwoods).

We can find in softwoos

- mainly tracheids,
- small amount of parenchymas,
- epithelial cells,
- strand tracheids,
- thin walled parenchyma cells,
- ray tracheids.

They do not contain fibres and vessels. In hardwoods we can find

- vessels,
- vascular tracheids,
- vessel tracheids,
- thick-walled fibres,
- libriform fibres,

- axial parenchymas,
- ray parenchymas,
- tyloses.

We can see, that the structure of hardwood is more complicated than softwoods (*Butterfield et. al.*, 1997).

Figure 3 shows, that all fibres and tracheids can be resolved in cellulose layers. Bailey named the cellulose layers in 1935 S1, S2 and S3. The letter S being shorthand for 'secondary' and the numerals reflecting the order in which the layers are laid down. (*Barnett et. al.* 2004)

- S1:
  - microfibrils are not so oriented (50-70°)
  - thickness: 0,2-0,3 μm
- S2:
  - microfibrils are oriented (5-30°)
  - thickness: 1-5 μm
- S3:
  - microfibrils are not so oriented (50-90°)
  - thickness: 0,1 μm (Butterfield et. al. 1997).

The layering is the result of differences in the degree of angular dispersion of cellulose micelles within the layers. The microfibril angle (MFA) in the S2 layer is an important determinant of timber and fibre quality. (*Donaldson*, 2008)

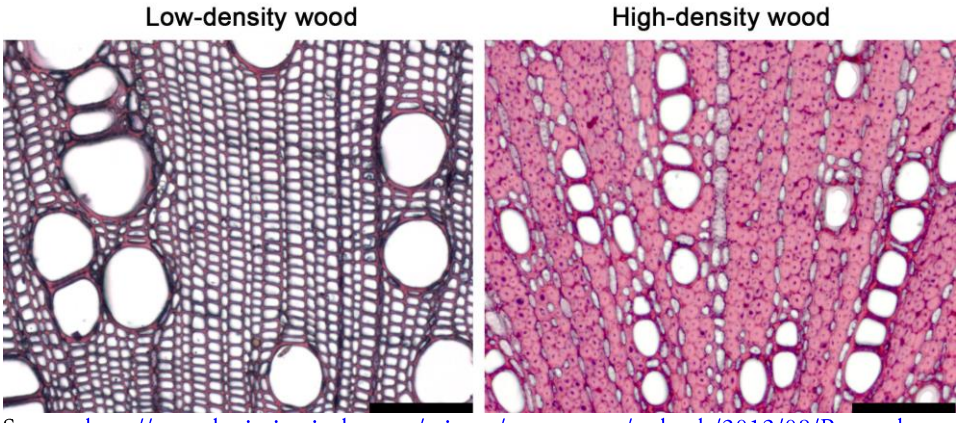
Relationship between MFA and wood properties

- Density (*Figure 4*): MFA shows a variable relationship with density. In some cases MFA and wood density correlated, while in other cases they are not
- Stiffness: There is a curvilinear relationship between MFA and Young's modulus
- Shrinkage (*Figure 5*): MFA is one of the dominant parameters that affect shrinkage and shrinkage anisotropy. For example, compression wood with increased MFA shows a corresponding increase in longitudinal shrinkage. Cell walls with very low MFA tend to have greater tangential shrinkage, while cell walls with very high MFA tend to have greater longitudinal shrinkage.
- Pulp and paper properties (*Figure 6*): MFA is related to the tensile strength and elastic modulus of pulp fibres, where small MFA values lead to stronger and stiffer fibres. In Pine (Pinus sp.) latewood fibres had 33% higher MoE 73% higher ultimate tensile stress compared to average early wood fibres, differences that were partially attributed to lower MFA in latewood fibres. Using unbleached kraft pulps from 10 individual loblolly pine trees with similar density, coarseness, cell wall thickness and fibre length, but differing in MFA researchers found that MFA was a major determinant of handsheet tensile strength, stretch, modulus of elasticity, stiffness and hygroexpansivity.
- Other factors: Cellulose, hemicellulose and lignin are main constituent of wood (*Figure 7*). Low MFA values in both early wood and latewood result in a high Young' s modulus. MFA shows a significant positive correlation with lignin content and a negative correlation with cellulose content in samples containing compression wood. MFA should also show a correlation with galactan content in compression wood. MFA shows a

positive correlation with xylan content, but no correlation with cellulose content in samples containing tension wood. Xylan and galactan belong to hemicellulos. (*Barnett et. al.* 2004, *Hein et. al.* 2012., *Kucera et. al.* 1982.)

Figure 4

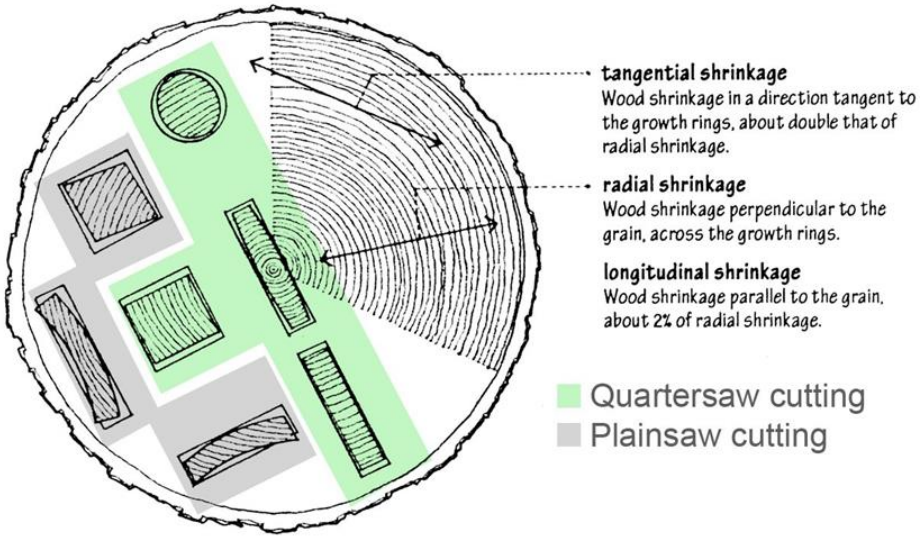
Anatomy of a low-density and a high-density wood



Source: http://www.kasiazieminska.com/science/wp-content/uploads/2012/08/Research-www_2-1024x448.jpg

Figure 5

Shrinkage of wood



Source: https://i.pinimg.com/originals/4c/10/7d/4c107d5ff5ac0215769890c9af361129.jpg

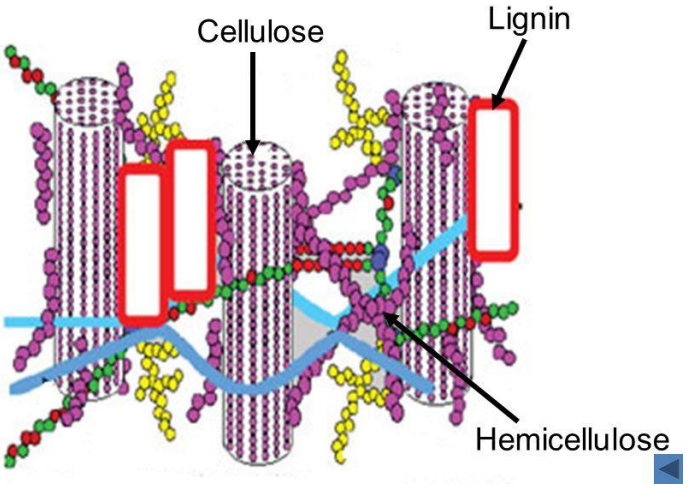
Figure 6

Mould-made paper

Source: https://www.panton.hu/uploads/webshop/webshop-images/tn/0007/057/A-5-Feher-meritett-papir-2019-07-15-38.jpg

Figure 7

The microstructure of wood



Source: http://slideplayer.com/slide/4014749/STEURH.HOME.XS4ALL slide 17

CONCLUSIONS

As we can see, wood is a chemically and anatomically fairly complicated system, in which the MFA in the S2 layer is an important determinant of the quality of tree, wood and fiber. To getting more information about the correlation between changing MFA under agroforestry and MFA under traditional landuse system, we need to have further examinations.

ACKNOWLEDGEMENT

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GETTING STARTED WITH AGRO-FORESTRY RESEARCH AT FERTŐD - HYDROLOGICAL POINT OF VIEW

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ABSTRACT

After the last few years farmers should solve new challenge in adapting to drought. The long-lasting strong sunshine causes sunscald of agricultural berries. Because this symptom is generally present on only the side of the fruit exposed to the sun, the prevention method can be the agroforestry system. The water is a key factor in Hungarian agriculture. This research focuses on open questions: How the trees modify the moisture pattern of the agricultural field? How can trees influence the groundwater level? Are there any differences in hydrological conditions of the individual berry species? We installed a research plot to study the spatial and temporal variability of soil moisture and groundwater level in the agroforestry system in Fertőd (Hungary). Six monitoring points were installed in this area: three wells in the agroforestry system, and three control wells in the agricultural area without trees. The pair of wells are in blackberry (Rubus fruticosus 'Dirksen'), in raspberry (Rubus idaeus 'Fertődi zamatos') and in blackcurrant (Ribes nigrum 'Otelo') plots. The species of the integrated shadowing trees is hybrid poplar (Populus x euramericana). Layering of the soil was detected on the field and soil analysis (grain-size distribution) was performed in the laboratory. The soil moisture and groundwater level are measured biweekly. The climatic parameters such as precipitation, air temperature, relative humidity are continuously recorded by a local meteorological station.
Keywords: agroforestry system, hydrology, soil analysis, groundwater

INTRODUCTION

Agroforestry systems have a larger evaporation surface than agricultural areas. A part of the gross precipitation falls on the canopy, branches, and trunks of trees from where it evaporates. Interception rate amounts depend on rainfall event characteristics, but the tree species, the number of individuals, and the location (free-standing trees, rows or groups of trees) are all factors that influence the LAI (leaf area index) (*Pitman* 1989).

One beneficial effect trees provide from a hydrological perspective is the reduction effect on the evaporation rate through windscreen and shading (*Gyuricza-Borovics* 2018).

Increased water consumption is another tree impact. According to *Madas* (1980), light-demanding species require fairly large water amounts per unit of dry matter production, while shade-tolerant tree species use considerably less water. In some cases, root competition may

occur (*Ong et al.* 2014), but partial root competition between trees and agricultural plants may also create complementary relationships such as spatial complementary relationships (the root system of some intermediate plants is shallower than a part of the tree root); or temporal complementary relationships (maximum tree water consumption and maximum agricultural crop water consumption do not coincide in this case) (*Dupraz et al.* 2005).

Hydraulic lift – the nocturnal movement of water from roots to soil (redistribution) rehydrates the layer of herbaceous roots (*Caldwell et al.* 1998) – can improve the water supply for agricultural plants.

This paper presents recently initiated research that aims to compare the hydrological differences between an agroforestry system and a control agricultural field.

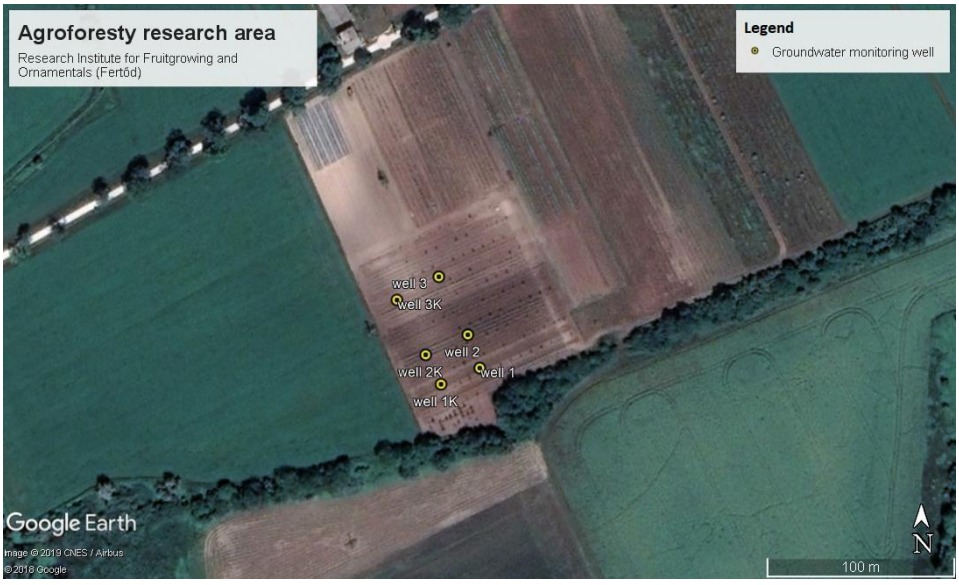
MATERIAL AND METHODS

The agroforestry research area (Lat: 47-37-57 - 47-37-59, Lon: 16-52-56 - 16-52-58 above WGS 84 datum.) is located in Fertőd, a town close to Lake Neusiedlsee (Lake Fertő) in Hungary. The area is situated on the border of three small regions, namely the Neusiedl Basin, the Hanság, and the Ikva Plain. Due to wind direction, the area is predominately characterized by the climate of the Neusiedl Basin, which is a moderately cool and dry climate. The annual amount of sunshine hours is 1850-1880. The mean annual temperature is around 10 °C. Annual precipitation is between 580 and 600 mm (*Dövényi* 2010).

The six groundwater monitoring wells were installed by manual drilling with extendable augers on July 19, 2019 (*Figure 1*).

Figure 1

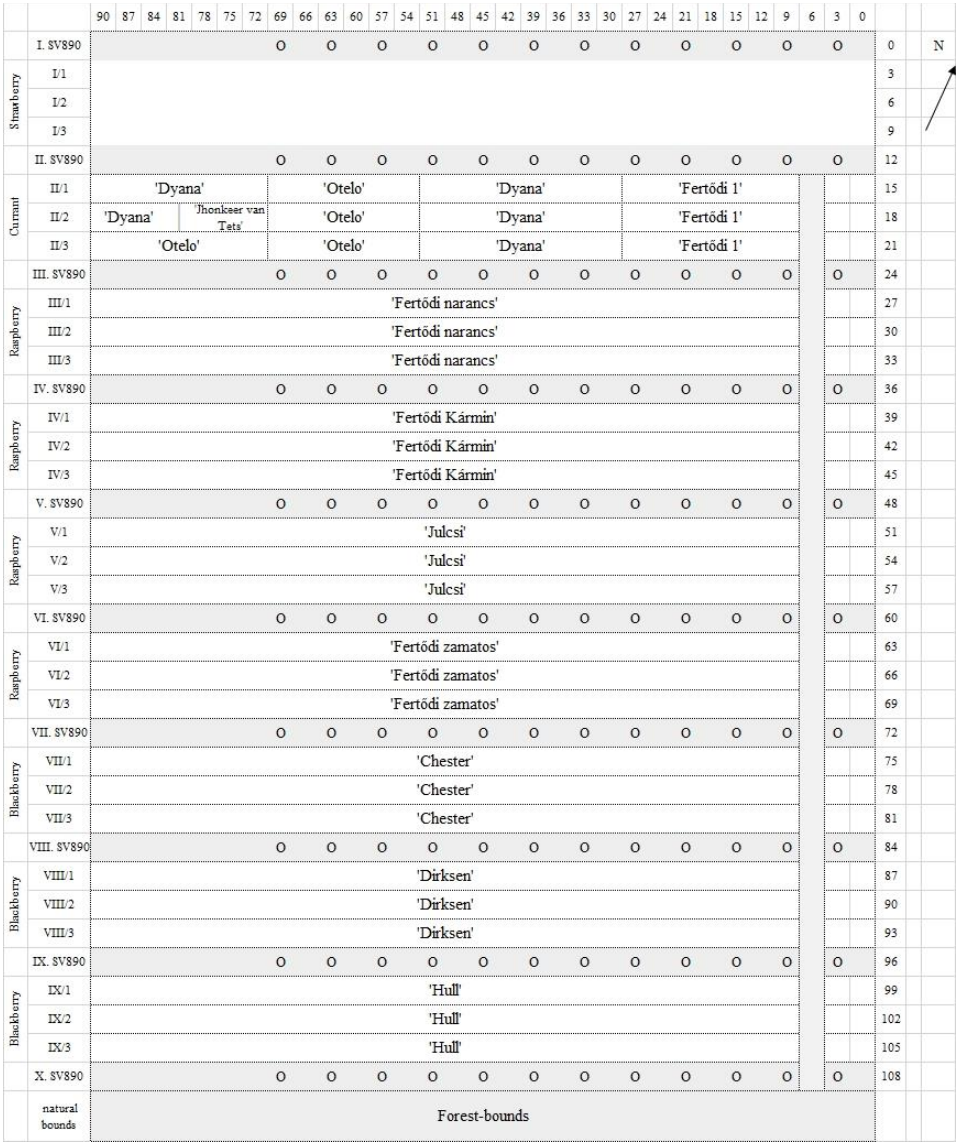
Locations of groundwater wells (marked in yellow)



Perforated pipes with screen were applied for the groundwater monitoring wells. Three pair of wells (agroforestry system and control) are situated in three different berry species plots: blackberry (*Rubus fruticosus 'Dirksen'*), raspberry (*Rubus idaeus 'Fertődi zamatos'*) and blackcurrant (*Ribes nigrum 'Otelo'*). Hybrid poplars (Populus x euramericana) were planted as shadowing trees in 2017. An experimental sketch drawing is shown in *Figure 2*.

Figure 2

Experimental sketch drawing



The groundwater level was measured with a manual optical water level gauge. Measurements provided data beweekly. During drilling, soil moisture was measured at each 25 cm soil level. We applied a HH2 moisture meter with ML3 ThetaProbe sensor (±1% soil moisture accuracy). Grain-size distribution of soil samples was performed with a series of sieves in the laboratory. Soil samples were collected by wells at least every meter (vertical) or more frequently if there was a visible difference in soil layers. Layering of the soil was detected on the field. Hydrological measurements are supplemented by on-site meteorological station with precipitation, relative humidity, and air temperature data.

RESULTS AND DISCUSSION

Table 1 shows the main data of the monitoring wells (detected on field). Drilling depths were about 4 to 4.3 m. The water table was 2.8-3.5 m deep from the surface. Line levelling data (soil surface levels above Baltic Sea Level) show the area slopes from well 1 to well 3K.

Table 1

Field detected data of groundwater monitoring wells

	well 1	well 1K	well 2	well 2K	well 3	well 3K
EOV Y	487351.686	487331.055	487345.725	487322.855	487330.858	487307.604
EOV X	256586.473	256577.875	256603.540	256593.710	256636.459	256624.418
Soil surface level (mBf)*	119.9009	119.4888	119.7278	119.3104	119.5391	119.1991
Well depths (m)	4.3	3.8	4.3	4.0	4.0	4.0
Saturation (m)	3.5	2.6	3.1	2.4	3.2	2.4
Water table (m)	3.6	3.4	3.4	2.8	3.4	3.0

**Soil surface levels above Baltic Sea Level (mBf)*

During drilling, the soil moisture content generally did not change appreciably to the depth of one meter (*Figure 3*). After this depth, soil moisture increased significantly until saturation (about 3.5 m). In general, field detections show that on the surface there is a 40-90 cm brown humic sandy loam sand layer. Below this layer lies yellowish sand, in some places (from 1 to 1.5 m); accumulation of iron with a red colour is detected along the roots. In the deeper layer, clay stripes appear. At depths of about 2.5 to 3 meters, a reductive blue color replaces the former yellowish-red color in the sand layer. In cases of several drillings, a gravel layer appeared in 3.6-4 m deep.

Soil samples (collected from drilling rows) are analysed in a laboratory. Grain-size distributions (*Figure 4- Figure 9*) show that a vast amount of the grains are medium sand and fine sand in all samples. The different lines show different soil layers, hence different depths. According to the soil-texture triangle, all the samples are in the sand or loamy sand category.

Figure 3

Soil moisture values in different depths during drilling

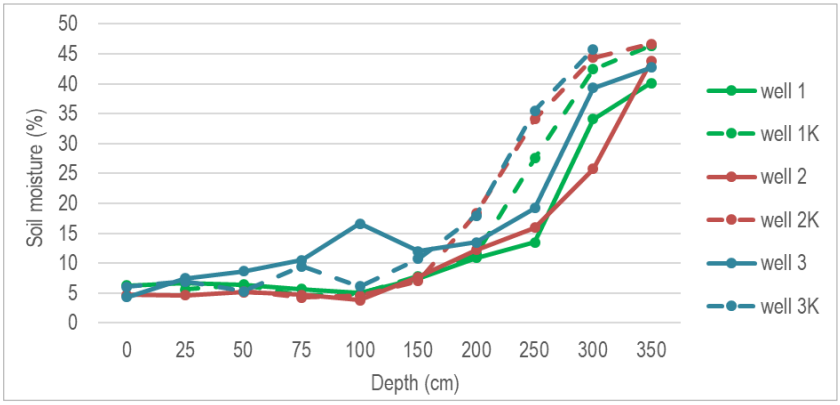


Figure 4

Grain-size distributions of well 1

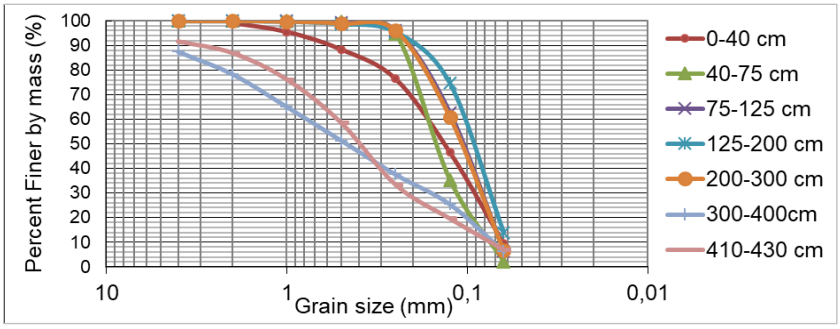


Figure 5

Grain-size distributions of well 1K

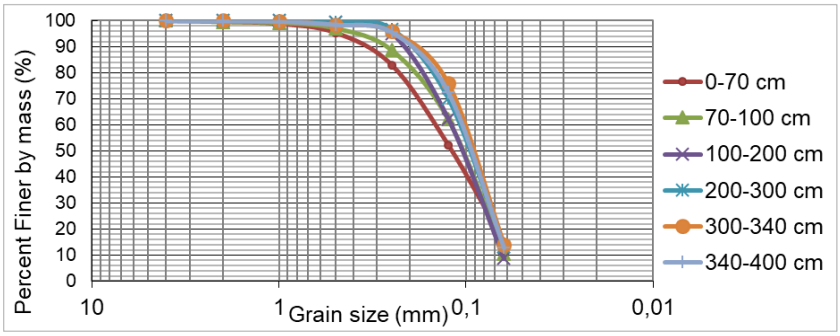


Figure 6

Grain-size distributions of well 2

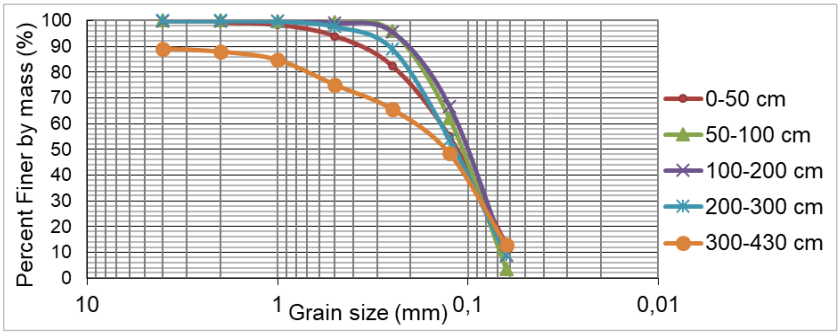


Figure 7

Grain-size distributions of well 2K

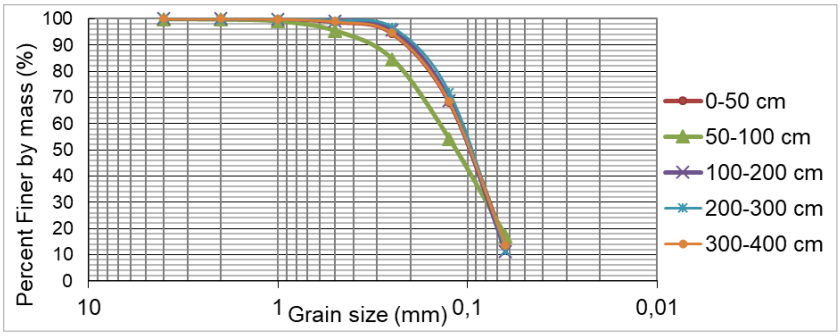


Figure 8

Grain-size distributions of well 3

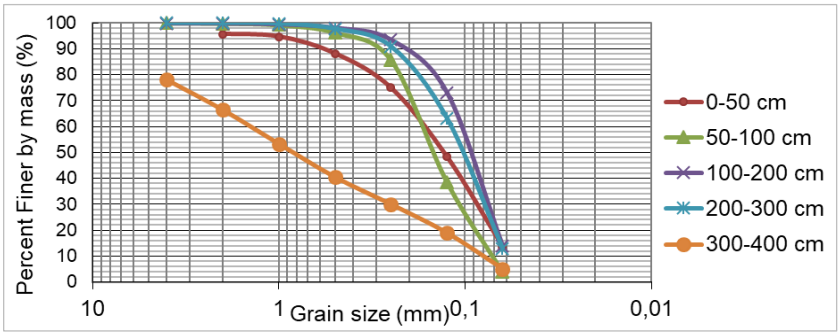
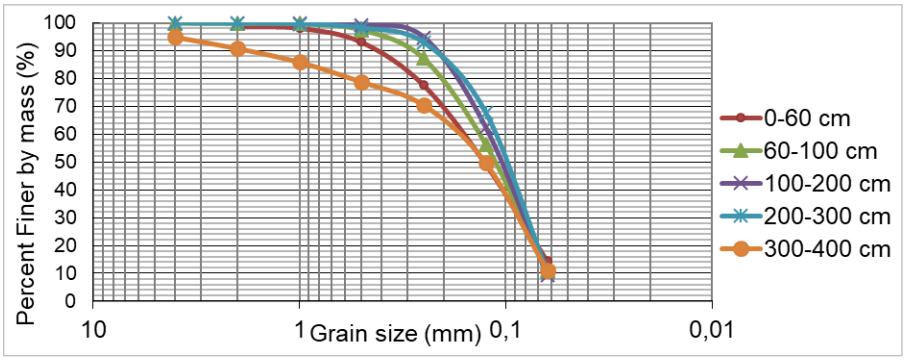


Figure 9

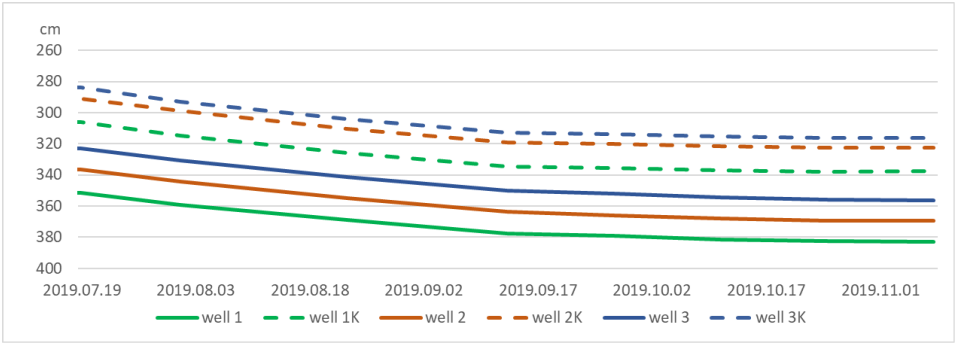
Grain-size distributions of well 3K



Water-level measurements from monitoring wells are the principal source of information about the hydrologic processes. *Figure 10* shows the distance of available groundwater level for the vegetation with the different observation wells. The water level decreases significantly to middle of September before the decreasing process slows down or stops. In winter, groundwater is presumably recharged due to absent water consumption and the rainy weather. The difference between the lowest (well 1) and the highest (well 3K) water level from the soil surface is less than 70 cm.

Figure 10

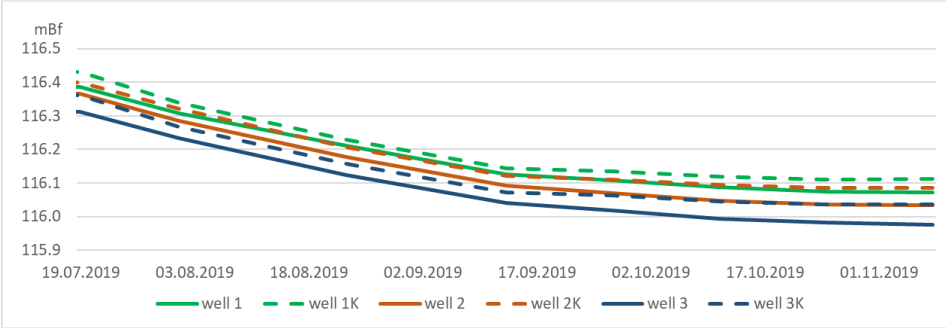
Groundwater level by wells from soil surface



To develop more complete assessments of the cumulative effects of biotic, topographical feature, soil related, and climatic phenomena, the groundwater level above Baltic Sea Level is also examined. The slope of groundwater-level lines is similar (*Figure 11*). The maximum difference between the lines is approximately 15 cm.

Figure 11

Groundwater level by wells above Baltic Sea Level



CONCLUSIONS

Farmers expect benefits from the shading effect of trees in the agroforestry system. Groundwater systems adjust continually to changes in climate and land use. This ongoing research tries to measure the direction and extent of potential hydrological changes. The soil conditions of the measuring plots are similar, which enables long-term comparative analyses. Systematic measurements of water levels provide the data needed to not only examine changes in the available water over time, but to also develop groundwater models. During drought conditions, the monitoring of ground-water availability requires the collection of "real-time" water-level measurements and track trends; consequently, we plan to use automatic water level devices.

ACKNOWLEDGEMENT

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ENVIRONMENTAL MANAGEMENT, CORPORATE SOCIAL RESPONSIBILITY, COMPANY SUSTAINABILITY TOOLS

KÄRCHER AS AN EXAMPLE FOR SUSTAINABLE CORPORATE DECISIONS

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ABSTRACT

"Sustainability is not a coincidence but the result of conscious decisions"
Hartmut Jenner, CEO Alfred Kärcher SE& Co.KG

Alfred Kärcher SE & Co. KG (Kärcher) is a manufacturer of cleaning equipment and systems with the headquarters in Winnenden, Baden-Württemberg. The family-owned company employs more than 13,000 people worldwide and is the world market leader in this sector. The company takes its responsibility very seriously, and is committed to providing a cleaner environment with its technology expertise, donations to charity, and its personal commitment, and supports people who need help. As the world's leading provider of cleaning technology, Kärcher has been implementing the sustainability strategy „Sustainability Excellence" since 2014, with measures and goals in various fields of action such as nature, society, supply chain and employees. By the end of 2017, 89% of the sustainability goals had already been achieved, and they should be fully reached in the next two years. For example, within five years (2012-2017) Kärcher succeeded in increasing the utilization rate of recycled plastics by 344 percent. Sustainability-related audits in the supply chain also increased significantly in 2017, compared to the previous year. In order to define future fields of action and sustainability goals as the basis for the Sustainability Program 2020+, workshops were held at the beginning of 2019, with more than 120 employees, in Germany, China, and Brazil. Not only in the selection of materials but also across the entire value chain, a sustainability strategy is applied. This alignment does not always have to be cost negative. Kärcher proves that innovative solutions can be used for efficiently designed processes. With this alignment, Kärcher was also able to convince the jury of the German Sustainability Award for 2020 and is currently in the final.

INTRODUCTION

The importance of sustainability is currently being intensively discussed and is described by the Cambridge dictionary as „quality of being able to continue over a period of time". (*Cambridge Dictionary*, 2019) Various current discussions are increasingly concerned with the regulation and restriction of limit values for emissions, as well as consumption conditions. In the study, I would like to use a company as an example to show that it is not short-term regulations but internal human convictions that are responsible for the damage we allow or protect to nature and assume social responsibility. The behavior of a company can very well illustrate the moral values of a society, with its employees and its management. I would also like to take up the criticism of the negative financial impact and examine what challenges exist and whether profitability suffers from a change in strategy.

This historical analysis will be used to identify sustainable companies and trends-driven initiatives.

MATERIAL AND METHODS

The qualitative analysis was based on corporate sustainability reports. The company key figures come from the primary source of the company website or the secondary source „Statista.com", which also consolidates published key figures. In addition, other literature sources were used to gain a better understanding of the strategic direction. The current discussion situation was supplemented by the analysis of current publications, e.g. by the UN or institutes. (*Europäische-Kommission*, 2019)

RESULTS AND DISCUSSION

Alfred Kärcher was born in 1901 and unfortunately died of a heart attack in 1959. He was married and had 2 children. After the death of Alfred Kärcher, his wife had taken over the management for the time being. His son Johannes Kärcher, who worked for the company for a long time, took over the management and, together with his sister, Susanne Zimmermann von Siefart, is still the owner in the 2nd generation. The origin of the family business dates back to the first entrepreneurial activities in 1935. Alfred Kärcher developed various industrial goods in his father's company and in 1962 began to lay the foundation stone for the currently well-known products with his „hot water high-pressure cleaner". (*Alfred Kärcher GmbH & Co. KG*, 2016)The sustainable way of thinking and behavior has a long tradition at the Kärcher company, which is shaped and continued by the decisions of the owner Alfred Kärcher. When the company moved to Winnenden in 1939, for example, Alfred Kärcher developed and integrated his own wastewater treatment system.

However, Kärcher has not only tried to find sustainable technical solutions for self-interest but has also participated intensively in social initiatives and charity projects. For example, Kärcher cleaned various historical monuments under the motivation to preserve buildings and monuments in a sustainable way. Kärcher also donated several water treatment plants to crisis areas, for example in 2004 after a tsunami in South East Asia or in 2010 after an earthquake in Haiti and Chile. In addition to active participation, Kärcher donated money to various initiatives. (*Alfred Kärcher GmbH & Co. KG*, 2016)

Kärcher is also a very positive example of the importance of the employees in the company and also showed historically impressive activities. In 1940 Alfred Kärcher founded a foundation for Employees in need and in 1950 produced Christmas toys especially for employees' children. The sustained increase in the number of employees impressively demonstrated the company's social interest as well as the regional protection of local jobs. (*Alfred Kärcher GmbH & Co. KG*, 2018)

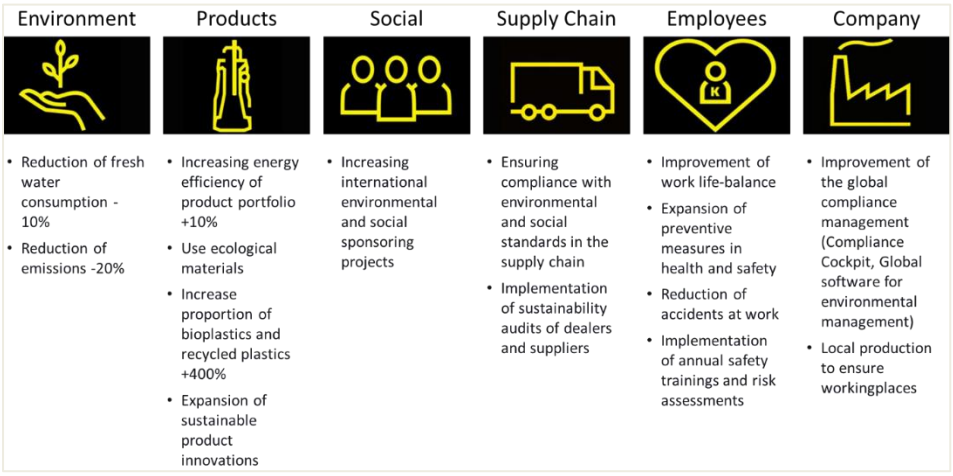
In addition to the social aspects, the company also represents strong nature protection interests. In this way, the company constantly optimizes its production and thus increases efficiency while at the same time reducing waste and emissions. The company is also increasingly using more environmentally friendly materials and is also saving wastewater and reducing energy consumption when using its products by end customers. (*Alfred Kärcher GmbH & Co. KG*, 2018)

The company does not only focus on its own processes but also strongly involves its suppliers. In order to integrate this sustainable orientation deeply into the value chain, suppliers, for example, are audited and joint optimizations are carried out on an ongoing basis.

The actions of the company are not random but are based on a firmly established corporate strategy. Kärcher has set itself 6 basic sustainability categories and aims to achieve significant goals.

Figure 1

Overview 6 sectors of sustainable goals



Source: *Alfred Kärcher GmbH & Co. KG* (2018)

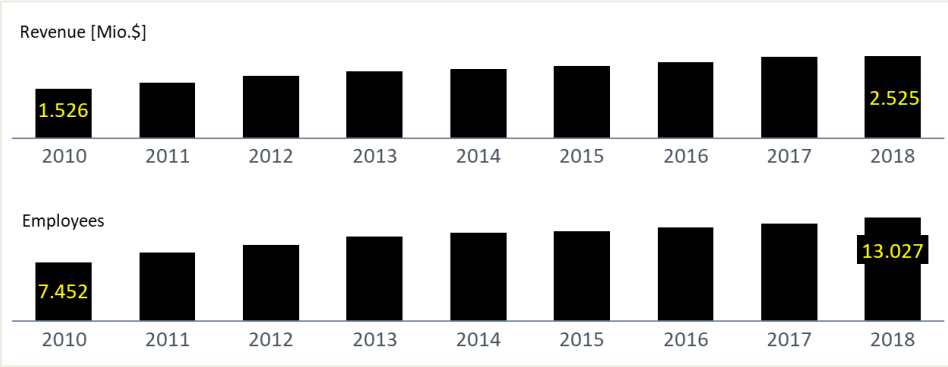
The company has committed itself to these categories and objectives and has already achieved 89%. Kärcher has saved over 33.278 m3 of water and reduced 2.751 t of CO2 emissions, which is comparable to 2,807 flights between London and New York. Also, 35 tons of plastic waste was reduced, and further social projects were supported, as well as various donations to charity made. At least 50% of the suppliers were audited and sustainably linked to the corporate strategy. 35% of accidents were reduced and the number of employees increased. All actions of the company sound at first atypical and costly for a company, which acts result-oriented. However, when it comes to sustainability, no negative effects on results have to be accepted (*Alfred Kärcher GmbH & Co. KG*, 2018).

I was only able to analyze the impact of the sustainability strategy on the financial situation on the basis of the number of employees and sales, as very little data is publicly available. For this purpose, I analyzed both data types and standardized them periodically in order to be able to assess the behavior in a period under consideration.

Based on the ratio, it can be observed that sales per employee rose by 2% from €189,000 in 2014 to €193,000 in 2018, thus assuming corresponding growth. While a consolidated net profit of € 66.4 million was recorded in 2014, the company was able to further increase this result by approx. 20% to approximately € 79.9 million in 2017. (*Unternehmensregister*, 2015) This performance is therefore not negatively influenced by the sustainable strategy, but, as Dieter Grajer, member of the board, explains, only possible through sustainable investments. For example, the tools for manufacturing the high-pressure cleaner housings have been optimized and therefore not only the waste reduction was an effect, but also 33% of the material can be saved. (*Alfred Kärcher GmbH & Co. KG*, 2018)

Figure 2

Revenue and Employees 2010-2018



Source: *Statista GmbH* (2019)

CONCLUSIONS

For companies like Kärcher, sustainability is not a short-term trend action, but a long-standing component of corporate culture and morality in the company. The historical actions and participation in charity projects give the company authenticity in its orientation towards a sustainability strategy. In contrast to some „green-washing" activities, which are increasingly penetrating the market, Kärcher shows what is important in the credible pursuit of sustainable goals. On the one hand, it is the fundamental decision of the owner or management which passes the values on to the employees and exemplifies them. The decision, which was made with intrinsic motivation and not from external influences, is the most sustainable and can be supported and pursued for more than 80 years. On the other hand, it is the creation of facts in which Kärcher acts very transparently and publicly sets itself ambitious goals and presents when and to what extent these have been or will be achieved.

The company was also able to prove that this strategy allows for a result-oriented continuation and that sustainable investments can be a basis for long-term success. The strategic reorientation can therefore also bring result-oriented positive effects.

ACKNOWLEDGEMENT

The presentation about the company Kärcher (Alfred Kärcher SE & Co. KG) was held in the course of the conference and added by negative examples of companies for comparison. The presentation and description in the „Proceeding Paper" serve to give listeners and readers an impression of the future differentiation between sustainable companies and to pay tribute to Kärcher.

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SUSTAINIBILITY IN REGIONAL UNIVERSAL BANKS: KEYWORD FOR PUBLIC RECOGNITION OR INTERNALIZED VALUE? EXEMPLARY CONSIDERATION BASED ON THE BANK CONTROL

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ABSTRACT

The growing importance of sustainability in politics is visible in the political programmes, the electoral behaviour and the recognizable prioritization of the acting persons in the media. The business community is taking up the issue not only for reasons of public image, but also for the purposes of verifying business partners along the entire value chain, potential efficiency gains, government subsidies and the procurement of capital. In society, demonstrations, staged actionism and everyday discourse bring sustainable considerations about changed consumer behaviour into the minds of citizens. All these facets are concentrated at the level of universal banks. The in-depth analysis of well thought-out and comprehensively implemented sustainability seems to be very interesting due to the influence of politics, society and the economy in the daily banking business, due to the simultaneously high financial pressure of low interest rates, increasing regulatory requirements, digitalisation and immense competitive pressure. The research question is: Do regional universal banks as institutions in the focus of population, politics and economy implement sustainable thinking in the heart of their bank management? The examination of internal target systems and the bank's own holdings of bank deposits, aggregated, produces very different but also largely sobering results from German Volksbanks. In spite of scientific research results, the practice of public relations work has so far been implemented and the elaboration shows that a potential transformation to influence behaviour and capital is still in its beginning.
Keywords: Sustainability, corporate social responsibility (CSR), German Volksbanks, implementation of ESG criteria, internal target systems

INTRODUCTION

As systemically relevant institutions, banks play a key role in the economy. Their actions steer capital and they are in the focus of social interest. For years, sustainable ideas have been gaining in importance throughout the industry. The scientific classification and the research of management practice, especially in depth, provide information about the current state of affairs.

A scientifically reliable consensus for the definition of Corporate Social Responsibility (CSR) does not exist yet. Already in 2008, *Dahlsrud* counted a total of 37 different definitions of CSR via a simply structured internet research in the period from 1980 to 2003. The uniform basis that *Brown and Dacin* set with a wide-ranging, strongly generalizing approach in 1997 is of great importance, proven by a multitude of citations, and focuses on the obligation of companies to treat their stakeholders respectfully. This concept is still adopted in slightly up-dated forms (*Freeman et al.*,2010; Walsh, 2005; Fatma and Rahman, 2016;

Martinez and Rodriguez-del-Bosque, 2013). The historical beginnings of this topic date back to Howard Bowen with his book „The Social Responsibilities of the Businessman" and its continuation by *McGuire* in 1963, which at the end of its definition was still essentially oriented towards the general happiness of employees. This principle was then included and enlarged in perspective, in accordance with today's discourse.

For the differentiation of the various components, the CSR pyramid was developed at an early stage (*Carroll*, 1979, 1991). This pyramid consists of the four layers economic, legal, ethical and philanthropic responsibilities. The foundation on which the pyramid is built on is economic efficiency. Economic responsibility adopts the classical meaning of profit orientation. A company should be profitable, maximize profits and display a strong competitive positioning (*Carroll*, 1991). There is thus an initial agreement on the classical doctrine of economics, which proclaims profitability as the primary goal in order to survive. Compliance with the law forms the second level of the pyramid. These are acceptable and above all unacceptable behaviors that the company follows in accordance with government regulations. Level three is based on social morality and ethical norms which are generally recognized by society. The top of the pyramid is philanthropic responsibility, meaning that companies are expected to voluntarily contribute to the common good of the community by supporting projects that promote education, arts or the quality of life in general (*Carroll*, 1991).

Another approach can be found in the three-dimensional structure of CSR classification consisting of economic, social and the additional environment (*Elkington*, 1998). Strikingly, this classification has often been described by the three "p" for profit, people, planet and was later rediscovered in the ESG criteria of the financial industry.

In 2001, *Mohr, Webb and Harris* stated on a more concrete level, based on the understanding of the employee / consumer, that it is a question of the binding insight and implementation of the companies to reduce the negative effects and maximize the positive effects on society. Due to an immense quantity of American research papers, the significance of the topic becomes obvious, especially after the turn of the millennium. In this phase, a tendency towards explicit CSR in the USA is also developing, with companies offensively aiming at public perception. This is different at present in the European approach to implicit CSR (*Crane and Matten*, 2007, p. 51).

Literature Review for CSR in Banks

As expected, the World Bank is broadly based on the definitions of the entire corporate environment. It describes CSR as a company's commitment to promote sustainable economic development together with its employees and to improve the quality of life in society, which in return is useful for business and company development (*Carroll and Shabana*, 2010). Before *JW Gelder* concretized sustainability in the banking business with great scientific attention in 2006, *Bouma, Jeucken and Klinkers* had already begun to transfer CSR research to banking in 2001. In order to avoid drawing of unclear boundaries, funds with six commitments and a handbook for measures in sustainable banking are taking precise steps with a pinpoint overview. This cluster is part of the content of expert interviews whose results are presented in the empirical part of the paper. The list shows the thematic breadth and the direct applicability / testability for financial institutions:

(1) **Commitment to Sustainability**
Change of perspective from pure profit maximization to prioritized social and environmental sustainability.

(2) **Commitment to „Do No Harm"**
By commiting to do no harm the banks minimize the environmentally and socially damaging impacts of their operations.

(3) **Commitment to Responsibility**
Banks take financial risks for which they are just as responsible as they are for the costs of nature and social welfare that must be borne by all.

(4) **Commitment to Accountability**
The above differentiated presentation of CSR research development is important for the realization of the scientific trend and the direction of our public perception. The entire corporate environment is taken into consideration. Accountability to all stakeholders is therefore essential. With the Global Reporting Initiative, it is currently gaining in importance that could not have been foreseen.

(5) **Commitment to Transparency**
Banks must be transparent towards their stakeholders. This not only includes providing standardized reports but also answering individual questions concerning policies, processes and particular transactions.

(6) **Commitment to Sustainable Markets and Governance**
Banks must systematically promote the sustainable system of the market and the general order, up to the broad full cost accounting of social and environmental externalities.

Limiting the Research Gap

During the last ten years, economic research in finance has massively developed the thematic scope and complexity of the principles described above, whose validity and relevance remain equally high. Almost final findings with a positive impact of sustainability on consumer confidence and loyalty are available, as is the risk-minimizing effect of sustainable management in the bank and in its lending activities. Even the increase in operational efficiency has been well studied. It can be assumed that measurable effects will already become visible with the raising of awareness among employees, managers, customers and all other stakeholders.

Particular attention is paid to the extensive studies on the causal link between the quantitative aspects of sustainability and profitability / investment risks. The consideration of central ESG criteria (Environmental, Social and Governance), for example in stock selection, is examined by the Frankfurt School of Finance for its measurable investment results. Very large amounts of data can be used to demonstrate an improvement in risk-return, especially when taking „E" and „G" criteria into account. In many places, the transfer to the entire credit process of banks has already been initialized and gives an impression of the huge steering function banks have on the real economic processes. However, when it comes company and especially bank reports, market participants frequently develop and adapt sustainability reports and corporate communication which renders their evaluations obsolete for classical research. Due to its high relevance to the following empirical part, the critical examination of bank reports from the German universal banking sector can be picked out. The study comprises 33 institutes and their reporting from 2014 to 2017. The following translation shows the first points of criticism:

„However, there are weaknesses in the reporting, especially with regards to the illustration of the sustainability performance of products, services and the value chain as well as the linking of financial and non-financial information" (*Cikanek and Landis*, 2019, p. 411).

This indication of incomplete coverage must be followed empirically, because the scientific literature does not provide a survey in the high degree of specialization of the following research hypothesis. In view of these arguments and lessons taken from the literature review, the following hypothesis is tested in this study:

H: *Sustainability was recognized to be important as a non-temporary trend among banks. The transfer of sustainable ways of thinking and working has not yet taken place in the heart of the management of regional universal banks. The core of sales controlling for monitoring employees with an affinity for numbers is not adapted to sustainable criteria.*

METHODS

The initial aim to test the hypothesis was to obtain a differentiated picture of sustainability in the bank management of Volksbanks and some comparable banks in Germany by using broad-based questionnaires. However, a pre-test with ten institutions showed that the results were not much differentiated and that they appeared to be generally glossed over. Even after adjusting the questionnaire with external support, the second run in the pre-test did not result in the desired differentiation in the marked answers, despite the considerable width in the subject areas. It was likely that the bank directors surveyed tended to give slightly prettier answers in those areas that had not been previously covered by their efforts for sustainability in their management process. It might also be the case that they are aware of their selective deficits, which are in contrast to their external image, but do not want to disclose this in specific terms. The change in method is supposed to prove this.

Thirty-seven interviews with experts enable a deep and at the same time differentiated review of the situation, which fulfils extensive criteria of representativeness for a meaningful sample. The interviews took place at the highest management level with members of the Board of Managing Directors, but also with the heads of sales and sustainability officers of regional Volksbanks and Sparkassen throughout Germany. In addition to the standardized questions, this methodology enabled the participants to obtain a deeper view with honest answers and a high degree of distinctiveness by asking questions during the conversations. The results were exemplary compared with the corresponding published sustainability reports in order to identify major divergences. To locate size effects, the following clusters were used in the balance sheet size:

Size classes in EUR million	Distribution of the sample
x < 250	32.4%
250 < x < 500	28.9%
500 < x < 750	16.2%
750 < x < 1000	10.8%
1000 < x < 2000	13.5%
x > 2000	8.1%
sum	100%

The mixture shows that a representative profile in the sample was achieved through the expert interviews. Its distribution is close to that of the population as a whole.

RESULTS

The interview participants (37) all attached great importance to sustainability in their business model. With the nationwide, also rural coverage across all customer groups and a very high amount of support through donations in the region, social engagement in the sense of the „s" for social is obviously evident. The Volksbanks are owned by their members, who are finally also their customers. They participate in the success of the bank on a very widespread basis by receiving dividends through the allocation of shares on a small scale. The founding concept is designed to provide mutual assistance through financial investments and loan financing. The investment possibility on credit level offers the members assistance to self-help. For more than 150 years, this has been a socially motivated and extremely successful banking concept that stands out from the alignment of other market participants.

With the targeted clarification of the control model in bank management at the respective employee level, the uniform picture of the surveyed regional banks is changing. Only 6 of the 37 institutions actually measured customer satisfaction, which can be assigned to the respective bank advisor, as part of the target map in the controlling system of the employees. While a large number of highly differentiated sales and earnings targets can be found here, the social approach of serving customers / members satisfactorily across all groups is not part of the incentive system. Employees are not rewarded for serving unprofitable customers. The six banks that have implemented customer satisfaction in the objectives of the bank advisors show a demonstrably deeper costumer penetration and thus stand for social consistency in the financial support of all their clients.

The situation is similar in terms of resource conservation and product structuring. For 86% of the respondents, the goal of conserving resources is rooted, for example, in the areas of paper and energy. However, in all these banks this is achieved through a verbal, qualitative goal - mostly at the level of sales managers. Measured quantitatively, this is not implemented as a concrete incentive for the consultant's goals. With regards to company cars, the situation is exactly the same. Apart from a tax incentive by the state and limitation by budgets, there is no reward for weaker motorization, alternative drives or the use of public transport.

When it comes to product design, the decision-makers surveyed painted a very mixed picture. All 37 banks use state programs for sustainable projects when lending. In the intermediation of sustainable investment, 70% were also able to show the corresponding products. In the case of self-issued products, such as green savings bonds or investments in regional projects that do not focus on making a profit, 43% responded that they were only planning in this direction.

These were the striking sections of the expert interviews. They show exemplary activities on high-profile measures, especially at top management level. The strong intention to make profit can also be counted as part of this, because with the distribution of profits to customers and the strengthening of reserves, which in turn enable further lending, sustainability is absolutely given at second glance. At the level of individual employees and their activity management, however, the company's sustainable maxim has not yet been consistently implemented.

CONCLUSION

These individual interviews with experts confirm the hypothesis of this research paper. The high level of sustainable management implementation, which could be deduced from the pre-test, drew a blurred picture, which was partially refuted by the expert interviews. The focus on Volksbanks and Sparkassen in Germany, the number of samples and possibly also subjective components of an interview must be taken into consideration. Overall, however, one result is still evident: the regional universal banks stand for financial education, donations and various non-monetary support services. They steer capital sustainably through their lending and investment business. Furthermore, they distance themselves from damage to human health, the environment and exclusive profit maximization. Especially at the top management level, the recommendations for action of funds described above are implemented. The strict monitoring of all activities of employees has been a social issue since the financial crisis. If the banks really mean it, there is still considerable potential for development in the sustainable structuring of consultant goals and in consistent transparency on the way to truly sustainable companies.

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SHOP IN PLACE- FOOD HUB PROJECT IN TRANSYLVANIA

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ABSTRACT

A food hub serves as a coordinating intermediary between regional producers, suppliers and customers, including institutions, food service firms, retail outlets, and end consumers. Food hubs embrace a spectrum of functions, purposes, organizational structures, and types, each of which can be tailored to achieve specific community-established objectives. Services provided by a food hub may include and are not limited to aggregation, warehousing, shared processing, coordinated distribution, wholesale and retail sales, and food waste management. Food hubs contribute to strengthening local and regional food systems as well as to broader community goals of sustainability and health. The purpose of a food hub is to increase small and midsized producers` access to wholesale market channels. The "Shop in Place" (Helyénvaló bolt) is a food hub located in Székelyudvarhely, part of a Romanian network. It integrates sustainable farming, environmental friendly and ethical trade, and responsible acquisition.

INTRODUCTION

The roots of „Shop in Place" food hub from Székelyudvarhely go back in 1992 when Civitas Foundation started its activity. At that time the organization was an answer to the need of improving and professionalizing the local administration in Romania, after the '89 Revolution. In 2010 the Foundation started their first social economy development projects. From this moment on, social entrepreneurship becomes one of the core sub-fields for Civitas and the team gains professional experience in this direction.

Ever since its beginnings, **the mission of the Civitas Foundation** has been to increase the development capacity of local communities through building success models that trigger well-being.

The vision of Civitas Foundation is that people in local communities can improve their daily lives by getting involved in innovative and sustainable social impact programs. We believe in the power of communities and civic involvement. We also believe that citizens and local administration have to come together to transform initiatives into projects, plans into reality and development opportunities into prosperity.

The **core values** of the Foundation have been defined as it follows:

Trust and loyalty: We trust in what we do and we inspire trust. We build strong relationships with our partners and beneficiaries, based on dedication and loyalty.

Professionalism and desire for improvement: The impact of our project is guaranteed by the professionalism of our team and their willingness to learn more, be more creative and to succeed in efficiently transforming their ideas, dreams and aspirations in reality.

Dedication and vocation: The Civitas community consists of professionals who believe in what they do; we also care strongly about values like vocation, devotion and we trust that our efforts matter.

Integrity and success: We respect our values and esteem people who share them. However, we choose as partners people and organizations that also actively enforce them.

Innovation and creativity: Every project is different because people designing them are different; we use our expertise to ensure the efficiency of our programs. We believe that innovation and creativity are vital in creating and running successful and appealing projects. It seems to be the only way in which our initiatives earn the trust of the people we work with.

Partnership and association: The success of our projects is guarantieed by the strong partnerships we build, by the teamwork and by sharing the resources in order to grant added value to the communities who require them.

Twenty seven years of community building projects led the Foundation toward a new and quite challenging field, namely, it registered a business of their own, a social enterprise, which can help small producers to find a local market. This became the „Shop in place" food hub.

Core values of "Shop in Place" Food Hub:

We like to believe that people in the area need healthy food including local ingredients not only to preserve their health but also to protect the environment. By introducing and maintaining a short distribution chain, we deliver products to consumers and customers without intermediaries. We sell appropriate products together with the services that can be assigned to them.

Food Hub- description and definition

Food hubs are popular organizations in several countries such as USA, UK, Holland. According to *Morley, Morgan, and Morgan* (2008) they serve as the 'Missing Middle' of the Local Food Infrastructure.

Morley, Morgan, and Morgan (2008) anticipated the wide array of definitions currently used. They highlight the importance of establishing a clear notion of what food hubs represent and how they can be developed. The authors note that food hubs can contribute narrowly to increasing market efficiency, or can offer a broader vision that encompasses a healthy food system and diversified food culture. Short of offering a definition, the authors state, "on the simplest level the Food Hub can represent any kind of organizational model where food sourcing and supply is coordinated, and may be contrasted with a wholly dispersed market system (becoming more credible through internet shopping) comprising of direct links between the producer and the consumer" (p. 3).

The concept of a Food Hub assumes that there are many market actors involved, and that its co-coordinating function will increase the efficiency of market relations. A Food Hub, therefore, may be thought of as acting as an intermediary that offers to put the produce of many suppliers, growers, farmers and processors into the hands of retailers, food service firms, public sector buyers and procurement consortia, and/or direct to the final consumer. Food Hubs may perform a number of different roles and operated by and for different actors in the agri-food system. Most simply a Food Hub may be envisaged as a middleman mechanism that removes the need for the farmer to deal directly with the final customer. In this role it may act as a conduit for information with regard to quality, quantity, timeliness and other supply criteria. Alternatively the hub may act as training and support agent, which aims to build the capacity of the producer so that they may deal with the final consumer independently or in collaboration with other small producers.

Hubs may be able to combine many of these functions and to act as a promoter and marketer for its suppliers. What is more, they add further value through a processing and/ or packaging and distribution functions.

The definition given by the US Department of Agriculture states that a food hub is a centrally located facility with a business management system that facilitates the aggregation, storage, processing, distribution and/or marketing of locally or regionally produced food products.

Final definition proposed by Journal of Agriculture, Food Systems, and Community Development in 2011: *A food hub serves as a coordinating intermediary between regional producers and suppliers and customers, including institutions, food service firms, retail outlets, and end consumers. Food hubs embrace a spectrum of functions, purposes, organizational structure, and types, each of which can be tailored to achieve specific community-established objectives. Services provided by a food hub may include and are not limited to aggregation, warehousing, shared processing, coordinated distribution, wholesale and retail sales, and food waste management. Food hubs contribute to strengthening local and regional food systems as well as to broader community goals of sustainability and health.*

The main purpose of food hubs is to increase small and midsized producers` access to wholesale market channels- in a sustainable way.

Recognizing the limits of these focused definitions, Megan Horst suggests that *Kloppenberg et al.'s* (2000) proposed list of sustainable food system attributes serves as a **useful platform** for creating a fuller understanding of the food hub phenomenon. The 14 attributes of a sustainable food system identified by Kloppenberg are:

- Ecologically sustainable
- Knowledgeable/communicative
- Proximate
- Economically sustaining
- Participatory
- Sustainably regulated
- Just/ethical
- Sacred
- Healthy
- Diverse
- Relational
- Culturally nourishing
- Seasonal/temporal
- Value-oriented (associative) economies

MATERIAL AND METHODS

History:

Starting in 2017 five food hubs were created in Romania in different cities: direct distribution and web shop in Iasi, Cluj Napoca, Putna, Brasov, shop and web shop in Székelyudvarhely (Odorheiu Secuiesc), the so called Shop in Place. The projects are supported by the Romanian American Foundation.

In order to understand the importance of short distribution chains, we have to make a historical walk before the Romanian Revolution from 1989, when the native population had only access to Romanian products. The offer was very limited and restricted, there were no hypermarkets and malls. Commercial advertising was not allowed at all, not even on the only one national TV channel. International travel was limited to one visit in every other year. The Revolution brought a major change in the Romanians life as they plunged into shopping in huge malls that were built in major cities and large quantities of Western European as well as US goods invaded the shopping centers.

Fascinated by the newly experienced consumption, people gradually unlearnt to nurture their local values, so the majority of customers have become accustomed to consuming foreign products. It seemed absolutely impossible to talk about the environmental impact of production and products because even education on this subject has not started yet. The people wanted to heal their suffering of lack and hunger so it seemed pointless to talk about the need to curb consumption and production. The wound caused by the cruelty of a far too long communism era was deep and people wanted to feel better about their new life. In these circumstances, the value of local products and the importance of maintaining and strengthening local economy had a long way to find people's consciousness. At first (around 2010), the fashion of the monthly fairs, where small producers sold their handicraft products, infiltrated into the public consciousness,. The range of offer from food to local art souvenirs has become increasingly diverse at these fairs. In each September, Civitas Foundation started to organize the so called Fruit Festival, sending for the small local producers to present their products made from local fruits/goods. A whole movement started as farmers in the area first rediscovered long abandoned orchards, then they learnt how to maintain and develop them, after that they began to market their products, and finally they could join the Fruit Festival every following September.

In 2017 the Romanian American Foundation published a call for the creation of food hubs and Civitas Foundation responded to this call by creating the „Shop in Place" (Helyénvaló in Hungarian) in Székelyudvarhely. The literal translation for helyénvaló is: appropriate, proper, right. In order to run the business, the Civitas Foundation established a limited company, a social enterprise.

About the "Shop in place" project

While working on the establishing of the food hub in Székelyudvarhely, the staff was keen on breaking through a paradigm of mainstream economics that states that companies have the only mission to make a profit. They wanted to prove that doing good can be the goal of a business as well, as Magnuson formulates so clearly below.

"People are creating a lot of alternative institutions in order to change the characteristics of the system. The road to this will begin at a local level, where individuals and communities will develop new institutions through their consciousness, leading to human and ecological well-being, changes in system characteristics." Magnuson

Helyénvaló –more than a store (properly local, appropriate, shop in place)

Food hub is a short distribution chain. The "Shop in Place" is a pioneering, alternative meeting place for conscious customers and proper producers from Szeklerland.

Products are delivered from a 70 km radius. In May 2018, the store opened with products of 23 local producers, and today there are 99 local farmers' products in the shop (bakery, meat products, dairy, fresh and processed vegetables, fruit, tea, spices, handicrafts). The legal requirements for selling on the local market and selling in a shop are different in Romania. Small farmers have to meet more stringent requirements if they want to sell their wares through the store.

There are two target groups in the project: **small producers** who need to be able to sell and be prepared for continuous delivery in the store, and **consumers** who consciously choose the local products. In addition to making a profit, the business aims to increase the number of conscious customers who want to consume the appropriate local products because they are fresh, healthy, environmental friendly, reflect our traditions, enhance social cohesion and community spirit, and contribute to self-identity. Costumers are encouraged to become aware that buying local goods can help to preserve the local countryside and also create a prosperous future. Lots of times, the staff has to explain to the costumers why the store does not sell products that are not locally manufactured and do not qualify to community service.

A product is considered appropriate when it is reasonably and consciously designed, uses environmental resources in a moderate way, minimizes waste, uses human labor wisely, puts it right, and responds to the needs of the community.

Characteristics of the appropriate entrepreneur / producer: non-violence, genuine care, generosity, cooperation, love of nature.

The Helyénvaló's staff considers, that all the 14 attributes of a sustainable food system identified by Kloppenberg are included in their business model:

- **Ecologically sustainable**: they work to optimize the transport of goods, linking suppliers and encouraging shared delivery; the shop reuses tea cups in a community campaign;
- **Knowledgeable/communicative**: its offer strengthens social cohesion and community spirit, encourages communities to engage in environmental friendly behavior and active citizenship;
- **Proximate**: it links directly the producer to the buyer/ no resellers, distributors (short distribution chain);
- **Economically sustaining**: for the time being, the economical sustainability is only provided by the application background, but it is not far from the point to become self-sustaining;
- **Participatory**: it is a community place; it is focusing both on producers and consumers; it gives lectures on appropriateness and healthy eating; it is involved in children's education about local values, local products;
- **Sustainably regulated**: works in accordance with environmental requirements in Romania;
- **Just/ethical**: the price of the goods is determined jointly with producers;
- **Sacred:** the primary concern of the business is the operation of the short distribution chain, the distribution of healthy local food consumption among the population and not profit-making;
- **Healthy**: the store sells healthy, local products;

- **Diverse**: it offers trainings for small producers in different topics: prescriptions of the Consumer Protection Office, of the Environmental Protection Agency, of the Public Health Agency, of the Veterinary Office; the staff participates in various events to promote the store;
- **Relational**: it organizes tea serving sessions, mugging, tasting events, farm visits; it has a village consultant who is in daily contact with the small farmers from the region;
- **Culturally nourishing**: it offers a community space for meetings;
- **Seasonal/temporal**: the shop offers seasonal fresh fruits and vegetables only;
- **Value-oriented** (**associative**) **economies**: it supports the local and regional economy; it provides a basic level of food supply; it creates employment opportunities and jobs.

In the designers` concept, the Shop in Place is **more than a simple shop**. It is a community place, a meeting point between local farmers and consumers, a tasting place. It is a place where environmental and social aspects are attached to the shopping process. It has a limited product range, offering only local products.

The "Shop in Place" food hub has a functional web shop in two languages / Romanian, Hungarian/.

All the activities around the store are related to the two main target groups mentioned earlier. The importance of products from local sources is growing in both health and economic terms. Consumers will receive healthier food and producers will have a predictable income. And this will lead to a more sustainable local economy.

- **Consumers/costumers:** The challenges of a consumer society are testing the consumers. They need to re-evaluate their timely shopping habits if they consider to give priority to local products. Thoughtful use of raw materials, planned shopping, environmentally conscious attitude, trust in the producer, seasonality are just some of the expectations/demands a conscious customer should be aware of. They might need help to make the conscious decision. Shop in Place is there to help.

  In order to identify its customers' expectations, the organization participates in a lot of studies about local products. The staff is very active in the community life, they are using all the opportunities to present the food hub both for locals and for tourists. A good relationship was established with the local University and Tour Operating Office.
- **Small producers:** Small farmers are also cornerstones of the formula. Often, they were forced by economical situation, family tradition, adventurousness and other circumstances to find their way toward the small producer status. Some of them know the tricks of being an entrepreneur, others know only the catches of production. Both groups need to learn and look for a market for their products. The shop can help them with this cumbersome process. It organizes trainings, meetings, consultancy for them and offers a market opportunity through the store, without the need for dealers. Proper indicators are measured each year in order to find out how the food hub succeeded in helping them with the market, knowledge and reducing their environmental impact. 54 producers were asked to fill in the

questionnaire in 2018. 18 answers came back (33%), 99 producers were asked in 2019, 31 answers came back (31%).

The results are shown in the *Table 1*.

Table 1

Indicators about the economic and social effect of the food hub

Indicators measured	Aug 2018	Aug 2019
Number of producers in the shop	54	99
Percentage of products sold through shop	7%	9%
Percentage of family members participating in production	58	68.9
Percentage of production growth in year 2018/2019	42%	37.7%
New workplaces created on farms	8	12.5
Percentage of turnover realized through food hub	5%	7.3%
Is it better to sell through shop than on the market?	11%	18.7%
Food Hub fills a serious gap in local sales	32%	50%
"It's also my job to promote the store"	43%	81.5%
"I can help the work of food hub with information transfer"	19.2%	53.4%
Shared transports monthly		47
Working connections between producers, common projects, participation on fairs, festivals		34

According to the completed questionnaires, it seems that the idea of co-operation in producers is slowly reaching maturity. At the beginning of the project, they had not been in contact with each other, what is more, they only saw each other as rivals. However, they gradually realized they were better off when helped each other. They have already started using shared transportation and product delivery, they have been going together to the faires lately, they have started to meet each other. Beside realizing that selling the products is a common goal for them, they also started to feel that the food hub is serving them by transfering vital information. For the moment the economic role of the food hub is not so significant as the social one.

RESULTS AND DISCUSSION

"The "Shop in Place" is an oasis in the desert of consumer society." (*Kolumbán Gábor*)

In Romania, very few NGOs registered their own businesses. Entrepreneurship requires a different mindset than that used by NGO leaders. The requirements of a market economy calls for profit-oriented thinking, and this is difficult to balance with faith in the future. The Civitas Foundation from Odorheiu Secuiesc has taken on a very ambitious task with the "Shop in Place" food hub. It sells food products from small farmers in the area through a short distribution chain, without resellers, to the local population and tourists arriving in the area. An additional task was to launch a webshop, when food ordering is not yet widespread in the Romanian market.

Both tasks require time, patience, and hard work. The company employs 3 people, 2 salespeople and a business manager, and two others from the foundation support their work (marketing, project management, event management). Economic indicators clearly show a slow but steady increase in revenues. The company still needs at least 2 years of financial infusion to reach the sustainability point, and the Romanian American Fund has promised further funding.

This means that through its hard work, Helyénvaló Ltd., as a social enterprise, helps local producers and consumers to find each other in a way that honors both environmental and human factors.

It also implies that the local population gets healthy, local products and small farmers survive, and thus indigenous landscape management in the Szeklerland is being maintained.

Everybody can find something to learn: increased awareness for consumers, cooperation and perseverance for producers, and a connecting role for the food hub.

CONCLUSIONS

The "Shop in Place" Project, the food hub does not change fundamentally the economic life of the Szeklerland. It only tries to bring back the sense of community action that communism has destroyed in this area. It calls on the conscious consumer and the small producer to reach out, as they are beginning to realize the importance of locally produced goods and their health and economic benefits. In this process, a proper meeting point is the Appropriate Shop.

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SUCCESS OR FAILURE OF ECOLOGICALLY SUSTAINABLE SHOPPING CENTERS

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ABSTRACT

The awareness of acting ecologically is more present and topical than ever. While the world population continues to grow rapidly, natural resources are increasingly diminishing. An excessive consumption of natural resources will inevitably lead to a destabilization of the closed ecosystem earth(Gissen, 2003). As a result, paradigm shifts are necessary, which call for a balanced market economy, also from a sustainable point of view (Sedlacek, 2016). Current social events and a clear declaration of intent in the form of Fridays for Future by Greta Thunberg, e-mobility by Tesla, but also the sustainable construction and operation of real estate „green buidling", show the presence and importance of this. Sustainability has long since become one of the most important factors in the European real estate market and is relevant to competition. But how can the success or failure of so-called green buildings be measured in today's environment? Is sustainable operation really a competitive advantage or do high sustainability costs even minimize success? This article uses the example of sustainable shopping centers and a survey on tenant-relevant performance assessment of the centers to provide insights into the current state of the art in the segment of German retail real estate market

INTRODUCTION

Fifteen years ago there were virtually no sustainable or certified buildings in European countries. Today, however, European building certifications such as BREEAM or LEED have become so important that hardly a new building is being created whose sustainability has not been tested (*Burnett*, 2007). However, according to a recent study by Jones Lang LaSalle on „Global Sustainability Perspective", it remains difficult for investors and experts to measure the value of sustainable investments. Although many owners and investors would generally prefer a portfolio based purely on the LEED standard, do the economic fluctuations in Europe and the continuing uncertainty on the financial markets lead to uncertainty as to whether the additional costs for an investment in sustainability are worthwhile and, above all, whether it can hold its own in the market profitably? As a result, a further look will be taken at sustainable impulses within the real estate.

The European Union has already adopted important ecological guidelines. In particular, the EU Directive 2020 is one of the driving forces in the region. According to this, all new buildings must be low-energy buildings by 2020. 30 years later, in 2050, all buildings must have been brought to a zero-emission standard as far as possible. Countries and their economies follow suit. The German Federal Government has tightened the Energy Saving Ordinance (EnEV) and the Energy Performance Certificate. The aim is to adapt buildings to increase their energy efficiency by at least 10%.

In France, the government is much more active in promoting sustainability in commercial real estate. It has set itself the target of reducing CO2 emissions by 38% by

2020. In addition, since the beginning of 2013, owners have had to add „green" appendices to their leases of commercial space over 2,000 m². As part of these new „green leases", they must list the entire technical equipment of a property, agree on data transparency and convene a committee to evaluate optimisation measures.

Since 2013, the EU has set minimum energy standards for every new building. Project developers are forced to implement these regulations, partly through higher rents. At the same time, however, the steadily rising energy costs are already triggering a rethink. Sustainable development is therefore seen as an opportunity. Other important players in this process are investors and tenants. The former are looking for a quality product and have been requiring sustainability certification as a standard for some time now. The additional costs associated with the desire for certification are usually accepted. Tenants, in particular internationally active companies, are increasingly attaching importance to environmentally friendly working conditions. As a result, the extent to which shopping centres can set accents as green buidlings is examined in more detail

A green trend is also consolidating itself in the European shopping center sector: more and more new and refurbished centers are showing improved climate balances. The developers have also learned from the mistakes of the early 90s. Shopping properties carefully integrated into the inner-city environment, which sensibly complement existing retail landscapes in central city locations and open up social and communicative spaces, have replaced isolated consumer machines on greenfield sites.

In the course of the redesign, the old floor space has often been extended and today is home to an attractive mix of shops and restaurants. Innovative architectural and space concepts also document social change: shopping is not synonymous with consumption, but also means a cultural activity that is carried out by people with social encounters, exchanges and life and is complemented by other leisure activities. In this context, sustainability also means generating sustainable streams of visitors - through appropriate gastronomic offerings as well as leisure, sports and entertainment opportunities. Swimming pools, libraries, kindergartens - more and more centers are also integrating uses of public life, the construction or maintenance of which is lacking in many communities. Public and private space merge. Nevertheless, owners and operators only rarely market the ecological and social qualities of their retail properties.

The European shopping center world has also not yet developed a broad awareness of the economic advantages that can be achieved for all parties through the sustainable and resource-saving use of real estate. It is therefore not surprising that good evaluations for exemplary spatial, ecological and social solutions have so far played only a subordinate role in purchasing decisions. Investors from the office segment are now far more critical. First the customer, then the environment. But why are retail properties among the laggards when it comes to sustainable and resource-conserving real estate operations? While „only" two parties - tenants and landlords - have to agree on a fair distribution of both the costs and the revenues of sustainable investments in office buildings, the shop customer is added as a third party in the group in the case of retail properties. Retail tenants, for example, gear their energy behaviour (heating, lighting, air conditioning) less to the needs of their own employees than to the wishes and habits of end consumers. Savings in water, heat and electricity consumption can be seen directly in the ancillary costs, as can office users.

However, the most important benchmark for traders remains the cash register. No matter how strong the sustainability argument may be, it will no longer be convincing if sales decline because the customer feels restricted for the sake of the environment. In addition, retail groups are rapidly reaching their limits in their efforts to implement ecological standards in real estate use in accordance with their corporate social responsibility catalogues. A good half of the major European companies have now publicly committed themselves to CO2 reduction targets and can also be measured against the achievement of these targets, including a number of retailers. But important stakeholders as tenants or landlords as well as investors are making it difficult to find the right way when it comes to additional green costs. For many retailers, expanding „green" at the moment would mean not expanding at all. The density of certified, resource-saving shopping center space in Europe is still too low for this. Since the number of permits for new businesses is declining throughout Europe, the focus in improving carbon dioxide emissions caused by shopping centers will be on green refurbishments. Interestingly, Germany has particularly good prospects for clean air above existing shopping centres. The reason for this is that many existing centers here are already very old. According to the EHI Retail Institute, a total of 444 German shopping centres with a total area of 14 million m2 were in operation in Germany at the beginning of 2017. 65% of these properties were completed at least 12 years ago and are therefore „old" from an expert's point of view (The EHI Retail Institute e. V). Over the next three years, 2.5 to 3.5 billion euros would have to be invested to bring these centers up to date. Reliable figures describing the redevelopment needs of shopping centres at European level are not yet available. Nor are we aware of the certification rates already achieved for office real estate in some major European cities. A paradigm shift is urgently needed: After all, there is hardly any centre development in Europe that does not at least check Green Building certification. The number of investors who attach importance to sustainability is also steadily increasing. It is to be hoped that in future tenants will also increasingly be the driving force behind this movement: lower operating costs and an improved image are the key driving forces here. The increased sustainability awareness of end consumers is additionally increasing the pressure on retail groups and developers. Many tenants are already demanding green leases or otherwise committing to green business. But how can a quantifiable added value be derived from the sustainability debate and the efforts and leads to an improved performance or performance evaluation of the respective object?

MATERIAL AND METHODS

In 2016, the ICSC presented the European Shopping Center Award to six selected properties, thereby underpinning exceptionally good and sustainable retail concepts. The award is multi-layered on the part of the jury and João Correia de Sampaio, as speaker of the committee, added that the projects are exceptional for their interior design, exterior design, innovative architecture but also for their very good industry mix and economic and ecological success.

The ICSC presented the Milaneo in Stuttgart, a mixed-use shopping center concept, with a resource award for sustainable and long-term development and operation. In

addition, the DGNB awarded the entire property a gold certificate, while the retail sector received a platinum certificate for sustainability.

With an area of 43,000 m² for shops and restaurants, the Milaneo is the largest shopping centre in the Stuttgart region. The building contains more than 200 shops and restaurants, as well as 417 rental apartments, a hotel and offices. The rent for shop space is 39.50 euros per square metre and month, for large shops with more than 1,000 m² of space a monthly rent is 17.90 euros per square metre. The annual rental income from the shopping centre is expected to amount to 22.83 million euros.

In the Shopping Center Performance Report, chain store companies from the retail, service and gastronomy sectors rate their satisfaction with the economic success of their stores in german shopping centres using the school grading system (1 to 5). The Shopping Center Performance Report fundamentally uses the principle of the Likert Scale as a methodical approach. One is interested in the attitude of the test subject towards a certain object. All related items are formulated as strictly positive or negative statements. The Likert Scale is based on the consideration that the more the subject deviates from the formulation of the item, the more he or she rejects the statement of an individual item. In the totality, the answers to the degree of adjustment are then mapped. It is hoped that this procedure will result in a methodically durable measurement of the setting.

The Shopping Center Performance Report was initiated in 2011 by the Wiesbaden-based company ecostra. Tenants in 400 german shopping centres with more than 10,000 sqm of retail space can evaluate their shops. Only centers to which at least five tenants give a mark are included in the evaluation. In 2019 this was 239. The tenants themselves must be represented in at least three of the 400 centers in order to participate in the Shopping Center Performance Report.

In 2019, a total of 108 chain stores from the retail, service and gastronomy sectors participated in the Shopping Center Performance Report. The data basis relevant for the current analysis is composed of the last four earnings years of the Shopping Center Performance Report, from 2016 to 2019, which are briefly presented below.

First place in the ninth edition is taken by the Elisen Park in Greifswald, an East German shopping centre. Second place went to Famila Einkaufsland Wechloy in Oldenburg, third place to Citti-Park in Kiel. The MEP in Meppen gets the worst score of all 239 placed centers.

The most famous german shopping centre, the Centro Oberhausen, received a negative rating. The mall in the Ruhr area lands on place 144 of the ranking. In Oberhausen, it is obviously the high costs that are taking the success away from the tenants, as sales were rated as generally good - in the SCPR 2018, the tenants had chosen the Centro as the shopping centre with the highest rents. Also the Alexa in Berlin doesn't get top marks. Tenants gave the Milaneo in Stuttgart a very negative rating (234). In contrast, older centers such as the Breuningerländer in Sindelfingen and Ludwigsburg and the Main-Taunus-Zentrum confirmed their good ratings from previous years.

Based on the Shopping Center Performance Report, the years 2016 to 2019 (yellow) are examined in more detail (*Figure 1*). The Milaneo Shopping Center and its service placement (red) are shown in comparison to the total of all participants (blue). The placement of the respective center corresponds to the rank and is derived from the

profitability, calculated between sales and center costs. The ranking corresponds to the Olympic principle of 1 as best and then numerically weaker. The average (green) shows the mean value in the respective year.

The *Figure 2* shows the years on the X-axis and the power value (placement) on the Y-axis.

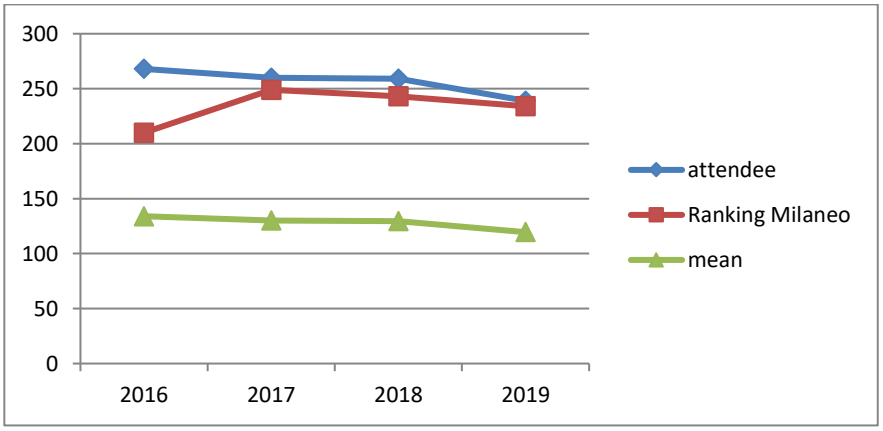
Figure 1

Data Ranking

Ranking	Year			
	2016	2017	2018	2019
Attendre	268	260	259	239
Ranking Milaneo	210	249	243	234
Mean	134	130	129,5	119,5

Figure 2

Data Performance Milaneo



The following can be stated:

- Shortly after its opening in 2016, the Milaneo is steadily deteriorating its position.
- The Milaneo is rated very bad in 2019 with rank 234 of 239
- An average placement at 128 is very far away.

Looking at the Shopping Center Performance Report, the following mean value is calculated for the Milaneo ranking and the average value:

$$\bar{x}_{\text{arithm}} = \frac{1}{n}\sum_{i=1}^{n} x_i = \frac{x_1 + x_2 + \cdots + x_n}{n} \quad (1)$$

- Ranking Milaneo, 4 year average: 234
- Average value, 4 years Average: 128

- These values can also lead to the following result by calculating the standard deviation;

$$\tilde{s} := +\sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \overline{x})^2} \quad (2)$$

Standard deviation, 4 years Mean: 74

The standard deviation 74 thus shows the range of the value around the characteristic around its mean value (arithmetic mean). In this respect, the standard deviation is the average distance of all measured expressions of a characteristic from the average. In the following, the Milaneo was ranked far behind the average in the past and will probably not achieve any significant improvement in the future, despite ecologically sustainable certification.

The relevance of climate protection and a sustainable understanding of resources is becoming increasingly important to customers and consumers alike, which is why the German retail trade cannot avoid dealing with this issue more intensively. However, a closer examination and analysis of the shopping center real estate market in Germany shows that expensive construction costs for ecologically sustainable operation are rated very negatively by retail tenants if there is no profitability between center costs and sales. Of course, it is to be critically questioned whether a conceptual error of the Milaneo might not have such disadvantageous overlapping effects that the positive sustainable ecological design cannot unfold? This remains open for further research, even though it is difficult to understand that the real estate industry places more value on ecological impulses and certification, but that the center with the highest award is judged by tenants as not „efficient".

RESULTS AND DISCUSSION

Sustainability requires a profound questioning of the basic assumptions that have shaped our actions to date. Only through an interactive, multi-stage reflection process that involves planners and construction companies as well as investors and users can we arrive at the solutions that we urgently need in the interests of ourselves as well as the generations to come. In the public debate, sustainability is still all too often focused on resource consumption issues.

Even though aspects such as energy efficiency play an important role, sustainable real estate is about much more than that. Sustainable buildings are characterised by the fact that they consider ecological, socio-cultural and economic aspects equally. The key to a balanced consideration and evaluation of these different factors is transparency. In recent years, sustainability certifications have become a central instrument for evaluating our built environment. With the help of internationally recognised systems such as DGNB, BREEAM and LEED, it is possible to describe very different sustainability criteria and thus make them measurable (and thus assessable and comparable). As a result, the certification systems play a key role in ensuring that new quality standards prevail in the real estate industry. In view of the complexity of construction projects and the associated use of materials and energy, sustainability certification makes a significant contribution to improving the quality and sustainability of our built environment. In concrete terms, the

same ecological standards must apply to developers and operators of shopping centers, since the development, construction and operation of centers without these standards can lead to economic competitive advantages. The evaluation of the Milaneo shows that, despite high ecological standards, tenants who pay the rent do not rate the center positively due to high costs, even though the majority of them are always ideologically in favour of ecology and sustainability.

Although many hundreds of projects have already been certified worldwide, much remains to be done. The real estate industry is only just beginning to systematically collect and evaluate sustainability information, especially in the real estate sector. The automotive industry is a good step ahead here: car manufacturers provide detailed information on their websites about the technical equipment, fuel consumption and environmental concept of their vehicles. In this way, interested parties receive a large number of comparative values that help them to assess a model and provide them with a solid basis for making decisions. In the case of real estate, this is only the case to a limited extent. For buildings, the interested party can ideally refer to a building description or the documents of the specialist planner - whether he understands them is a completely different question. Finding systematically processed information about the ecological, economic, functional or technical quality of a building continues to be very difficult, if not impossible. The necessary transparency and comparability are usually simply lacking for a qualified assessment of buildings. In this way, neither investor nor user can make a well-founded judgement about the value and sustainability of their property. More transparency regarding the performance of our built environment is by far not only an economic factor - it also serves to ensure (and increase) quality. Moreover, it is slowly but surely becoming an indispensable part of corporate social responsibility. The quality of a building can be measured, evaluated and compared by means of a sustainability certification carried out in accordance with internationally recognised standards. This is an important contribution to more sustainability, both ecologically and economically, and can be used credibly for internal and external communication. Overcoming short-term thinking achieving a truly sustainable building culture requires a profound change in mentality on the part of all those involved. It must be learned not only to focus on the immediate planning and construction costs, but also to consider the entire life cycle. What savings can be achieved over what period of time through a higher initial investment - and what added value does this offer for owners, operators and users? Which usage scenarios are possible or can be implemented with which effort? Which quality level can be achieved by the planned investment - and to what extent does this match the expectations of the market? All these are central questions that have to be discussed in a construction or investment decision and for which the relevant information must be available as the basis for the decision to be taken. Especially in the case of municipal building owners, the corresponding discussion is often postponed in favour of the cheapest solution (in the short term) - with corresponding consequences in the use phase, but all too often also during the construction phase itself. But even investors who are sensitized to the long-term economic consequences of their actions often lack the appropriate instruments. Individually developed island solutions are used instead of industry-wide recognized standards.

CONCLUSIONS

A holistic lifecycle approach requires much more intensive communication between all those involved in planning and execution. The question of how a property can be optimally used and operated is much more in the focus of planners than has been the case to date. In this context, sustainability certification offers a decisive advantage: by clearly defining quality objectives, it promotes and demands an interactive and interdisciplinary approach, while at the same time highlighting the added value of a long-term perspective. This inevitably leads to changes in the planning and construction processes - for the benefit of all involved. Sustainability certification is not a mandatory prerequisite for such a change. However, it promotes and supports them substantially. Contemporary evaluation of buildings Planning, construction and operation of buildings are highly complex processes that involve a large number of companies. A building certification does not only enable the consideration and evaluation of a multitude of information. It also offers a clear overview of individual qualities. Buildings can thus easily be assessed for their future viability and compared with others - according to recognised methods and clearly comprehensible criteria. Building certificates can and should make a significant contribution to the worldwide establishment of a sustainable building culture in the future, and a duty for all actors.

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Associations:

[ICSC] The International Council of Shopping Centers (ICSC) is an international trade association of the shopping center industry. The New York City-based organization was founded in 1957 and has over 67,000 members in more than 100 countries. Among the members are owners of shopping centers as

well as developers, managers and corporations and government organizations with business interests.

[DGNB] The German Sustainable Building Council (DGNB e.V.) is a non-profit and non-governmental organization whose mission is to develop and promote ways and solutions for the sustainable planning, construction and use of buildings.

[BREEAM] BREEAM is the world's leading sustainability assessment method for masterplanning projects, infrastructure and buildings. It recognises and reflects the value in higher performing assets across the built environment lifecycle, from new construction to in-use and refurbishment.

[LEED] BREEAM or Leadership in Energy and Environmental Design, is the most widely used green building rating system in the world. Available for virtually all building, community and home project types, LEED provides a framework to create healthy, highly efficient and cost-saving green buildings. LEED certification is a globally recognized symbol of sustainability achievement.

[ENEV] The Energy Saving Ordinance (EnEV) is part of German economic administrative law.

[EHI] The EHI Retail Institute e. V. (EHI) is a research and educational institute for trade and its partners based in Cologne. The EHI was founded in 1989 and is supported by trading companies and trade associations and supported by manufacturers of consumer and capital goods. The EHI network comprises around 770 members worldwide. The EHI is also the founder and conceptual sponsor of EuroShop, an international trade fair for capital goods in the retail sector.

STRENGTHENING OF LINKS BETWEEN AGRICULTURE AND R&I WITH ENVIRONMENTAL FOCUS

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ABSTRACT

The study is aimed at shedding light on what interventions – more specifically what EAFRD financial instruments in the 2014-2020 Rural Development Programme – can enhance the role of research and innovation in agriculture and to what extent. The focus is set on to what extent RDP interventions have supported the strengthening of links between agriculture, food production and forestry and research and innovation, including for the purpose of improved environmental management and performance in Hungary. The literature review is followed by a selection of relevant RDP interventions, description of judgement criteria and analysis of indicators. Qualitative assessment is carried out through an anonymous and voluntary survey that was sent to experts in the field of rural development and potential EIP beneficiaries. Description of challenges during evaluation and proposed solutions based on the results are included, as well.
Keywords: research and innovation in agriculture; rural development program, European Innovation Partnership (EIP)

INTRODUCTION

The scientific literature review and the analysis of policy documents focused on two strands at the beginning. On the one hand it covered the innovation – within that innovation exerting an influence on the environment and eco-innovation (e.g. *EC*, 2011a; *EC*, 2011b; *Rodima-Taylor et al.*, 2012; *Díaz-García et al.*, 2015; *Galliano et al.*, 2017; *Mazzanti et al.*, 2018), on the other hand it explored agri-environment. The former topic was discussed in great detail both by several international authors and by researchers of the NARIC - Research Institute of Agricultural Economics, who published a book under the title „Innovation in Hungarian agriculture and rural development" in 2014. (*Biró et al.*, 2014) As regards the latter there are a lot of Hungarian and international scientific publications and other EU or OECD documents available, too e.g. *EC*, 2000; *Ángyán*, 2005; *EB*, 2006; *Kormosné*, 2006; *Sztahura and Rezneki* (eds), 2015; *Kanter et al.*, 2018; *Henderson and Lankoski*, 2019). These two topics have merged due to the EU development policy by now. This is proven by several scientific and professional documents published over the past few years (e.g. *ENRD*, 2009; *Ridley and Hill*, 2018; *Sayer and Cassman*, 2013; *EC*, 2015b; *Scown et al.*, 2019; *Caffaro et al.*, 2019; *Chieco et al.*, 2019) and the fact that the present evaluation of the Rural Development Programme in the EU's member states, i.e. in Hungary as well - includes also the question to what extent RDP interventions have supported the strengthening of links between agriculture, food production and forestry and research and innovation, including for the purpose of improved environmental management and performance.

In the European Union the principles of sustainability have been strongly merging into the Common Agricultural Policy since 1992 and as for the environmental pillar of

sustainability, the EU agri-environmental scheme was introduced and widely spread. Among the countries which joined the EU in 2004 Hungary was the one which committed itself to full adoption and implementation of the EU's agri-environmental schemes.

As for the innovation it can be stated that fostering innovation became a central part of the EU development policy between 2014 and 2020. In case of agriculture and rural development it means that the innovation performance – including innovation performance having an effect on the environment – can be improved at EU level through the European Agricultural Fund for Rural Development (EAFRD), the research and innovation framework programme of the EU, i.e. Horizon 2020 or the LIFE programme. (*Prime Minister's Office*, 2015)

Detailed analysis of different – in a mainly coherent and transparent policy environment effective - economic incentives is not an objective now. The study scrutinizes relevant instruments of the Rural Development Programme in the period between 2014 and 2020. Priority 1 of the Rural Development Programme is fostering knowledge transfer and innovation in agriculture, forestry and rural areas. Focus area 1B within priority 1 is aimed at strengthening the links through financing 470 cooperation projects (Measure 16). The study is aimed at one sub-measure among the sub-measures directly programmed under measure 16 (M16.1, M16.4, M16.5, M16.9) and the measures, sub-measures linked indirectly to the focus area (M01.1, M01.2, M01.3, M19.1, M19.2, M19.3, M19.4). This sub-measure is M16.1 European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI). Innovative project proposals submitted by EIP Operational Groups have been analysed.

MATERIAL AND METHODS

Payments were not made in Hungary under Measure 16 - establishment of EIP operational groups and support of investment necessary for the implementation of the innovative project (Number: VP3-16.1.1.-4.1.5.-4.2.1.4.2.2.-8.1.1.-8.2.1.-8.3.1.-8.5.1.-8.5.2.-8.6.1.-17) until 31th December 2018.

As there are no payment data available there is basically no clear answer to the question: "To what extent have RDP interventions supported the strengthening of links between agriculture, food production and forestry and research and innovation, including for the purpose of improved environmental management and performance?" Based on IACS (Integrated Administration and Control System) data of proposals submitted to the call for proposal under measure 16, expert interviews and contributions of EIP project initiators patterns of changes can be described to a certain extent and trends of changes can be projected for the near future. Besides, data uploaded to the Hungarian EIP-AGRI website by the project initiators could orient us.

An online survey with 10 questions was sent to 77 key experts (experts working in the Ministry of Agriculture, Managing Authority, Universities, farmers or experts of EIP focus groups) and to 86 EIP project initiators, among which there were both farmers and researchers. They received 16 questions. The surveys under the titles 'Innovation in the Rural Development Programme – from the point of view of environmental management and improvement of environmental performance' and 'Rural Development Programme: Innovation-Environment' were published online, on the website of NARIC-Research Institute of Agricultural Economics in April 2019.

Expert opinions and information shared by EIP project initiators cannot be considered comprehensive, they might have mostly informative purpose at this stage of research. Furthermore the fact that most experts voted for anonymous and voluntary online surveys instead of personal deep interviews (due to the limited timeframe) and that the survey could be sent only to half of those who submitted their proposals to the call for proposal under Measure 16 and who had a moderate willingness to fill in the questionnaire implies even more a cautious interpretation of the results. The statements are expected to become more accurate by the progress of the Rural Development Programme, as we will have access to the payment and other related data, as well.

RESULTS AND DISCUSSION

58.8 percent of experts who received the survey and gave meaningful answers indicated a slight contribution of Rural Development Programme interventions (2014-2020) to the strengthening of innovation's role in agriculture and the increase in the number of innovative solutions. Further 17.6 percent considered the interventions' role to be considerable. One forth (23.5%) of them thought that these measures had not resulted in any changes in this specific context. By analysing broader context in almost half of the experts' opinion (47.1%) environmental issues had been embedded in the RDP from the point of view of multidisciplinarity, complex approach and longer timeframe. About 12 percent did not share this view at all and more than 40 percent not exactly.

More than half of the respondents (52.9%) saw clearly the global approach and nearly one third (29.4%) experienced definitely innovative approaches. According to the majority of respondents (64.6%) the latter didn't seem to be stressed. At the same time the EIP project initiators considered the innovative approach to be better in general and the longer time frame to be a weaker aspect. As for the former more than one third of the respondents (35%) and as for the latter only 15 percent thought that the RDP treated the environmental management issues by taking these viewpoints and approaches into account. Regarding the aspects of multidisciplinarity, complex approach and global approach the EIP project initiators had only slightly nuanced opinions. More than one third of them (35%) thought that these aspects were taken into account and 40-45 percent answered not exactly. The majority of experts (52.9%) and one tenth of EIP project initiators perceived the role of R&D measures to be of little significance in terms of better environmental management and improvement of environmental performance. The abovementioned role of R&D&I was moderate according to less than one fifth of experts (17.6%) and one third of EIP project initiators (33%). Less than one third of experts and about one fifth of project initiators perceived this role to be strong or very strong. The answer to the question: 'In your opinion to what extent has agricultural R&D&I to be funded under the RDP with the aim to improve environmental management and environmental performance strengthened between 2014 and 2018?' was 'it did not strengthened at all' according to nearly one fifth of the experts (23.5%) and 10 percent of the EIP project initiators and 'only slightly' according to a significant share of them (41.2%, 38% respectively).

Both experts and EIP project initiators listed those RDP interventions, which in their opinion contribute mostly to the improvement in agricultural R&D&I promoting environmental management and resulting in better environmental performance. The EIP project initiators named only the measure on 'establishment of EIP operational groups and support of investment necessary

for the implementation of the innovative project', but the experts had a longer list including e.g. the agri-environmental programme or the LEADER programme.

About half of the experts (47.1%) and about half of the EIP project initiators (43%) thought that the measure on setting up and running EIP operational groups promoting productivity growth and sustainability of agriculture, food processing and forestry did not provide enough financial support to improve measurably the environmental performance at national level (nor at the level of the measure or at the level of the project). More than half of the experts (52.9%) and 38% of the EIP project initiators answered that the financial support was rather low. None of the experts but nearly one fifth of the project initiators (19%) considered the grant to be enough. Opinions on the grant size should be however treated with reservations, as the limitations of the sources and the internal distribution should be taken into consideration, too.

More than four fifth (82%) of the experts would strengthen the role of innovation approach in the RDP interventions – i.e. they would increase the available budget - and one fifth (18%) wouldn't do it.

Three forth of the EIP project initiators (76%) thought that their project results are expected to contribute to environmental management and to improve environmental performance to a great or even full extent. Based on the responses 62% of the EIP project initiators will be members of such an operational group in which there is at least one member who gained experiences in one or more successfully closed R&D&I projects aimed at improving environmental management and environmental performance and three forth of them have a member who has published one or more scientific work related to environmental management and environmental performance since 1st of January 2011. Three forth of the project initiators intends to file a patent application related to environmental management and performance to the National Intellectual Property Office or the World Intellectual Property Organisation (WIPO) until the closure of their project. According to IACS data on grant applications the focus areas of activities under measure 16.1 are 2A (69.6%), 2B (4.1%), 3A (14.6%), 5C (1.5%), 5E (6.2%) and P4 (3.6%). 75 percent of the activities are related to the first target area, i.e. mostly operational groups carrying out agricultural activities and projects focusing on agricultural production applied for grants.

The connection of grant application data registered in IACS and the project data uploaded to the Hungarian EIP-AGRI website contributes to a deeper analysis of the call for proposals under measure 16.1.

The information on a little bit more than half of the grant applications (87 out of 169) can be extended by information from the website. (This is due to the fact, that the registration of the project idea on the website earns additional scores. According to the call 73 operational groups can be supported.)

Among the additional information there are policy objectives to be found, to which the project initiator assigned the project idea. There are altogether 10 policy objectives. Besides the most popular (36%) one - 'Promoting knowledge-based modern farming and farmers' cooperation' there are such policy objectives the titles of which imply directly the projects' relationship to the environmental management and performance. These are the following policy objectives: 'Technological and social underdevelopment of organic farming'; 'Sustainable intensification besides improving soil condition and water management', 'Fighting against the

spread of plant and animal pathogens due to climate change and globalization' and 'Sustainable extensification with ecosystem services, biodiversity'. One third of the 87 grant applications fall under the abovementioned policy objectives. On a proportional basis (by scaling up to the total number of grant applications under Measure 16.1.) and assuming that - based on the currently available information on the project ideas not containing identifiable policy objectives - there are no project proposal among them that are related to the environment in any way at all it can still be stated that one third of all grant applications have explicitly something to do with the improvement of environmental management and performance. This ratio is however expected to reach 50-60 percent. Major financial data of the project proposals are listed in Table 1. Other data - as for example how many collective investments are included, what is the size of the applicant firm or which classes of NACE Rev. 2. were provided by them – are analysed by policy objectives in the text following *Table 1.*

Table 1

Financial data of project proposals by policy objectives

policy objective	project's total cost, billion HUF, (number of project proposals, pc)	amount of grant requested, billion HUF – expressed as percentage of the project's total cost
'Promoting knowledge-based modern farming and farmers' cooperation'	9.71 (35)	6.2 billion HUF - 63.8 %
'Sustainable intensification besides improving soil condition and water management'	*6.30 (11)*	*3.7 billion HUF - 58.7%*
'Increasing the efficiency and added value of supply chains'	2.78 (13)	1.72 billion HUF - 61.8 %
'Unlocking the potential of protein crops'	2.2 (6)	1.32 billion HUF - 59.9 %
'Technological and social underdevelopment of organic farming'	*1.69 (10)*	*1.09 billion HUF - 64.8%*
'Fighting against the spread of plant and animal pathogens due to climate change and globalization'	*1.2 (7)*	*0.84 billion HUF -70.2%*
'Increasing the industrial utilization of agricultural and forestry biomass'	0.67 (2)	0.43 billion HUF - 65.5%
'Promoting the first generation change in agri-food enterprises'	one project proposal was submitted – data is confidential	
'Migration trends, challenges, policy responses'	one project proposal was submitted – data is confidential	
'Sustainable extensification with ecosystem services, biodiversity'	*one project proposal was submitted – data is confidential*	

Source: IACS and project data on the Hungarian EIP-AGRI website (note: not comprehensive)

10 project proposals could be identified as proposals under the policy objective *'Technological and social underdevelopment of organic farming'*. 9 out of 10 requested collective investment. In the case of 9 proposals the eligibility check was in progress and 1 was under evaluation according to data available on 31st December 2018. The project proposals were submitted mainly by micro- and small enterprises. The classes of NACE Rev. 2. provided were as follows: other scientific and technical research and development (4pcs), spice, aroma and narcotic herbs growing (1pc), cultivation of cereals, pulses and oilseeds (2pcs), other community and social activities (1pc), accounting, auditing and tax consultancy activities (1pc) and manufacture of pasta (1pc).

11 project proposals could be identified as proposals under the policy objective *'Sustainable intensification besides improving soil condition and water management'*. All of them were submitted by business organizations. Almost all of them (10 out of 11) requested collective investment, in the case of 10 proposals the eligibility check was in progress and 1 was under evaluation according to data available on 31st December 2018. The project proposals were submitted mainly by micro- and small enterprises. The classes of NACE Rev. 2. provided were as follows: other scientific and technical research and development (8pcs), sawmilling (1pc), pig farming (1pc) and mixed farming (1pc).

1 project proposal could be identified as proposal under the policy objective *'Sustainable extensification with ecosystem services, biodiversity'*. It was submitted by a micro enterprise that requested also collective investment. Its eligibility check was in progress according to data available on 31st December 2018. The class of NACE Rev. 2. provided was 'other scientific and technical research and development'.

7 project proposals could be identified as proposals under the policy objective *'Fighting against the spread of plant and animal pathogens due to climate change and globalization'*. 4 out of 7 requested collective investment. 6 project proposals were submitted by business organizations and 1 by a private person. Their eligibility checks were in progress according to data available on 31st December 2018. The classes of NACE Rev. 2. provided were as follows: other scientific and technical research and development (4pcs), retail sale of new goods (1pc), crop production services (1pc), growing of vegetables, melons and root tubers (1pc). The project proposals are related to nut rot before harvest, invasive plants, remote sensing, chestnuts, forest protection problems, plant protection procedures and bee disease.

Besides the abovementioned 4 policy objectives the project proposals are related to the following policy objectives: 'Increasing the industrial utilization of agricultural and forestry biomass', 'Promoting knowledge-based modern farming and farmers' cooperation', 'Increasing the efficiency and added value of supply chains', 'Promoting the first generation change in agri-food enterprises', 'Unlocking the potential of protein crops' and 'Migration trends, challenges, policy responses'.

2 project proposals could be identified as proposals under the policy objective 'Increasing the industrial utilization of agricultural and forestry biomass'. 1 of them requested collective investment. Their eligibility checks were in progress according to data available on 31st December 2018. The project ideas were related to industrial use of biomass and the establishment of industrial tree plantation.

35 project proposals could be identified as proposals under the policy objective 'Promoting knowledge-based modern farming and farmers' cooperation' 23 (18 business

organizations and 5 private persons) out of 35 requested collective investment. The other 12 project proposals not requesting collective investments were submitted by 9 business organizations and 3 private persons. The project proposals were submitted mainly by micro- and small enterprises (15 and 8 respectively). In the case of 33 proposals the eligibility check was in progress and 2 were under evaluation according to data available on 31st December 2018. The project ideas were related to bees, grape and fruit production, harvest, production technology, pest monitoring, precision farming, mushroom cultivation, animal heath and breeding technologies. The most often (in 10 cases) provided class of NACE Rev. 2. was 'other scientific and technical research and development.'

13 project proposals submitted by 12 business organizations and 1 private person could be identified as proposals under the policy objective 'Increasing the efficiency and added value of supply chains'. 8 out of 13 requested collective investment. In the case of 10 proposals eligibility check was in progress, 1 was under evaluation and 2 were withdrawn according to data available on 31st December 2018. The classes of NACE Rev. 2. provided were as follows: 'apple and stone fruit cultivation' (1 firm), 'post-harvest service' (1 micro enterprise), 'other scientific and technical research and development' (4 micro enterprise, 1 medium sized enterprise, 1 non-SME entity), cultivation of cereals, pulses and oilseeds (1 micro, 1 small and 1 medium sized enterprise), market research and public opinion polling (1 micro enterprise) and dairy cattle breeding (1 small enterprise).

1 project proposal could be identified as proposal under the policy objective 'Promoting the first generation change in agri-food enterprises'. It was submitted by a micro enterprise that requested also collective investment. Its eligibility check was in progress according to data available on 31st December 2018. The class of NACE Rev. 2. provided was 'other scientific and technical research and development'. In the proposal complete technology is offered for food plants under construction.

6 project proposals submitted by 5 business organizations and 1 private person could be identified as proposals under the policy objective 'Unlocking the potential of protein crops' 5 out of 6 requested collective investment. Their eligibility checks were in progress according to data available on 31st December 2018. The project proposals were submitted by micro and small enterprises. The classes of NACE Rev. 2. provided were as follows: 'other scientific and technical research and development' (3pcs), cultivation of cereals, pulses and oilseeds (1pc), moving catering (1pc) and in one case no class was named.

1 project proposal could be identified as proposal under the policy objective 'Migration trends, challenges, policy responses'. It was submitted by one micro enterprise with collective investment request and its eligibility check was in progress according to data available on 31st December 2018. The class of NACE Rev. 2. provided was crop production service.

In summary, 72% of the proposals - or 82% of them, if we analyse only those 4 policy objectives in the title of which there is direct implication for the projects' relationship to the environmental management and performance – requested also collective investment. The majority of applicants is micro enterprise, there are small enterprises in a smaller proportion and just a few medium sized enterprises. There is a wider variety of classes of NACE Rev. 2. provided, the class 'other scientific and technical research and development' is however in vast majority.

CONCLUSIONS

Based on the experience of experts and the opinion of EIP project initiators we can state that:

- The RDP interventions have so far resulted in a small increase in the innovation's role in agriculture and in a small increase in the number of innovative relationships among the stakeholders. For the future the innovation approach needs to be emphasized to a greater extent.
- The RDP typically does not include innovative approach. The role of research and development is barely emphasized in the improvement of environmental management and performance within agriculture.
- Functioning of the EIP is extremely slow and complicated.
- The EIP basically seems to be a good measure. It promotes the generation of project ideas, but in many cases, it serves nothing else but the adaptation of existing technologies.

Taking all of the abovementioned into account it might be useful to allocate more money for the EIP measure within the RDP, to introduce another measure very similar to the EIP measure or to focus better on improvement in environmental management and performance within EIP.

Moreover fast, flexible and simple administration (e.g. processing payment claims) and communication is highly required. Besides mitigation of patent law anomalies, the EIP measure could be split into to phases (1. phase: establishment of innovation groups, 2. phase related investment). As for financial resource management of EIP grant applications innovative actions and related investment could be weighted differently.

Finally, it should be noted as soon as payments are made several indicators that are at the moment not available (e.g. number of EIP operational groups, number of partners within EIP operational groups etc.) will be evaluable. As a result in 1-2 years we will be able to answer the question: To what extent have RDP interventions supported the strengthening of links between agriculture, food production and forestry and research and innovation, including for the purpose of improved environmental management and performance in Hungary?

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New Economic Vision

A REVIEW OF FINANCE-GROWTH NEXUS: THEORIES AND EVIDENCE

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ABSTRACT

The main purpose of this piece is to provide brief evolving literature that discusses links between financial and growth. The theoretical and empirical literature has shown that sound and effective financial systems have a critical function for economies' growth, however, financial sectors can also be a source of fragility, which might vary over time and country conditions. we found also recent literature focuses on financial innovation and non-intermediation services as measures of financial development, the notions of "too much finance off" and "the trade-off between higher growth and higher crisis risk". While traditional literature focuses on financial depth and economic growth.
Keywords: financial development, financial liberalisation, economic growth.

INTRODUCTION

The growth is perceived as essential for a country's long-term development and stability, and it's the main factor in the well-being and prosperity of billions of people. Some countries achieve high levels of economic growth and others fail to do so (*North*, 1994). This question has attracted a lot of attention from decision-makers, economists, and even Nobel Prize winners who attempt to explore the potential causes of dissimilar growth between countries through identifying the main drivers of economic growth. Several theories have been given over the past decades, however, no one theory has the perfect solution. According to the endogenous growth theories emphasizes that economic growth results from the use of knowledge rather than labor and capital as neoclassical growth theory postulated. The growth theories affirm that the level of financial development is one of the drivers of growth. However, there is still no consensus and the evidence is not conclusive and does not necessarily imply that financial development is always the cause of economic growth, economists hold different opinions regarding whether financial development is the cause (*Levine*, 1997) or the effect of the growth process (*Robinson*, 1952), or even it is a destabilizing factor in that it generates macroeconomic and financial volatility by excessive risk-taking its cause of crises (*Minsky*, 1975).

The well-functioning financial system stimulates economic growth through the channel of productivity growth and resource allocation more than through pure capital accumulation, and enhance growth through its various major functions (*Levine*, 2005), are: (i) allocating resources; (ii) mobilizing and pooling savings; (iii) reducing risks; facilitate the trading; (iv) facilitating transactions and exchange of goods and services; and (v) exercising corporate control to verify of project returns. However, the relevance of each one of those functions of output growth is country-specific, due to differences in political, legal and other institutions that are adopted and differences also across time.

Over several centuries, considerable evidence from around the world suggest that finance and growth have evolved together and often in a synergistic manner, for example, the regional financial institution played an important in motive macroeconomic cooperation and promote growth in the European area in the post-war period through the Marshall Plan, and similarly the European Investment Bank recently, (*Barhoom*, 2018). Also, to finance the construction of vast railroads, specialized investment banks have been developed.

This paper provides an overview of the theoretical and empirical evidence on the link between financial development -growth nexus. The rest of the paper is structured as follows, sections 2 briefly review the theoretical literature, section 3 briefly reviews empirical evidence and section 4 provides the conclusion and recommendations.

LITERATURE REVIEW

Growth Theories

Over the centuries, determinants of economic growth in both theoretical and applied research, several theories, and models have been devised. However, to date, the process underlying economic performance is inadequately conceptualized since it is a complicated process, has not been reached unifying theory. Generally, the Harrod–Domar model, Solow's growth model and endogenous growth models are perhaps the most famous in recent economic.

Harrod 1939 and Domar 1946 extended the short-term Keynesian model to the possibility of sustainable growth. They explain the economic growth rate in terms of the level of savings and productivity of capital especially in economies with a large and rapidly growing population. In their model, the economic growth rate (g) is viewed as a direct function of savings ratio (s) and an inverse function of the capital-output ratio (r). Thus g = s / k. Whereby, growth is sustainable if three growth rates (the actual growth rate, guaranteed growth rate, and natural growth rate) are equal. whereas achieved macroeconomic balance ensures by full use of capital and labor together. Also, the savings rate and how efficient the investment is, are necessary conditions for accelerated economic growth.

The Solow growth model is advanced by a Nobel Prize winner Robert Solow (1957), growth is caused by capital accumulation and exogenous rates of change in population and technological progress. Solow views the world as one in which output, Y, is generated by the production function Y = F (K, L), Where, K = Capital, L = Labour. Solow assumes that temporarily the rate of savings affects the rate of growth through increasing capital accumulation that raises the productivity of labor and the level of GDP. But in the long run, the rate of change in the labor force and the rate of technological progress only are factors drives growth.

However, in the 1970s and 1980s, due to the predictive failure of the Solow growth model, more specific, the growth experiences in different countries of the world were not consistent with the two hypotheses of the model. This consideration motivated the emergence of endogenous growth models following the seminal work of (Romer, 1986), who built on the idea of technological progress and innovation in the economic growth of Schumpeter (1911) since those factors possibility to grow boundlessly, thus, reduces the

diminishing return to capital accumulation. Further, the endogenous growth theory primarily holds that the long-run growth rate of an economy depends on incentives for innovation and the inclusion of productivity factors such as aggregate knowledge capital (R), Stock of physical and human capital (Kj), Stock of labour (Lj), Stock of research and development expenditures (Rj). Romer requires, however, that in this function the size of scale effect must be significant, and the economy grows according to the Cobb – Douglas function: Y= A (R) f (Rj KJ L j). Also, although the endogenous growth model assumes, like the Solow model, diminishing returns for capital accumulation at the economic enterprise level, however, assume that this accumulation has a positive externality that limits of diminishing returns at the macro level.

However, there are other researchers who postulate that there have been other determinants factors affecting the growth, which are not less important in influencing economic growth such as public infrastructure (*Barro*, 1991); the efficiency of the price mechanism (*Fischer*, 1993);inflation (*Tobin*, 1965; *Fischer*,1993); financial development or repression (*McKinnon and Shaw*, 1973); international trade (*Dollar*, 1992); real exchange rate stability (*Dollar*, 1992); and government spending on economic growth (*Barro and Sala-i-Martin*,1992). However, the determinants of economic vary depending on the level of development in countries, for example, knowledge, technology, and innovation, human capital perhaps more important developed countries than the developing wherein non - economic determinants of growth are much more important.

Financial Development and Growth

The idea that financial sector development stimulates economic growth dates to Bagehot during the 1870s. There may have been some earlier theoretical thinking before this, for instance, Adam Smith noted that the first banks were established in Scotland have contributed very considerably to increase trade and industry. Similarly, Bagehot's idea in his book "a description of the money market", confirmed that the success of economic development in Britain is due to the superiority of the British financial market, which had a relatively easy to mobilize savings to finance various investments in the long-term. But, the most important contribution came with the work of (*Schumpeter*, 1911) who emphasizes the critical intermediary role of a country's banking system for growth in mobilizing savings and encouraging technological innovations and invent better methods for screening entrepreneurs by financiers, those methods require constantly develop since every screening process becomes less effective as technology advances. Building on this view has been later developed the models of endogenous theories. However, Schumpeter's view was not widely spread due to partly the mess of the First World War and the great depression, thence the emergence of Keynesian theory in 1936. All of that led to a paradigm shift into focusing on real economic development. Development economists like (*Keynes*,1936; *Robinson*,1952) and others for many decades have ignored the financial development and focused on other policy areas, support a role for government intervention in the working of financial markets. Further, Keynes argues that financial development is an obstacle to economic growth because of the inherent instability. While Robinson's view that financial development primarily follows economic growth. However, in the mid of the 1950s, Gurley and Shaw disprove the evidence of Neoclassical theorists that the importance of the financial sector is

overstressed by economists, highlighted the importance of finance for growth. Many economists supported his view that financial development is indispensable for economic growth (*Goldsmith*, 1969; *Levine*, 1997); among others.

In the 1970s the discussion concentrated on the phenomenon of financial repression, especially after the Bretton Woods international monetary system breakdown in 1971. (*McKinnon*,1973; *Shaw*, 1973) recommended governments to abolish interest rate ceilings, that raising increased savings and advised them also to give up raising seignorage through inflationary monetary policies. However, this view has been strongly contested in the economic discussion, the experience of financial liberalization in several countries shows there were frequent and severe banking crises, numerous country studies document such as Nigerian experience (*Lewis and Stein*,1997))and Thailand experience (*Knox-Lovell*,1998) following financial sector liberalisation, which led to the aggravation of economic downturns and imposed substantial real economic costs on the local economies, even (*World Bank*, 2005)admits that financial liberalization failed to achieve its targets in terms of financial deepening and in terms of growth as well. Further, (*Stiglitz*, 2000) who associated the occurred of financial crises with liberalization of the financial sector, this view has received popular after the global financial crisis, in which, the financial meltdown has exposed the shortcomings of liberalisation economic strategies, wherein economies that experienced considerable inflows of capital difficulty managing external shocks resulting from shrink of those flows, beside the economic downturn have encouraged revisiting in the hypothesis of financial liberalisation, its policies have increasingly come under scrutiny(*Goldberg and Veitch*, 2010; *Asongu*, 2014).

Yet, in the 1980s, the concept of financial development was reintroduced with the emergence of the endogenous growth theory that gave particular attention to analyzing the relationship between finance and growth,some models have been developed by (*Greendwood and Jovanovic*, 1990; *King and Levine*,1993; *Berthelemy and Varoudakis*, 1996; *Pagano*, 1993), emphasized the importance of the financial system in promoting economic growth through many functions such as intermediaries role, information collection and analysis, and risk-sharing ... etc., a topic I return to later.

However, the finance–growth theories have been criticized by many researchers, for example (*Lucas*,1988), who is early criticizes the overemphasized the importance of financial development in spurring economic growth. The critics warn of the generalization of biased findings in economic policy, especially for developing countries (*Neusser and Kugler*, 1998), argue that contrary to developed countries, the developing countries with inefficient financial markets, couldn't be financial development is a crucial factor in promoting economic growth, and the relationship between financial deepening and economic growth might vary over time and country conditions. For instance, in Syria, although the financial liberalisation private banks followed a conservative operational and lending approach (*Barhoom and Varga*, 2017).

Also, a number of empirical studies criticize the finance and growth relationship (e.g. *Rousseau and Wachtel*, 2011) have shed doubt on the robustness of the finance and growth relationship.

Even though the long-run relationship between finance and growth has been broadly addressed, there have been two main areas not fully resolved, are causality and homogeneity

(*Panizza*, 2014; *Loayza et al.*, 2017). In terms of the direction of causality, to date, four viewpoints emerge in the literature that empirically has been supported, these are (i) supply-leading, postulating that financial development stimulate economic growth by the financial system functions (*King and Levine*, 1993; *Panizza*, 2014) (ii) demand-following, opposite of the previous view, which postulates that economic development creates and stimulates demand for financial services (*Robinson*, 1952; *Jung*, 1986); (iii) feedback, in the sense, causes each other, the causal relationship between financial development and growth depends on the stage of economic development (*Patrick*, 1966; *Greenwood and Smith*, 1997). And (iv) independent views or neutrality hypothesis, which suggests that there is no relationship between financial development and economic growth, and even if any, it will be unimportant (*Lucas*,1988; *Ram*,1999; *Mukhopadhyay et al.*, 2011). A more detailed discussion of those hypotheses (see, inter alia, *Patrick*,1966; *Samargandi et al.*, 2015).

In regard of the homogeneity issue, the impact of financial deepening on growth is not the same and is not a one-size-fits-all approach, varies according to several factors such as the level of economic development, the level of financial development, and other country characteristics (*Ang*, 2008). In the same context, some of the recent studies have raised the issue of important non-linearities on the finance-growth nexus (*Rousseau and Wachtel*, 2011; *Arcand et al.*, 2015) who point out that the level of financial development is beneficial for economic growth up to a certain threshold, then further development of finance leads to declining economic growth. Arcand et al., concluded this point is when credit to the private sector reaches 100 percent of GDP. In the work of (*Beck*, 2012) summarize the explanations that as put forward by the recent literature for the notion of "too much finance," or "non-linearities", in five alternative explanation, is that not all credit is created equal; "non-intermediation" financial activities; financial development helps catch up to the productivity frontier, the safety net subsidy; misallocation of talents; political capture.

The literature studying the interaction between the finance and the development of fragility in the economic system has also received considerable attention, in particular, after the recent global crisis, show that the same mechanisms(maturity transformation, information asymmetries, excessive risk-taking) through which finance stimulates growth likely they make it also exposed to shocks and fragility. It's important to mention that there has been some earlier theoretical thinking about this interaction before this, there are two contradictory schools, the monetary school, and the post-Keynesian school, recently, its' view has been revived to explain many causes of the global financial crisis in 2007 after it had been neglected for a long time. Contrary to the post-Keynesian view, Monetarists believe in the efficiency of market forces mechanisms in general, crisis has an exogenous monetary origin shocks due to some outside disturbance leads to bank failures like as the government intervention that leads to a decrease in economic efficiency that end up to crisis and causing the economic collapse as the Great Depression in 1929. Contrary, the post-Keynesian view, that financial crisis and instability are endogenous to the capitalist economies, associate with directly to business cycle turning points that provide new, profitable investment opportunities in key sectors of the economy leading towards a boom (*Bordo and Wheelock*, 1998), spread of speculation, problems of moral hazard, and random selection paradigm (*Mishkin*, 1992) and the accumulation of private-sector debt. (*Fisher*,1933), in his debt-deflation theory of great depressions, emphasize that the

important role of debt and deflation in the meltdown of the financial markets in 1837, 1873, and during the great depression in the 1930s. Recently, an integrated approach of the effects of financial development on growth and crises has been developed, its hypothesis that the existence of a trade-off associated with the dual effect of policies fostering financial development, financial liberalisation policies that likely lead to higher growth and higher crisis risk particularly.

Financial Development and Economic Growth Models

Keynesian Model

Keynes assumes that aggregate demand and productivity growth are the determinants of factors growth (*Keynes*, 1937) , investment decisions are independent of saving decisions since individuals hold money for different motives such as transaction, precautionary and speculative motive; the autonomous components of demand, however, may affect the rate of growth of the economy. Indeed, there is a trade-off between holding money and holding bonds is determined by the current of the return or interest rate on bonds and expectations about the interest rate in the future. Hence, pessimistic expectations can give rise to stagnation traps. According to Keynes's view that when the bond interest rate is low generates more incentives to hold speculative money balances, more, the market interest rate and the demand for real balance are inversely associated with each other.

The Solow Model

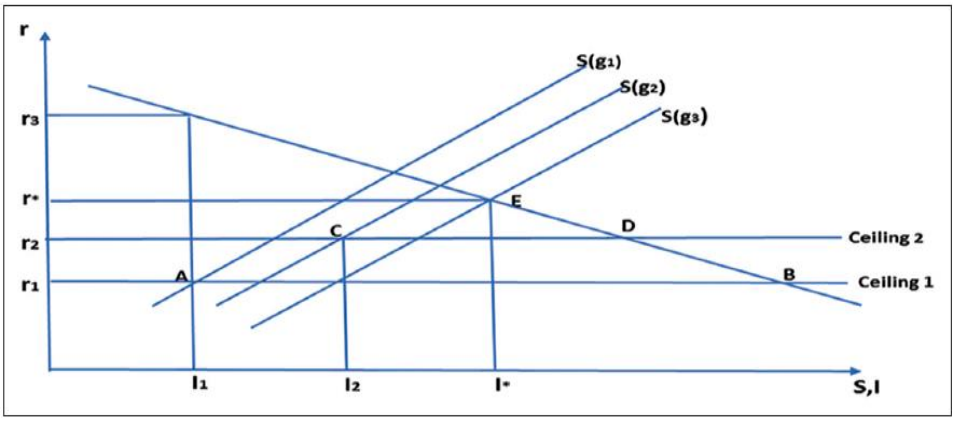
Assumes that the accumulation of capital due to higher savings within an economy is important, but can only have an impact on growth in short-term, in addition to assumes that the capital market operates costlessly and perfectly, money and capital are substitutes for each other (*Solow*,1957). Hence, the mechanism of using capital is also important within an economy for growth, which has been expressed in the Solow model as in the following equation of the real money demand ((M/P) D: (M/P) D = f (Y, RCAPITAL, RMONEY); fY > 0, fRCAPITAL < 0, fRMONEY >0. Where Y, RCAPITAL, RMONEY are the real income, the real rate of return on capital and the real return on money respectively.

Financial liberalization in the McKinnon -Shaw model

McKinnon and Shaw develop two financial liberalization models, focus specifically on financial repression in the form of ceilings on deposit and \ or loan interest rates. Real interest rates influence growth in the economy via their impact on savings and investment. Investment (I) is assumed to be a negative function of the real rate of interest (r): I = I (r): Ir < 0 … (1) Savings (S) is assumed to be influenced by not only the rate of interest but also the rate of growth of national income (g): S = S(r, g): Sr > 0; Sg> 0… (2). In order to increase efficiency in capital accumulation and allocation to promote economic growth, should remove interest rate and ceilings, credit control and other restrictive financial legislations. *Figure 1* Mckinnon- shaw financial repression, explain the interaction of market forces in the market for funds.

Figure 1

Financial repression, savings and investment



The figure above shows the impact of an interest rate ceiling on savings and investment. The savings function is drawn for given rates of economic growth where $g1 < g2 < g3$. If there were no ceiling imposed, equilibrium, would be at E, interest rate, r* and investment and savings equal to I *. Assume initially that there is a government-imposed ceiling (ceiling 1) on nominal deposit interest rates (i.e. the interest rate received by severs) which ensures that real deposit rates are below their equilibrium level given by r*. Assume additionally that the rate of economic growth is $g1$. at a real deposit rate of $r1$, $I1$ savings are forthcoming. Given that banks can charge whatever interest rate they like on loans, $I1$ investment will be demanded at interest rate $r3$. The margin which banks make on lending activities ($r3$-$r1$) is likely to be used for non- price competition. It is more likely that interest rate ceilings will apply to loan rates as well as deposit rates, since government regulation is frequently aimed at encouraging investment through reducing the cost of borrowing. Assume therefore that ceiling 1 applies both to the deposit and the loan rate. Again, $I1$ savings are forthcoming, allowing $I1$ investment to be financed. This implies that investment demand given by AB is unsatisfied. What happens if the government raises the interest rate ceiling say to ceiling 2? This increases the efficiency of investment (since entrepreneurs are now undertaking projects with higher expected rates of return), the rate of economic growth rises from $g1$ to $g2$ and the savings function shifts to the right. Thus, the new interest rate ceiling at $r2$ encourages savings of $I2$. credit rationing is still present, but it has been reduced to CD. Only when interest rates are fully liberalized does credit rationing disappear. Economic growth increases to $g3$ and the equilibrium savings and investment is at E.

However, several schools of thought criticize financial liberalization theory, for example, the Keynesian criticized rates transmission mechanism between interest rates and economic growth. Whilst, post- Keynesian criticized supply credit, that is not exogenous as treated by the McKinnon-Shaw school, but banks can create credit without having to increase their deposits. In addition, access to finance relies on other factors such as the pre-

existing health of banks' asset portfolios, and the sustainability of government finances. Another critique is based on the argument that savings may not necessarily depend on the rate of interest only. Also, the financial liberalization theory has been criticized due to ignored the other determinants of savings such as the size of income and substitution.

The endogenous growth models

The endogenous growth models tender a theoretical framework, that indicates to the significant importance of financial development for growth, whereby finance generates an external effect on aggregate investment efficiency through support the production of new inventions and channeling financial resources towards their most productive uses (*Bencivenga and Smith*, 1991), which offsets the decrease in the marginal product of capital (*Romer*, 1986; *Pagano*, 1993). The production function in the endogenous growth model is an increasing function of the financial development of the economy. The models show how financial development may affect the rate of economic growth, for example, (*Saint-Paul*, 1992) shows that financial markets stimulate growth by allowing firms to diversify portfolios, to increase liquidity, and hence reduce risks. While, (*Greenwood and Smith*, 1997) develop a model of the role of financial markets to foster specialization in entrepreneurship and the adoption of new technologies. While (*Greenwood and Jovanovic*, 1990) develop a model to examine a causal relationship between financial development and growth. Recently, in their model, (*Jeong and Townsend*, 2008) find that about three-quarters of total factor productivity growth is explained by occupational choices and financial deepening in Thailand. More recently, (*Laeven and Levine*, 2014) developed a Schumpeterian model to explore whether financial innovation necessary for sustaining economic growth, they predict that technological innovation and economic growth eventually stop unless financiers innovate.

Growth and crisis model

Recently, an integrated approach has been developed to study the effects of financial development on growth and crises by (*Ranciere et al.*, 2003) who build on the treatment effect model developed by (Heckman, 1978), and a panel error correction model of (*Pesaran et al.*, 1999). Ranciere and his colleagues develop a model to test the dual effects of financial liberalization on growth and crisis together, in which, combines two equations, a growth equation that includes also, two dummies, one for financial liberalization and the second for financial crises, measure the impact of financial liberalization on growth in normal times, and a crisis equation that endogenizes the probability of a crisis, measure the expected cost of crisis. Formally, we obtain:

E(Growth Gains From FL)=E (Growth Effect of FL | No Crisis) +E(Crisis Costs)∗[Pr(Crisis | FL)− Pr(Crisis | No FL)]. where FL is a dummy for financial liberalization.

The idea of the model is the long-run relationship between financial depth and economic growth is positive, however, but is subject to downside risk in the short-run due to being affected by heterogeneous, country-specific. Based on the model, if the effect of financial development on growth in the long-run exceeds the negative impact risk in the

short-run, imply that growth associated with crises positively, also, crisis-prone countries are about twice more likely to experience a negative relationship.

Empirical Review

The relationship between financial development and economic growth has been investigated extensively in literature empirically, using various indicators of financial development and growth with different econometric approaches, using aggregate macro-level data and micro-level data. Some studies use credit markets data for example, (*Berthelemy and Varoudakis*, 1996; *King and Levine*, 1993), while in another's studies, stock markets data was used, for example, (*Atje and Jovanovic*,1993; *Rioja and Valev*, 2014), among others. They have concluded results, however, are apparently inconclusive. The empirical on this subject could be divided based on the nature of the data employed into three categories pure cross-country, time series, and panel studies.

Due to the lack of enough time-series data for developing countries especially, cross-country empirical studies on the relationship between finance and growth have been dominated in the early literature. Generally, although those studies used different techniques, most those studies affirm there is financial development exerts a positive influence on growth (e.g. *Goldsmith*, 1969; *King and Levine*, 1993); have used OLS; (*Bangake and Eggoh*, 2011; *Levine*, 1999; *Caporale et al.*, 2009) GMM is used; (*Demirguc-Kunt and Maksimovic*,2002; *Harris*,1997) applied 2SLS, among others. However, the credibility of these findings has been questioned due to many limitations, for example, those studies use growth equations in the regression model of (*Barro*, 1991) which treats both finance and growth as endogenous variables. The static assumption of the econometric models is used in those studies and the observations for each country calculate by averaging out the variables over the entire study period that may hide the real face of the growth path of the economy in addition to eliminating all dynamics. Hence, it likely appears a spurious correlation between calculated variables doesn't represent the real correlation (*Ahmed*, 1998; *Ericsson et al.*, 2001). In addition to conceptual problems and problems of endogeneity bias, they estimate the short-run rather than long-run relationship (*Ang*, 2008). Recent, some studies test for the cross-country heterogeneity of the finance and growth relationship, provide evidence that there is strongest among middle-income countries, whilst in countries richer, this effect decline (see *Samargandiet al.*, 2015), explaining this effect is discussed in details by (*Beck*, 2012).

More recently, to avoid the econometric shortcomings associated with pure cross-sectional studies, some studies apply dynamic panel techniques (e.g. *Levine*, 1999; *Beck et al.*, 2000; *Rioja and Valev*, 2004; *Levchenko et al.*, 2008 among others), confirm also the positive relationship between finance and growth. However, in some cases may still be subject to 'spurious' regressions, to address this problem, panel unit roots and panel cointegration techniques are proposed by (*Christopoulos and Tsionas*, 2004) when the causality is used. However, may still be subject to the same limitations of cross-country that mention above and heterogeneity bias. In addition, often in those studies conclude biased and inconsistent estimates (*Pesaran and Smith*, 1995), since the unobserved country-specific effects are included in the error term.

Whilst the studies that use time series to analyze the finance-growth relationship, evaluates the data of many countries or individual countries, using the various time series techniques, they conclude mixed findings (*Gupta*, 1984). While there is a branch of the literature dedicated to investigating whether a bank-based system or market-based system, on one hand, whether one is more important for growth, studies suggest a negative or insignificant impact of financial markets on economic growth more in developing countries such as (e.g. *Narayan and Narayan*, 2013; *Rioja and Valev*, 2014) while banks have a significant positive effect on economic activity. however, (*Levine*, 2002) suggests that there is no overall empirical support for either the bank- or market-based view. on the other hand, whether one is better for growth and stability (see *Beck*, 2012; *Gambacorta et al.*, 2014; *Haisset et al.*, 2016; *Loayza et al.*, 2017), their findings are ambiguity.

CONCLUSIONS

The literature on financial development, economic growth has considerably evolved since the 1990s. The initial literature focuses on the role of financial depth on long-run growth, then the effect of finance on growth, provide evidence pointing to a positive impact of financial development on economic growth, but is not conclusive, since the influence is partly depending on the precise spatial and time dimension of investigation, on the measurement methods related to the indicators of financial development as well as. Whilst, after the last financial crisis, a trade-off between higher growth and higher crisis risk, financial innovation and non-intermediation services, and too much finance have been more attractive. However, more research in this area is necessary. Since the finance–growth nexus is largely determined by the nature and operation of the financial institutions and policies pursued in each country such as regulation and supervision, quality of institutions, competition, and financial liberalisation, geographic and cultures' factors and others, thus, without an in-depth understanding of the factors and the financial environment of each individual country, the cross-country evidence provides is not strong and are unable to capture those determinants of each individual country, so it is important to carry out country-specific studies.

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ABSTRACT

Even tough the research was conducted and published in 1996 the topic is still of high relevance today. The authors develop a quantitative ecological footprint analysis and stress the severity of an ecological deficit. Additionally, the analysis determines consequences of behavior at any level of individual, household, community, nation, etc. In our presentation at the "New Economics" session of the conference we will assess the relevance of Wackernagel's/Rees's analysis from todays perspective and point out why it can still be considered as relevant.
Keywords: Biocapacity, carrying capacity, climate change, earth, ecological accounting, ecological economies, Ecological Footprint, ecology, ecosphere, ecosystem, environmental economics, equality, footprint calculators, Ecological Footprint, Global Footprint Network, Gross Domestic Product (GDP), literature review, quantification of inequality, overshoot, resource management, sustainability, sustainability planning.

INTRODUCTION

In 1990, Mathias Wackernagel and William E. Rees created the concept of the Ecological Footprint with the goal to demonstrate the demand and supply of nature in regards to the world's consumption and waste assimilation. By now the approach is used by scientists, businesses, governments, but also individuals and institutions (*Wackernagel*, 2019). All with the goal to get a better understanding of their footprints and possible reduction methods for a sustainable future.

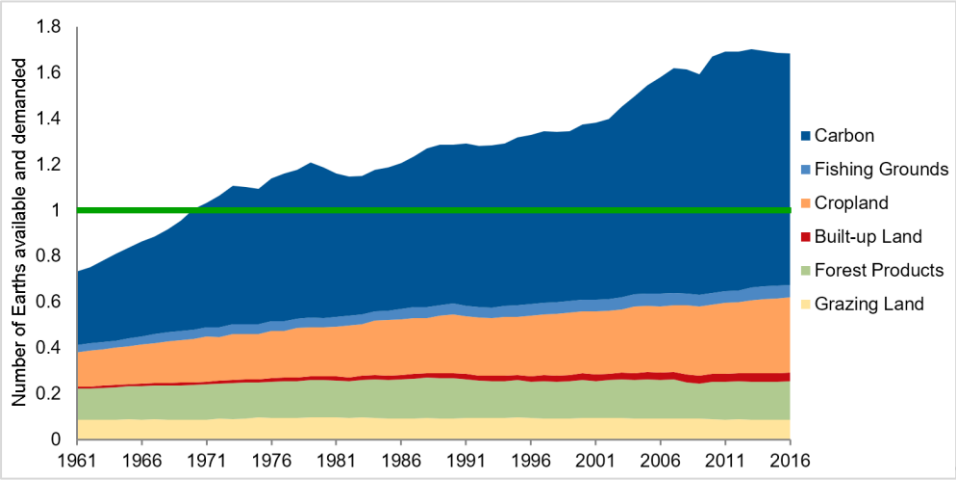
The basic idea of the model is to estimate the quantity of land, which is required to maintain a certain level of resource consumption and waste assimilation. On the demand side, the Ecological Footprint measures all ecological assets which are required by a defined population. The population's requirements result out of natural resource consumption such as plant-based food, livestock and fish products, as well as the required space. Easily spoken this is fruits and vegetables, meat, fish, wood, cotton, and carbon dioxide absorption.

According to the concept, productive land can be divided into six areas: cropland, grazing land, fishing grounds, built-up land, forest area, and carbon demand on land. The *Figure 1* demonstrates the division in more detail, showing that the biggest demand arises from carbon dioxide absorption, need of cropland and forests (*Global Footprint Network*, 2019).

On the supply side, the model presents the biocapacity, which is the ecological productivity of the land (including the land, which is consumed). This land is supposed to reproduce resources and absorb the generated waste, such as carbon dioxide. The biocapacity of a country stays mostly equal over time and generally does not increase. In case of lost or a change to unproductive land, the biocapacity can decrease.

Figure 1

World Ecological Footprint by Component



Source: *Global Footprint Network* (2019)

In order to visualize the demand (=Ecological Footprint) and the supply (=biocapacity) better, but also to have one global comparable standard both are expressed in global hectares. There are different options and variations for a country's footprint and biocapacity. If the footprint of a country exceeds its biocapacity, the country faces a so-called ecological deficit. In other words, this means that the demand of a certain population exceeds what the land can reproduce. In case of a deficit, countries need to react in order to meet their required demand. This can be done in different ways: import, over-exploitation of ecological assets (e.g. over-fishing) and/or emitting carbon dioxide into the atmosphere. Unfortunately, the number of countries with an ecological deficit is growing and can be analyzed in the world map below.

Of course, countries can also have more biocapacity available than actually needed to cover its Ecological Footprint. This is then called ecological reserve.

On the subsequent pages, the ecological deficits/reserves are evaluated in more detail and data on the Ecological Footprint is analyzed and evaluated. Additionally, the next paragraph shows how reliable the results are by investigating existing literature and gaining an understanding of how Wackernagel's and Rees's work is perceived in academia (*Global Footprint Network*, 2019).

MATERIAL AND METHODS

The qualitative part of this paper is based on Wackernagel's and Rees's cutting-edge publication "Our Ecological Footprint" (*Wackernagel and Rees*, 1997). Additional academic literature is assessed in order to get a good understanding of how the model is perceived and understand potential shortfalls, but also underline the importance of Wackernagel's and Rees's work.

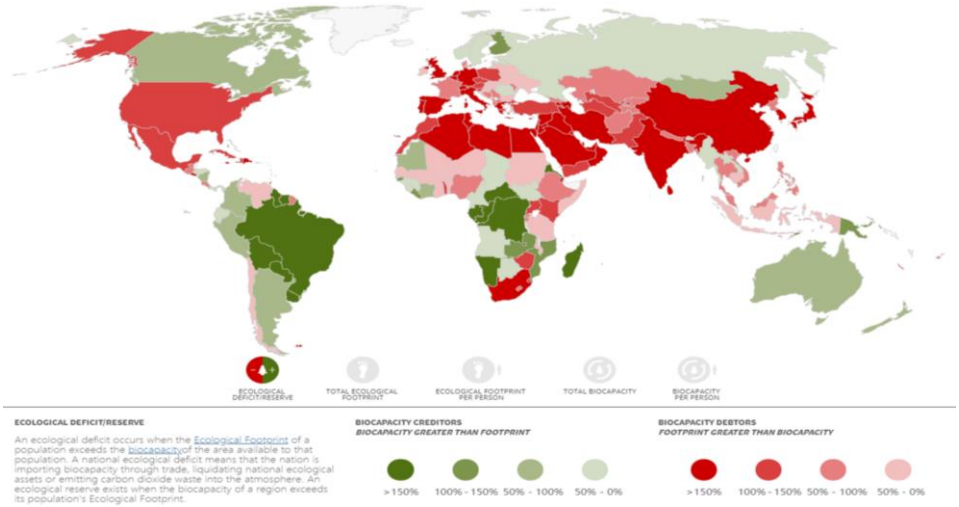
The quantitative part (e.g. analysis of countries footprints) is based on data from the Global Footprint Network.

RESULTS AND DISCUSSIONS

Looking at the entire world, humanity has a footprint already significantly higher than its biocapacity. Today we would need 1.75 times the earth in order to live sustainable. Since years, there is the Earth Overshoot Day, which is the day when humanity's footprint has exceeded biocapacity for the year. Meaning that from that day onwards, the biocapacity cannot cover any demand anymore. In 2000, this day was in September, which is still too early, but at least in the end of the year. Today the date has shifted to 29th of July, which is a radical deterioration within only 19 years. Prognosis don't predict any improvement and expect the situation to worsen even more and predict that by 2020 humanity demands 75% more than the world can actually reproduce. The consequence will be that we completely overexploit our resources no matter if it is overfishing, overharvesting of forests or emitting excessively much carbon dioxide. The *Figure 1* indicates the economic reserve or deficit of each country and indicates roughly the strength (*Global Footprint Network*, 2019).

Figure 2

World map of ecological reserve/deficit



Source: *Global Footprint Network* (2019)

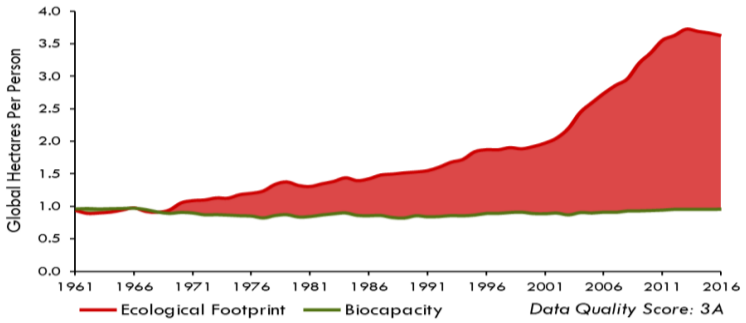
The next paragraphs will demonstrate the footprint and biocapacity of some example countries and also point out the deficit most countries already phase.

The *Figure 3* illustrates China's increasing footprint, with an unchanging biocapacity. As a result, the deficit of China increases rapidly. Generally speaking, one can analyze that countries with a high GDP mostly also present a high footprint. However, this also connects to the population of a country, on the size of land these people are living on and many other

factors. Taking China as an example, even though the land is huge, its biocapacity is still relatively low, especially compared to the increasing needs of the country. With the rise in GDP, the footprint also increased significantly (*Global Footprint Network*, 2019).

Figure 3

China: Ecological Footprint and Biocapacity



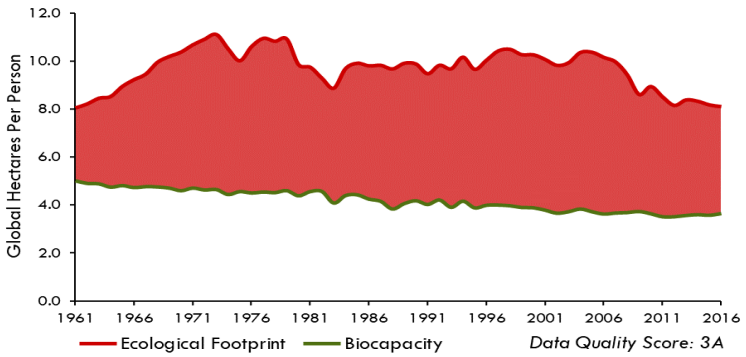
Source: *Global Footprint Network* (2019)

Other Asian countries with a high GDP, such as Japan, demonstrate the same phenomenon. In Asian countries with lower GDPs, such as Myanmar, the footprint is also still lower, but also often exceeds its biocapacity (*Global Footprint Network*, 2019).

The United States had one of the highest footprints of 8.1 in 2016, which is only exceeded by a very small number of other countries, mainly the Arab regions such as Qatar or United Arab Emirates (*Figure 4*). The GDP of the United States remained mostly equal over the years and so did the Ecological Footprint, only changing up and down a little over the years. The biocapacity decreased slightly, which can be related to lost land, for example, due to the clearing of forests (*Global Footprint Network*, 2019).

Figure 4

USA: Ecological Footprint and Biocapacity



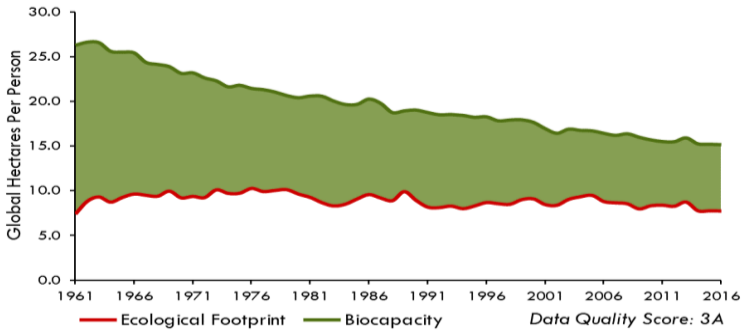
Source: *Global Footprint Network* (2019)

Most European countries have a similar problem like in the United States. Their GDPs are often comparatively high, looking at the rest of the world. Nevertheless, their footprints as well. The one of Germany, France and Italy is around 4.5 – 5.0; Hungary has a footprint of 3.0. The biocapacity is exceeded in the majority of European countries (*Global Footprint Network*, 2019).

Looking at the world map above one could assume that the situation of Canada is very good, compared to most other countries with a high GDP (*Figure 5*). Nevertheless, Canada still has a very high footprint, but their biocapacity is immensely high. Probably mainly due to the broad land available in the country.

Figure 5

Canada: Ecological Footprint and Biocapacity



Source: *Global Footprint Network* (2019)

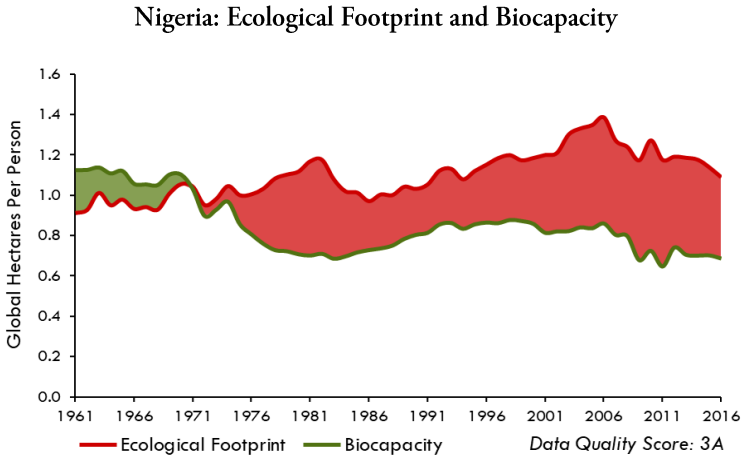
Most South American countries demonstrate a similar phenomenon. Their GDPs and footprints aren't as high as the one of Canada, but vary between 1.5 and 3.5. Their biocapacity is comparatively high and therefore most countries still live with economic reserves (*Global Footprint Network*, 2019).

The footprints of most African countries (*Figure 6*) are very small and mostly vary between 1.0 and 2.5, but their GDPs are also one of the lowest ones in the world. Their biocapacity is not extremely high, compared to South America, who also mainly have economic reserves left. Their deficits or even economic benefits are comparatively good, but mainly due to the low GDPs, a bad economic, poor living standards and therefore low footprints (*Global Footprint Network*, 2019).

To sum up, the result it needs to be added that at the end of the 20th century 20% of the wealthiest countries consumed 80% of the resources and the situation did not improve significantly. Still a great amount of poverty remains (*Wackernagel and Rees*, 1996).
Looking at these numbers, it seems to be necessary to act now on a more sustainable future, but to the same time enable poorer countries such as Africa to consume more resources.

Therefore, it might be inevitable for governments and institutions to invest in new technologies or infrastructures that foster sustainability. On top, it is essential that the main consumers, which also take most resources from other countries by importing them, need to find a way to consume less.

Figure 6



Source: *Global Footprint Network* (2019)

In order to get a better understanding of the severity of the problem and if decision makers can actually use these results for final decisions, we further check the concept of the footprint. We do so by presenting a detailed literature review, focusing on its reliability and available critics of the concept.

Wackernagel's and Rees's "Our Ecological Footprint" has been cited numerous times. Through analysis of quantitative data on country's footprints (see above) using Wackernagel's and Rees's concept it becomes obvious that we do live in an "overshoot period". This results in several important questions. First, if Wackernagel's and Reese's model is valid and, additionally, if assumptions are sufficient what can we do to mitigate or even reverse overshooting? Second, if Wackernagel's and Rees's model is not able to describe the fundamental problem of increasing overuse of resources adequately and/or wrong assumptions are done how would we need to amend the concept. This conference paper in the following focuses on the second question, in order to assess validity of Wackernagel's and Rees's model. The first question we leave, for the moment being, to policy-makers and other institutions.

Literature which has been published after "Our Ecological Footprint" has been published in 1996 and shows that viewed from different angles the concept of the Ecological Footprint does have shortfalls, which does of course not discredit Wackernagel's and Rees's work. In the following, fundamental criticism (*Fiala*, 2008) aims at, for instance, "arbitrary" assumptions. Especially, the fact that zero greenhouse gas emissions are assumed as a starting point leads, according to Fiala, to distorted conclusions. The assumption of national boundaries additionally distorts results as they affect average calculations and distort results, even though, national boundaries are not relevant when it comes to a global realistic analysis. Moreover, Fiala criticizes that Wackernagel's and Rees's concept lacks correlation between the ecological footprint and the degradation of the land. Fiala asks the question if rather land degradation, instead of an Ecological Footprint, should be measured.

In the context of geographical shortfalls, Lenzen et al add that the expression of the Ecological Footprint of Wackernagel and Rees is based on generic calculations. Especially the

translation of hectares of land to global hectares are criticized. Improvements on the general formula, which is understood as a mere sum of path, need to be done (*Lenzen et al.*, 2007).

Additionally, Van den Bergen and Grazi criticize that, even though Wackernagel's and Rees's model contains valid contents, it does not offer starting point for public policy making. The reason is again the geographical dimension, which hinders policy makers to make sound and meaningful decisions, i.e. public policies and emissions should be overarching (*Van den Bergh and Grazi*, 2013). In this context, Pillarisetti and van den Bergh point out that especially policies with the aim to encourage development of countries should be based on indices which are not based on the ecological footprint concept. In detail, the ecological footprint concept is criticized for evaluating undeveloped countries rather as sustainable, due to their relatively small footprint, while evaluating developed countries rather as unsustainable (*Pillarisetti and Van den Bergh*, 2010). Other sources or evaluation methods disagree with these results.

Despite some suggestions for improvements of Wackernagel's and Rees's model can be found as well as criticism the publication "Our Ecological Footprint" is "cutting-edge".

To start with, Burke acknowledges the publication for simplifying and concretizing the underlying fundamental issue with the goal of making "nonscientists" aware. In fact, Burke considers Wackernagel's and Rees's academic work as good starting point for "ecological economists". Burke appreciates that the two authors advocate sustainability and in this context stress the importance of an "ecological reform" (*Burke*, 1997).

Other voices say that the ecological footprint indicates inequality and advocates the increasing pressure on mother earth and its scarce resources (*Ball and Milne*, 2005). Ball and Milne witness that Wackernagel's and Rees's ideas have inspired calculations of CO2 use, travel, electricity, etc.

Recently Wenjun et al. have published the results of a case study with focus of tracking and evaluating the Ecological Footprint of Chinese city Qingdao. Content-wise Wenjun et al. made use of an enhanced method (e.g. through use of four indices) to determine the "emergy carrying capacity" and "emergy ecological footprint" (Wenjun et al., 2018). This shows the relevance of the original model by Wackernagel and Rees as well its potential.

CONCLUSIONS

Without doubt, Wackernagel and Rees are pioneers in their field also due to the fact that "Our Ecological Footprint" stimulated debate regarding sustainability and, most importantly, created higher awareness. The application of the model, which admittedly is to a certain extend simplified, show that planet's resources have been over-exploited and are beyond earth's production capacities. This is a good starting point to further think about how to make life more sustainable, through influencing daily life and also through inspiration of similar or enhanced models. The Ecological Footprint has become a globally known concept with high descriptive power which, may there be conceptual flaws or not, contributed to a better understanding of the root courses of ecological problems. If the concept would not have been so intuitively appealing the effect would have possibly been different.

The above-analyzed articles are a cross section of the academic discourse. These generally show some shortfalls. Especially the fact that the ecological footprint is an accounting measurement tool as well as an aggregate indicator is likely to create biases. Despite having

said this the publication "Our Ecological Footprint" can, with credits to Wackernagel and Rees, still be considered "cutting-edge".

Finally, we recommend to integrate additional points into the overarching analysis of CO2 emissions and sustainability. For example (the list is due to the broad spectrum of the topic not exhaustive), find ways of how to allocate CO2 emissions for e.g. aviation services, which cannot be clearly mapped to the level of emissions and the usage of resources of a country or region. Similarly, there should be smarter ways regarding the allocation of emissions, which stem from global production and supply chains. In this context, maybe there should be focus and incentive to reduce activities rather than reducing average (e.g. per capita) emissions. This can be achieved through promoting and incentivizing the reduction of air travel per person, number of children, eating les meat, etc.

ACKNOWLEDGEMENT

The results presented in the paper are an output from an academic research project and presentation for the section „New Economic Visions" of the Kaposvár University International Conference on Sustainable Economy and Agriculture. The presentation has been conducted and the conference paper has been written to give credit to Wackernagel and Rees, who both have contributed to discussion around sustainability significantly.

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INTRODUCTION OF THE POSTGROWTH ECONOMIST TIM JACKSON: PROSPERITY WITHOUT GROWTH

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ABSTRACT

The paradigm underlying our economy is a constant, almost exponential economic growth. This paradigm is represented both by politicians as well as leading economists. Tim Jackson contrasts this with the postulate of a post-growth economy. He is very precise in his argumentation and considers not only the form of the companies but also the quality of our working life. He also discusses the role of the money supply. He points the way for tomorrow's sustainable economy, which not only safeguards jobs but also reduces social inequalities, and, in the end, safes our planet.

INTRODUCTION

Tim Jackson is a British sustainability researcher and environmental economist. He holds a professorship in sustainable development at the Centre for Environmental Strategy at the University of Surrey. Jackson is also Director of the Research Group on Lifestyles, Values and Environment (RESOLVE) and the Sustainable Lifestyles Research Group (SLRG).

MATERIAL

GDP to measure social prosperity is not meaningful, it cannot be said that the higher the GDP, the higher the prosperity. With this fundamental thesis, Tim Jackson questions the growth of GDP as an objective for the economy, politics and society. Tim Jackson sets out this basic thesis in his 2009 book "Prosperity without Growth", which in the course of the review was traded as the Bible of the post-growth debate.

By questioning the growth of GDP, Tim Jackson regards the entire current capitalist economic system as a failure:

- Worldwide inequality is very high and even on the rise
- People's satisfaction in affluent countries stagnating despite rising GDP
- The ecosystem is being destroyed by an economy that relies only on growth.

Just the last point Tim Jackson impressively illustrates with the following example:

Since 1950, the global economy has been growing at an annual rate of 3%. If this growth rate is maintained at a constant level, the global economy will grow by 2100 in relation to the year as a whole:

- Compared to 2009: 16 times as big as it was in 2009
- Compared to 1950: 80 times as big as it was in 1950

This means that resource consumption in 2100 will be about 80 times higher than in 1950 (not considering efficiency savings based on technological progress).

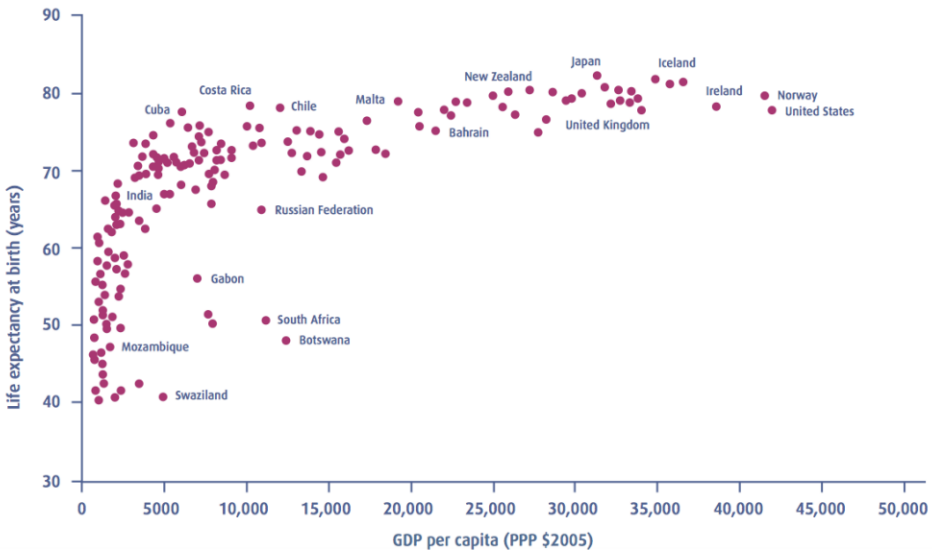
But even if policymakers recognize and identify areas of environmental degradation identified by policymakers in good time, economic interests in the form of economic growth have priority. Between 1990 and 2009, global greenhouse gas emissions rose by 40%, despite the Kyoto Protocol (adopted at the end of 1997 as an additional protocol to the United Nations Framework Convention on Climate Change).

Even if growth is pursued as a primary goal in all economic systems worldwide, regardless of the political structure of the system or the state, the myth that growth is positive still persists. If, as Tim Jackson examines it in various areas, this is followed up, the following points can be identified:

- Not only is there no global reduction in global poverty, but the inequality between states and within the wealthy states themselves is also increasing.
- Even the beneficiaries of economic growth have little or no advantage. Life expectancy or health, for example, do not actually increase any further from a relatively low income level (about US$ 15,000, based on the UN Human Development Report 2005) (*Figure* 1).
- The effects observed for life expectancy and health also apply analogously to individual feelings of happiness and life satisfaction.

Figure 1

Life expectancy at birth vs average annual income



Source: *Jackson*, 2009, p. 56

Tim Jackson does not reject economic growth from these points of view; economic growth is much more sensible and even necessary for poorer countries in terms of improving life expectancy and health as well as increasing satisfaction.

But if economic growth, especially in industrial nations, as shown above, has no discernible effect on the improvement of physical and mental well-being, why is it the overriding paradigm of politics and society?

To answer this question, Jackson uses the disciplines of psychology and sociology to provide an explanatory approach at the individual level:

- The all too human desire for something new and the production of ever new goods are mutually dependent.
- These goods have a symbolic meaning, even to the point of creating identity.
- With corresponding goods, a high or higher position on the social hierarchy ladder can be achieved.
- Even if an increase or increase in the social hierarchy is achieved individually, only the social boundaries (zero-sum game) shift when viewed as a whole.

In addition to this individual level, there is also an explanatory approach at the political level.

When economic efficiency and productivity are increased, less input (labour) is used for the same output (i.e. the same quantity of goods):

- Thus, with constant production of goods, fewer workers are needed and unemployment, with all its political and personal negative consequences, rises continuously.
- Only growth in the production of goods and the associated consumption of these goods can compensate for these negative effects of the increase in productivity.
- In qualitative terms, therefore, growth is an essential prerequisite for avoiding rising unemployment and is thus necessary to ensure social and political stability.

It is precisely in order to maintain the foundations of this stability of the social and political system that politics focuses on growth in production and consumption, overlooking the ecological limits of the environment and ultimately of Planet Earth. No value is placed on the sustainability of economic activity.

In the current economic environment, this has led to the financial crisis at the end of the zero years. The financial sector was completely deregulated and the volume of money massively expanded. Loans with low interest rates were granted to people with increasingly poor credit ratings. The financial crisis thus represents the failure of the underlying market economy system. Even if short-term measures such as a large number of state aid packages and aid programmes were necessary to avert further catastrophes, Jackson cannot return to political and economic day-to-day politics in the long term. The financial crisis has shown that consumerism was the wrong way to go.

Rather, in response to this crisis and in view of the increasing environmental problems (among which global warming is only one of many urgent problems), a completely new economic structure must now be developed and implemented.

There are two central questions here:

- How can we escape the pressure to grow?
- How can we manage to live in prosperity despite the lack of growth?

In addition, Tim Jackson is optimistic that such central questions can be solved:

- How can the earth still be saved?
- How can today's generation achieve greater justice?
- How can the future generation achieve higher justice?

In the new economic system, the focus is on real prosperity. Real prosperity is not materially defined, i.e. in the consumption of goods. Rather, it is all about:

- Social and societal coexistence;
- Friendships;
- Health.

Politics or the new economic system must invest in it:

- Reducing injustice;
- Recognition of voluntary work;
- Development of social infrastructure and public facilities.

Jackson thus outlines the first outlines of the new economic system, the so-called ecological macroeconomy. He is aware, and expresses this very clearly, that he does not have a ready draft for such an economic model. On the other hand, he provides the guard rails for such a model:

- Inclusion of ecological boundaries;
- Decoupling from Resource Consumption;
- End of growth;
- Reduction of working hours in the form of shorter individual working hours;
- Ecologically oriented investments;
- He sees the state as responsible for changing the behaviour of citizens in this direction.

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POSTGROWTH ECONOMISTS – CHRISTIAN FELBER: "CHANGE EVERYTHING: CREATING AN ECONOMY FOR THE COMMON GOOD"

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ABSTRACT

Post-growth economists see the current market economy as the motor for negative human traits in the soil that can be nourished at the expense of the weaker, and as creating a growth constraint that is fatal for society. In the competition of the market economy, people always strive for something new, the purpose of which is based more on short-termism, i.e. status symbol character, than on intrinsic value and long-termism. Things that make people happy in the long run. This topic is taken up and critically questioned by post - growth economists. One of these post-growth economists is Christian Felber, whose ideas and works are perceived by a broad public. Christian Felber was born in Austria and is well known for his work for the common good. The economy for the common good advocates a more ethical economic model in which the well-being of people and the environment becomes the primary goal of the economy. In all areas of society, the economy contributes to a culture of good living in a peaceful and sustainable civilization for the common good. Living together in a non-profit society is characterized by human coexistence, a high degree of trust and esteem, strong social cohesion, manageable structures and fundamental rights. Together with sovereign democracy, the common good society offers citizens the right framework. In order to provide a framework of orientation for social action, Felber developed the Common Good Balance Sheet, an assessment procedure that examines the extent to which organizations, companies, educational institutions and local institutions serve the common good. Ecological, social and other aspects are evaluated. Accordingly, the original success, which is normally measured against market competition, is oriented towards new standards: increasing efficiency. The common good becomes the main goal, not just financial gain. And that is the main vision.

INTRODUCTION

In the context of the financial and sovereign debt crisis, a new social movement emerged in 2010 - the Economy for the Common Good (ECG). Originally created in the context of the Attac movement in Austria, which was critical of globalization, the protagonists aim to radically change the current economic system. Christian Felber, one of those post-growth economists, has been campaigning for this rethinking for many years. Before his revolutionary invention of the so-called „Economy for the Common Good - balance sheet", he published numerous specialist literature dealing with money and values. ECG founder and - guidance figure Christian Felber stresses topics related to common welfare economics and stated the common welfare and profit should be the highest goal of economic activity. It refers thereby to some constitutions of democratic states: In the constitutions of democratic states consensus prevails, which is the goal of economic activity: the promotion of the common good. His 2010 publication „Gemeinwohl-Ökonomie" has so far been translated into nine languages.

According to Felber, the „Common-good Economy" should in future be promoted and rewarded in economic relations with humane basic values by reversing the polarity of the incentive framework for individual economic actors. The pursuit of profit and competition should be transformed into the pursuit of the common good and cooperation. The aim of this change of polarity is to achieve the end of the growth constraint. The conversion is to take place with a „common welfare balance". According to Felber's idea, every company should draw up such a balance sheet, which in the end evaluates the economic actions according to alternative standards. The focus is not on financial profit, but on how the company contributes to the implementation of certain values.

BRIEF INTRODUCTION TO THE COMMON GOOD ECONOMY

The Economy for the Common Good (ECG) is a comprehensive economic model and is practiced by a number of companies, universities, municipalities and local branches throughout Europe and South America. It is an alternative to capitalism and communism. It arises from a holistic view of the world and is based on „sovereign democracy, stronger democracy than it exists today"[1]

Figure 1

Economy for the Common Good[2]

The common good is the greatest possible good
for the greatest possible number of individuals.

- The Common Good Economy is an **economic alternative** to the free market economy and the centrally planned economy.
- In contrast to the others it places the **human being** and all living entities as well as **fulfilling interpersonal relationships at the centre** of economic activity.

[1] Cf. Christian Felber and Gus Hagelberg.
[2] Cf. Franziska Klaus, Anna Kroczak, Giovanni Facchinetti, Stephan Egloff 2013.

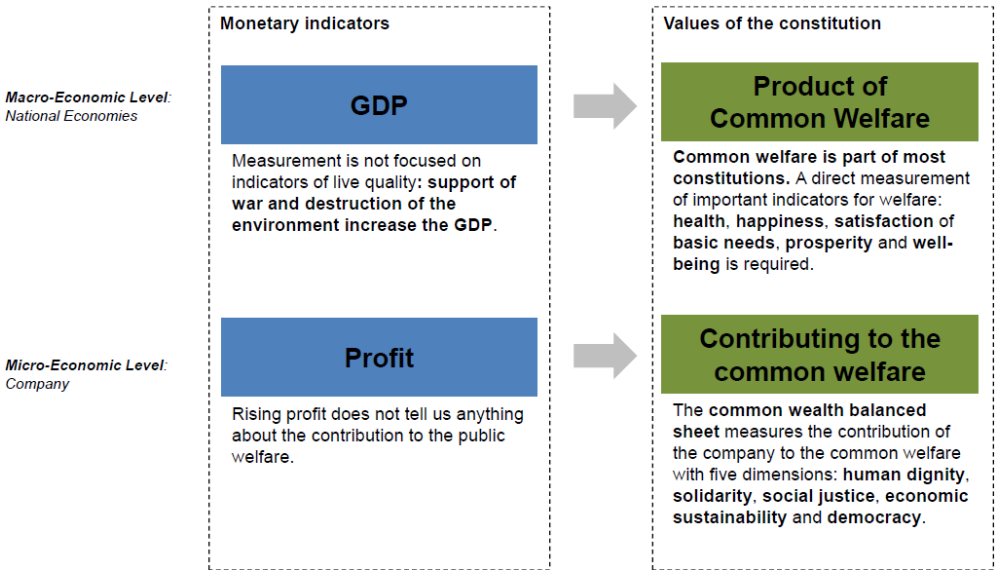
The basic model of Economy for the Common Good (ECG) has five basic objectives:

1. Linking the economy with the fundamental values that govern society in general. The ECG promotes business decisions that promote human rights, justice and sustainability.
2. Business and all other economic actors should adhere to the uniform and universal values enshrined in constitutions around the world.
3. A company is successful and reaps the benefits of its success when it does its best to serve the common good and not when it is increasingly profitable.
4. Democratically defining the cornerstones of the economic framework in processes leading to concrete recommendations for reform and reassessment of national constitutions and international treaties.
5. Closing the gaps between feeling and thinking, technology and nature, economics and ethics, science and spirituality.

Rewarding „good" behavior and improving the visibility of „bad" behavior in the public sphere and profitability lead to a general paradigm shift at all levels of the economy. There should be less uncontrolled, destructive growth. Companies will (have to) strive for their goals. Corporate profits will increasingly be used to improve products, infrastructure and working conditions rather than to increase dividends to investors, which would otherwise widen the social divide. The hope is that the unceasing drive for more and more profits and market shares will slowly diminish, because this behavior is contrary to the common good. The ECG promotes the private sector, but only within a common good framework.

Figure 2

From profit orientation and competition to the pursuit of the common good[3]



[3] Cf. Franziska Klaus, Anna Kroczak, Giovanni Facchinetti, Stephan Egloff 2013.

The ECG is based on a proposal for a sovereign democracy that offers citizens the necessary rights. These include the exclusive right to amend the constitution, the right to replace the government, and the right to stop a law that the legislator intends to pass or initiate. This reduces the disenchantment with politics[4], reduces political apathy and enables voters to become more involved in their communities and workplaces. The ECG cooperates with other social and new economy movements to create synergies and join forces within the current system, but also to transform our political system towards a sovereign democracy[5].

A central concern of the public welfare economy is the elimination of the discrepancy between means and ends in our economic system. Money and capital should no longer be the end or the goal of economic activity. Rather, they should serve as a means to improve the common good. The concept is not new but has already been established by Aristotle.[6] The constitution of Bavaria, Germany, defines: „Economic action in its entirety serves the common good." The Italian constitution states: „The private commercial enterprise is free of charge. It is perhaps not so. which are carried out against the common good. In the preamble to the US Constitution it is stated that one goal is the „promotion of general well-being".

An innovative aspect of ECG is the redefinition of the success of a company as a contribution to the common good. The fundamental error of the current system is that economic success is measured strictly by monetary indicators, e.g. Gross Domestic Product (GDP). Business success is not measured by the satisfaction of basic needs, such as quality of life or environmental protection. In a new economy focused on promoting the common good, new methods of measuring success must be available. At the national level, the Common Good Product will measure the success of a country by common values. At the corporate level, the ECG accounting process will show how much a company contributes to the common good.

THE COMMON GOOD - ACCOUNTING PROCEDURE

The accounting procedure focuses on four value categories: „human dignity", „solidarity and justice", „ecological sustainability" and „transparency and co-decision". These values are related to five stakeholder groups: „suppliers", „donors", „employees", „customers" and „social environment", resulting in 20 indicators, for example:

1. do products and services meet human needs?
2. how humane are the working conditions?
3. how environmentally friendly are production processes?
4. how ethical is the sales and purchasing policy?
5. how are profits distributed?
6. do women receive equal pay for equal work?
7. to what extent are employees involved in the central strategic decision?

This is presented in a common-good matrix, the so-called „anchor" of the common-good balance.

[4] Christoph Heinemann with Anton Hofreiter 2019.

[5] Cf. Liane von Billerbeck 2017.

[6] Wikipedia 2019. - Chrematistik

Figure 3

Public welfare matrix By mid-2017, the number of balance sheet companies has risen to 500. The participating companies come from a wide variety of sectors, legal forms and sizes.

VALUE / STAKEHOLDER	HUMAN DIGNITY	SOLIDARITY AND SOCIAL JUSTICE	ENVIRONMENTAL SUSTAINABILITY	TRANSPARENCY AND CO-DETERMINATION
A: SUPPLIERS	**A1** Human dignity in the supply chain	**A2** Solidarity and social justice in the supply chain	**A3** Environmental sustainability in the supply chain	**A4** Transparency and co-determination in the supply chain
B: OWNERS, EQUITY- AND FINANCIAL SERVICE PROVIDERS	**B1** Ethical position in relation to financial resources	**B2** Social position in relation to financial resources	**B3** Use of funds in relation to the environment	**B4** Ownership and co-determination
C: EMPLOYEES	**C1** Human dignity in the workplace and working environment	**C2** Self-determined working arrangements	**C3** Environmentally friendly behaviour of staff	**C4** Co-determination and transparency within the organisation
D: CUSTOMERS AND BUSINESS PARTNERS	**D1** Ethical customer relations	**D2** Cooperation and solidarity with other companies	**D3** Impact on the environment of the use and disposal of products and services	**D4** Customer participation and product transparency
E: SOCIAL ENVIRONMENT	**E1** Purpose of products and services and their effects on society	**E2** Contribution to the community	**E3** Reduction of environmental impact	**E4** Social co-determination and transparency

Behind each of the above topics there is a catalogue of questions and requirements. In addition to reporting, the aim of this accounting should be to evaluate the companies in the respective subject areas. Using a points system, up to 1000 plus points can be earned for services that exceed a defined minimum standard. A reduction of the credit points can result in negative aspects - such as the prevention of a works council, a lack of anti-corruption measures or violations of environmental regulations - which can have a negative impact on the score. The companies that join the common good economy and want to carry out a balance on a voluntary basis are supported internally by ECG consultants*. After the internal review, the evaluation is evaluated externally by a public welfare auditor*in. Felber sees the incentive for compliance with and maximization of the overall score in legal and profit-enhancing advantages such as a reduction in the VAT rate, more favorable credit conditions or preferential treatment in public procurement.

RESULTS AND CONCLUSION

The public interest balance in its entirety shows advantages as well as deficits. In principle, the instrument makes a significant contribution to the common good and thus initiates valuable discussions in practice, as can be seen from the increasing popularity. It also hits the nerve of society today. A large number of scientists have so far dealt with the common-good economy and the common-good balance.

In terms of content, however, it shows deficits, because this is based on an ideologically narrow understanding of the common good and encounters constitutional hurdles, which become apparent in some examples. For example, the internal evaluation of the balance is classified as difficult by public welfare advisors as well as the external evaluation by public

welfare auditors, since including the own enterprise with its acting and acting is evaluated. A comparison with other enterprises is not possible thereby or only insufficiently under acceptance of a peer group. Thus, the assessment of the extent to which a company considers generally formulated evaluation standards is rather subjective and also depends on the point of view of the public welfare auditors*. Furthermore, a common-good auditor must have extensive knowledge. It can also be speculated or assumed that companies could make more generous use of public welfare points due to their independent distribution.

The preferential treatment of companies that receive legal, tax or public benefits as an incentive when using the public interest balance sheet is also viewed critically, for example. This already creates discrimination against companies that do not voluntarily participate in this matrix.

A closer look at the individual incentive factors reveals further deficits.

For example, Felber suggests that money as a loan should become a public good and the financial markets closed."[7] Instead of investment funds, stock exchanges, trading in government bonds, derivatives and currency markets, a Democratic Bank operates. In addition: „Commodity prices are set democratically by a committee in which producers* and consumers* meet each other at eye level...". In view of these demands, the essential tasks of the European Central Bank are completely suspended. The task of the European Central Bank is the supervision of the banking system and the regulation of the money supply in an economy. It therefore takes countermeasures as soon as the economy goes into trouble. It should be noted here that the financial crisis caused by the European Central Bank and the rapid action of the European Union has prevented a worse crisis. The financial crisis was triggered by the burst real estate bubble in the USA in 2007. According to Felber's idea, it would not be possible to set up a Democratic Bank. Because the banking system is networked worldwide and not focused on individual countries.

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Regional and Rural Development

THE THEORY OF THE "SUSTAINABLE OUTSOURCING"

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ABSTRACT

Outsourcing is mostly used as a tool to reduce one company's costs. There are many areas that they work well (i.e. call centres, shared service centres), but in others there are not sustainable. Many scholars pointed out the negative consequences of outsourcing nowadays, but it has a large and well-known reputation in different companies. The result of this outsourcing was that companies lost the very same core competencies that originally allowed them to develop manufacturing that could supply a product capable of competing on the world market and that fuelled innovation. Since strategy is a collection of interlocked activities that strengthen one another, removing one of these activities breaks the entire chain. We can use the idea of the "industrial commons" to demonstrate that idea. Pisano and Shih have written about it for the first time in 2012. They are a critical mass of buyers, sellers and highly educated workforce concentrated in a geographical area. Due to outsourcing, these industrial would commons collapsed and the companies would bankrupt. In my presentation I would like to argue the probability of outsourcing and the usage of industrial commons in Hungary. Although the idea of the "industrial commons" was born in the USA, we should take a look at it from Hungarian point of view, from the Carpathian basin. If we look at the country's economic policy we would find clues of "sustainable outsourcing". It means that even though the company export its manufacturing skills, it can become an "industrial common" itself in the other country. For example we would take a closer look to the Hungarian automotive industry and its effect on the country's economic system. We can assume that there is no fear about Hungary become a new-born competitor for mostly German automotive companies in the near future.

INTRODUCTION

The aim of this paper is to present how outsourcing emerged as a common practice in production, and how it makes developing a coherent corporate strategy difficult.

The first structural unit of the study is a historical overview of the steps that ultimately led to the spread of outsourcing practices. This section does not specifically aims at providing an extensive overview of the transformation of the role of production since the industrial revolution, but rather demonstrating that the succession of rational, well-considered, logical steps has ultimately led to a practice that is against the best interest of a company itself.

The second major structural unit intends to demonstrate exactly why outsourcing production is against the company's interest. What are the main areas where this practice has such harmful consequences that it jeopardises the company's core business in the long term? I will argue that these main areas are innovation and strategic dynamism. However, the negative effects of outsourcing go beyond the company and endanger the entire industry within a particular geographic unit. When presenting this final thought, I will also highlight on why it is much more difficult to reverse this process than it was initiated.

In my view, the historical overview and addressing the issue of the negative consequences of outsourcing is essential for demonstrating that outsourcing is a tool that can actually help to cut the cost of a company, but commitment to it must be a strategic decision that goes far beyond a simple profitability analysis.

HISTORICAL OVERVIEW

The aim of this chapter is to show how the role of production in corporate strategy has evolved. In my study, the strategy, based on the views of *Pisano* (2015), is interpreted that it is a commitment to coherent, mutually strengthening methods and forms of behaviour that aim at achieving a particular competitive objective.

Alternatively, once a strategic goal has been identified, it is necessary to review each activities of the company to see whether they really help to achieve this goal. In case it is not confirmed, the activity concerned needs to be strictly reconsidered.

During the Industrial Revolution, the so-called Taylor paradigm emerged in production, resulting in the United States becoming a dominant industrial power by the 1920s. Since the strategy was clearly focusing on the product (*Dawar*, 2013), it was difficult to separate the production strategy from the strategy of the company, as it more or less defined it. If during this period the company's production strategy is interpreted as the strategy of the whole company, then, in my opinion, the Taylor paradigm is a coherent strategy according to *Pisano* (2015).

Its purpose was obviously to maximize profits through mass production. To this end, all production activities were restructured. The tasks were divided into small parts to perform tasks with a specialized tool so that it could be performed without being fully aware of the entire workflow. Skilled people were removed from physical work; their primary task was to organize production. One of the biggest drawbacks of mass production is that production would have stopped in case of any shortage, therefore, in order to make up for fluctuating supply, companies held large stocks of raw materials in that era. One of the key elements of the system was that holding large stocks and having a certain number of rejects in the production was considered inevitable (*Hayes and Pisano*, 1994).

In the 1950s Toyota developed its revolutionary production system, the Toyota Manufacturing System (*Mishina and Takeda*, 1992). Lean manufacturing (*Hayes and Pisano*, 1994) emerged from this system, which, in the 1970s, became a major competitor to the American industry which was essentially still based on the Taylor paradigm, and it challenged the basic idea of keeping large stocks of raw material and having a certain amount of rejects is inevitable.

The underlying idea of lean manufacturing, on the other hand, is that waste is unacceptable. (*Hayes and Pisano*, 1994). Rejects, or unnecessary stocks or excessive amount of raw material of course, are considered such waste. In more detail, inventories or unnecessary movement of people between production lines, are also considered wasteful, thus this excess time has to be cut down. Specialized production tools are not desirable, as they are not utilised in all manufacturing processes. Untapped knowledge is also considered as waste, as a result, the general expertise of workers is much greater compared to the Taylor system, and communication is more direct.

In fact, the biggest advantage of Lean Manufacturing was that it boasted much greater operational efficiency. *Porter* (1996) defined operational efficiency as performing tasks

similar to those of a competitor's *better*. Seeing the better results, companies in the United States set the goal of introducing the Japanese system into production often associated with daring development goals.

Investing in the development of production was a temporary competitive advantage, as competitors also introduced or copied these developments. Further improvements were limited by the fact that, as operational efficiency increased, it began to reach the technological constraints of the period. In the end, there was a need for a different approach and in the 1990s *Porter's* (1996) strategic positioning became the basis for competitive advantage.

As technological constraints, especially in the United States, began to affect operational efficiency, the focus of corporate strategy inevitably shifted from further optimization of production to strategic positioning (*Porter*, 1996).

If operational efficiency means that a company performs tasks *similar* to those of a competitor's *better*, strategic positioning means that a company performs tasks *different* from its competitors. This means that, unlike operational efficiency, it does not try to do everything better than a competitor, but wants to create values in some other areas instead. This differentiation is the base for competitive advantage.

The goal of strategic positioning for a company therefore is to target a part of the entire population and satisfy the needs of this consumer group better than a fully-marketed product could satisfy it or better than a competitor's product satisfies it. The economic consideration behind this is that although there are fewer consumers in the narrower market who generated demand however, products that are tailored to their needs are more valued by them, thus higher prices can be charged. The higher price collected from fewer consumers may ultimately result in higher profits. The age, gender, marital status, world view, geographical location, habits, disposable income or some combination of them can all be considered when a consumer group is created. Some further aspects can be easily found whereby the population can be divided into sections, but that is not the purpose of this study. The lesson to be learned is that mass market production was to target all consumers, lean manufacturing attempted to create a competitive edge by reducing cost structure, while strategic positioning aimed at targeting a certain part of the consumers to have competitive advantage.

This kind of strategic positioning increases the utility of consumers, on the one hand, and on the other hand it reduces competition between companies, as while they compete within an industry, they can be regarded as competing in a monopolistic position based on their own market position.

Accordingly, instead of focusing on the product orientation of the Taylor paradigm and or on efficiency like in lean manufacturing, the central issue of strategic positioning is which specific consumer group is targeted by the company, how to adjust all its activities to serve this consumer group's needs, how to strengthen this strategic position and protect it from potential competitors.

However, in the 2000s, strategic positioning was not enough. For example, Siebel Systems' strategy was built on targeting a narrow market segment in the software development market. At the time when the company was created, background office applications such as SAP or PeopleSoft emerged. While these programs primarily helped the company's financial, accounting, manufacturing organization and distribution tasks, Siebel Systems developed software specialised for sales, consumer information and marketing, and

related software. (*Simons and Dávila*, 2013). This is a typically static strategy based on a strong strategic position, and Siebel performed well in the 1990s, reaching a revenue of $ 1 billion (*Simons and Dávila*, 2013) in merely seven years.

Later, however, this static strategy could not respond efficiently to the rapidly changing market conditions. Since the 2000s, the company's profits had been steadily declining and despite its stable strategic position it collapsed in 2005, and its competitor, Oracle, acquired it.

Nowadays dynamic competition strategy and ability-based competition are decisive (*Stalk, Evans and Shulman*, 1992), which emphasizes the acquired abilities of the company rather than a firm strategic position. These capabilities enable the company to quickly change its strategic position even in a changing economic environment and to readjust its acquired capabilities to perform a new task.

Integrating goods into services (*Sawhney*, 2016) and the acquisition of companies closer to the consumer in the value chain, vertical integration, have become dominant strategies (*Wise-Baumgartner*, 1999). The main issue for companies was which customer they needs could serve rather than what else they could still sell (*Dawar*, 2013). Meanwhile, the strategic role of production has diminished.

OUTSOURCING

The primary reason for outsourcing is that companies do not consider production and its organization as valuable resources.

A resource is valuable if it is difficult to imitate, durable, appropriable, difficult to substitute, and better than that of the competitors'. (*Collis and Montogomery*, 1995).

Copying of patents or permissions is forbidden, so they immediately comply with the requirement of something difficult to imitate. However, not only those resources are difficult to imitate where copying is prohibited by law. Something that accumulates at a company over a period of time, such as a familiar atmosphere or employees' experience in performing a task can also make a valuable, difficult-to-imitate resource.

A fundamentally quickly amortising raw material or product, for example food, cannot be considered durable, however, there can easily be durable resources in the industry, for example, the recipe whereby certain foods were made on.

A resource is valuable only if it can be appropriated. For example, a property at a good location can be a valuable resource for a company because other companies may be excluded from using it. However, resources such as electricity or infrastructure, although they are of the utmost importance, can also be used by competitors, so they do not create competitive advantage for the company.

The value of a resource will cease to exist if it is replaced by another similar or better resource, for example, if the same product can be manufactured from cheaper material. *Collis and Montogomery* (1995) cite the story of steel industry, which suffered a huge loss when manufacturers started to produce several of its major products from the substitute aluminium.

If each of two companies has a well-defined, valuable resource that complies with the above criteria, then it is up to the competition to decide which of the two valuable resources is more valuable.

According to *Collis and Montogomery* (1995), the innovation system of a production system is not a valuable resource, since it is easy to copy and therefore is not explicitly durable. Increased profits resulting from improved cost structure can only be temporarily exploited, since after the innovations have been copied, price competition between competitors is pushing down the price according to the new cost. This type of innovation, therefore, is a valuable resource in the short run only. Accordingly, most companies do not handle this as such. This creates the grounds for outsourcing as a means for improving cost structure.

Similarly, companies do not consider good managers, who are responsible for day-to-day operations, valuable assets, despite of the fact that, according to *Sadun, Bloom and Reenen* (2016), under the guidance of a good manager, a company can grow on average 25% faster and achieve 75% more productivity.

The path of development outlined, the shift of value on the value chain from production towards the consumer, the continued decline in the value added of the product, and the shift of the focus of strategy from a well-defined static market segment to a dynamic, capability-led management resulted in that, in order to improve the cost structure, companies outsourced production (*Pisano and Shih*, 2012). Nowadays, not even the Far East is a suitable target; even cheap Chinese labour is not cheap enough for companies that keep close and tense track of their profitability, and the focus of outsourcing is shifting from Far East to Africa (*Sun*, 2017).

THE CONCEPT AND USE OF INDUSTRIAL COMMONS

Pisano and Shih (2012) refer to industrial commons as a critical mass of suppliers, customers, competitors, skilled labour, universities, and infrastructure that belong to the same industry and are situated in the same geographical area. While *Porter* (1993) mainly emphasized the competition between competitors, *Pisano and Shih* (2012) show the symbiotic relationship between economic and state actors within these industrial communities.

These commons are created due to the fact that the companies want to be close to their customers. This attracts their suppliers to them, as companies are customers at the suppliers' market and the suppliers also want to be close to their own customers. When a new competitor enters the market, the most logical step according to game-theory is to be situated in the proximity an existing competitor's supplier network, however, this network will be unable to supply for two companies. This will attract additional suppliers and skilled workforce to the region, and sooner or later the emerging universities and infrastructure will emerge to provide professionals to the industrial commons. It is evident, how this virtuous circle gains momentum.

An essential feature of industrial communities is that all economic operators benefit from their existence, for example by having more workforce available, their transfer between firms allows knowledge to be spread, or due to the concentration of the supplier system, according to the five forces by *Porter* (2008 [1979]) competition is getting fiercer, which in turn will reduce the cost of raw materials for the company concerned and reduces the bargaining power of suppliers.

The process of evolution also shows how an industrial commons can disintegrate. An economic downturn or, for example, outsourcing may result in the stopping or even

reversing the process above (*Pisano and Shih*, 2012). When companies quit or cease their activity, suppliers and skilled labour will move away. The declining labour supply and increasing bargaining power of suppliers will intensify competition within the industry concerned (*Porter*, 2008 [1979]). This can encourage companies to outsource their business or can make further companies go bankrupt. While the evolution of industrial commons is a virtuous circle, their evolution, is just the opposite: a vicious circle.

The evolution process described above is typical of Western Europe and the United States. According to *Khanna* (2014), distance, including cultural distance beyond geographical distance, makes it difficult to apply certain results, considerations and models. The emergence of industrial commons by *Pisano and Shih* (2012) is a concept not easy to interpret and apply in Eastern Europe, for example. In contrast to the above organic process of evolution, it is more common in this area that governments of individual nation states invest heavily in the establishment of business units outsourced from Western Europe and the United States.

ECONOMIC STRUCTURE OF SLOVAKIA AND HUNGARY – THE AUTOMOTIVE INDUSTRY

Table 1 shows the volume of Hungary's product exports, in billion forints, in 2018, and their share of total exports in percentage. It is evident by the table that vehicles and transport vehicles occupied a prominent position in foreign trade in 2018. In fact, this category accounted for more than half (55.7%) of Hungary's exports and nearly half (47.7%) of its imports. Vehicle manufacturing has been the number one engine of industrial production since 2011, with the exception of the period of the economic downturn, and has been growing ever since. The reason for this is that this sector is essentially export-oriented, which has ensured constant demand for the products manufactured (*KSH*, 2019).

Table 1

Distribution of Hungarian foreign trade in goods broken down by category, 2018 (HUF billion)

Main Export Categories	Export	Percentage	Import	Percentage
Food, drink, tobacco	2266.6	6.8%	1635.4	5.2%
Raw materials	751.8	2.3%	676.6	2.1%
Energy resources	943	2.8%	2589.9	8.2%
Finished products	10830.3	32.4%	11656.3	36.8%
Motor vehicles, means of transport	18617.4	55.7%	15098.4	47.7%%
Total	33409.1	100.0%	31656.7	100.0%

Source: *KSH - Central Statistical Office* (2019)

The data of the Central Statistical Office are supported by the *GlobalEdge* (2019) collection, which reveals that three of the five leading Hungarian export products, boasting with the highest turnover, are closely related to the automotive industry.

Table 2

Export Volumes of Hungary in 2017 (USD)

Product	Volume
Electronic machine	23,062,394,486
Industrial machine	20,709,378,491
Motor vehicle and parts	19,292,912,934
A pharmaceutical Products	5,209,103,575
Plastic goods	4,365,179,353

Source: *GlobalEdge* (2019a)

Four of the first five major export products account for over $ 60 billion, which is more than half of Hungary's total exports, belong here. Not surprisingly, according to *GlobalEdge* (2019b) statistics, Hungary is ranked 28th among the exporting countries, which is a prestigious position.

Table 3

Volumes of products exported by Slovakia in 2017 (USD)

Product	Volume (USD)
Motor vehicle and parts	22 563 634.386
Electronic machine	17 514 454 552
Industrial machine	10 323 800 063
Iron and steel	3 951 279 224
Mineral and mineral oil	3 809 857 567

Source: *GlobalEdge* (2019b)

Table 4

Hungarian and Slovak car production (2018).

	Passenger cars (pieces)	Total (pieces)
Hungary	472,107	472,107
Slovakia	949,365	949,365
European Union	16,957,230	19588909

Source: Based on *ACEA* 2019-2020.

Table 4 clearly shows that automotive-industry cooperation between the two neighbouring countries can be fruitful for both parties in the future. Considering the volumes, it can be seen that the Slovak automotive industry produces twice as much as its Hungarian counterpart and is thus they are considered competitors in terms of economic competition.

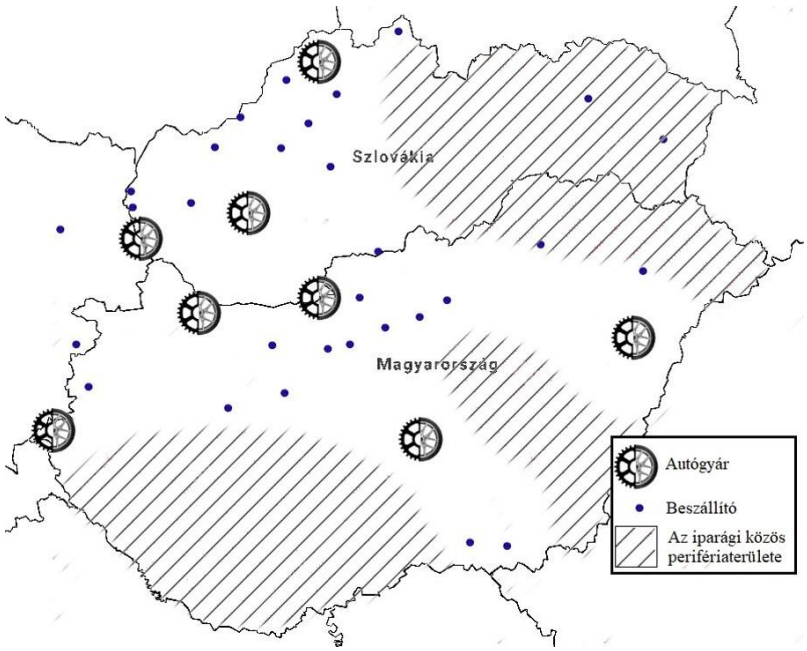
The car production of the two countries accounts for almost 8% of the total EU production, which is significant compared to the countries' regional and population data.

After the change of regime, several car factories were established in Hungary. They include Opel (Szentgotthárd) and Suzuki (Esztergom). They were followed by Audi (Győr), Mercedes-Benz (Kecskemét) and most recently BMW (Debrecen). The number of factories suggest that Hungary has become favourable for the automotive industry, as a serious system of suppliers has been established over the years. This began the process of the development of industrial commons, which later became a self-accelerating, productive process.

In view of this, it may be appropriate to study the Hungarian automotive industrial commons, as this has the greatest impact on the country's economic performance and is the basis of Hungary's positive foreign trade balance.

Figure 1

The industrial common of Hungary's and Slovakia's automotive industry and its peripheral area



Source: Based on data by *Invest in Austria* (2018), *Slovak Investment and Trade Development Agency* (2018) and *Hungarian Investment Promotion Agency* (2012)

Figure 1 shows the Hungarian and Slovakian automotive industry commons. *Pisano and Shih* (2012) point out that industrial commons often disregard national borders and intertwine through them. *Ghemawat* (2013) generally states that there are factors that influence the intensity of trade between two countries. There are several factors that make trade between Slovakia and Hungary more difficult - the lack of a common currency, the lack of a common language - while many factors have a positive impact on it, such as

belonging to a common economic bloc or the simple fact that the two countries border one another. All of these factors mean that Slovakia is an important export destination for Hungary, and vice versa. The two industrial commons are thus intertwined.

Figure 1 is also suitable to illustrate the difference between an industrial common and an industrialized zone. Areas of high industrial concentration include those left out of the automotive industry, and there are places which, despite the lack of industrial concentration, are involved in the supply chain as a supplier. Typical examples are suppliers in South Hungary or East Slovakia.

AUTOMOBILE INDUSTRY IN EUROPE

The analysis of the statistics released by ACEA reveals how many cars have been manufactured in the European Union this year. The figures show that the EU itself have produced nearly 20 million (19.2 million) vehicles this year, of which the Visegrad countries contributed actively. In terms of passenger cars, V4 countries accounted for 20% of EU production, so every fifth car came from here. Looking at the other categories, it can be seen that, of the V4 countries, only Poland was able to achieve significant results in the category of light and heavy commercial vehicles. It is also interesting that compared to the sizes of the countries concerned, the Czech and Slovakian car production is several times higher than the Hungarian average, and therefore there is still room for improvement for the Hungarian market.

Table 5

Automobile industry in Europe

	Passenger Car	Light commercial vehicles up to 3.5t	Medium commercial vehicles from 3.5t to 15t	Heavy commercial vehicles over 15t (incl. buses)	Total
Czech Republic	1,345,031		61	744	1,345,846
Hungary	430,988				430,988
Poland	451,600	180,058		15,650	653,700
Slovakia	1,031,241				1,031,241
European Union	16,540,052	2,127,857	110,130	427,056	19,205,095
Visegrad countries	3,350,053	161,055	6,112	13,974	3,531,194
V4 / EU (%)	**20%**	8%	0%	4%	**18%**

Source: *ACEA* 2019-2020

In the next table we can see the differences between the "home country" Germany and the "outsource-land" East-Central Europe.

In *Table 6* we can examine the production data of Central Europe through Germany and the Visegrad countries. At first sight the data shows that the Visegrad countries have become a competitor to German automobile industry. Although, the region's industry is based on foreign – mostly German – resources and factories. The competition of automobile industry quickly become a pursuit of geographical position among East-Central

European countries. The provided data indicates that the post Comecon states (Czech Republic, Hungary, Poland and Slovakia) chaned their economic status rapidly due to the innovations of automobile industry. In passenger cars the V4 countries have 2/3 third of German automobile industry production. This data changes in the light commercial vehicles (half of Germany's data). The biggest gap in the vehicle industry can be found in the medium and the heavy commercial vehicle segments. Only Poland have a significant slice of the industry based on local traditions. Based on the recent data provided by ACEA we can say that the export-oriented automobile industry of the Visegrad countries reduced the gap from Germany. This data also can be misleading as many of these companies are German hands so the competition is not based on fair and equal position.

Table 6

Automobile industry in Germany and in the Visegrad Group

	Passenger Car	Light commercial vehicles up to 3.5t	Medium commercial vehicles from 3.5t to 15t	Heavy commercial vehicles over 15t (incl. buses)	Total
Germany	5 120 409	362 438	27 899	131 986	5 642 732
Visegrad Countries	3 258 860	180 058	61	16394	3 461 775
Percentage	64%	50%	0%	12%	61%

Source: *ACEA* 2019-2020.

CONCLUSION

In my paper I would like to show the problems of outsourcing. In my opinion, many of the scholars choose to view this phenomenon through "American" eyes rather than European (East-European) point of view. Using the theory of Pisano and Shih, we can find functional and reliable industrial commons in Hungary and in the Visegrad countries: the automobile industry. In this case we can see that outsourcing have positive effects on one country, while others could face difficulties. After 1989 the German automobile industry made many investments in the region, because of available cheap and well-trained workforce and business opportunities. After 20 years of development these countries have build a huge potential in automobile industry. According to the latest statistics of ACEA we can see that the Visegrad Countries have maintained their position by having 2/3 of Germany's automobile production. Their participation in automobile producing also endangers them to crisis and global market effects. Only industrial cooperation and self-management could offer them a better future.

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ANALYSIS OF THE IMPACT OF DEVELOPMENT TAX BENEFIT ON EMPLOYMENT

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ABSTRACT

Increasing employment and job creation is a key area of fiscal policy, which can lead to a wide range of tax benefits. As a member of the European Union, the government can only provide tax subsidies within certain limits, so at first to review EU harmonization rules for direct taxation. The following is a description of the extent and rules for applying certain tax benefits related to developments in corporate taxation in Hungary. Based on municipal corporate tax data, we are analyzing the employment impact of the development tax benefits. In our study we determined how the development tax benefits in the Hungarian corporate tax rules influence the labor market of certain regions / settlements.
Keywords: development tax benefit, SME's, corporate taxation

INTRODUCTION

Based on the European Union guidelines, the strategy of small and medium-sized enterprises, within that increasing the competitiveness of enterprises both in terms of employment and added value, is also a priority in Hungary. The EU tax policy regulation provides limited opportunities for enterprises in the distribution of subsidies. In this paper, we present the rules for recourse to and the extent of development-related tax benefits in the domestic tax system.

Firstly, we analyzed how it is realized the actual tax burden per settlement between 2014 and 2017 in parallel with the legal regulations. Support measures of domestic economic policy provided wide-ranging tax benefits for SMEs, so we examined to what was the rate of utilization of tax benefits and development tax benefits at enterprises in the settlements.

In our analysis finally, we would like to specifically examine the correlation relationship between the development tax benefit used by enterprises operating in settlements and their employment.

MATERIAL AND METHODS

We used our data from the National Spatial Development and Spatial Information System (TEIR) database for our analysis between 2014 and 2017. Data on Hungarian settlements (N = 3155) were analyzed by counties (N = 19) and regions (N = 8). The data filtered from the database includes for that year the number of tax payable per settlement, pre-tax profit, total tax benefit, development tax benefiz, and number of registered jobseekers.

We performed the necessary data cleaning in the database. We were not taken into account that settlements where the data on the taxation of operating enterprises and the change in the number of unemployed were not available.

Data from the capital, Budapest, were not used in the study because the extremely high data distort the data set in our examination.

First, we analyzed the average tax payable in the investigated settlements aggregated by counties. With the help of this variable we determined that how much corporation tax payment per company were realized on average per settlement.

At the settlement and county level, tax benefits and the use of development tax benefits were treated separately according to the utilization rate of enterprises.

Finally, we examined the effect of the development tax benefit on employment on the basis of corporate tax data. The Pearson correlation coefficient was used to show whether there is a relationship between the development tax benefit and the number of registered jobseekers, whether there is a relationship between the two variables, and if so, how close.

RESULTS AND DISCUSSION

Characteristics of EU tax harmonization in direct taxation

In the impact of globalization on tax systems appear both positive and negative elements as well. Tax-collector states are adversely affected by the fact that the free movement of capital offers a new opportunities to minimize the tax payable. At the same time, tax competition encourages countries to reduce taxes on mobile factors of production. Governments remain responsible for carrying out the public tasks of each country, and it is therefore in their fundamental interest to protect the tax base, which is the main revenue source of the budget. Competition may result in certain companies enjoying the tax advantages of tax havens (even with zero tax payments) while using domestic public services. The OECD plays a leading role in international action against harmful tax competition. According to a 1998 report (Harmful Tax Competition,1998), tax competition can be harmful if it distorts financial and investment processes, thereby undermining the fairness of tax structures and undermining tax morale.

The problem was also on the agenda in the European Union. At the end of 1997, the Council of the Union adopted a Code of Conduct for Business Taxation (*Council of the European Union*, 1997). This means that member states can commit themselves in their future tax regulations to refrain from creating solutions that would allow harmful tax competition to occur and, on the other hand, to withdraw their previous rules that provide incentives for business start-ups in the EU. The EU Code and the OECD Guidelines share the same main thrust, with the fundamental difference that while the scope of the Code extends to business activity, the general principles of the OECD Directives cover a broader scope. In addition, the OECD typically considers extent of tax in tax havens (close to zero) to be harmful, while in the European Union, low (harmful) levels of taxation can be identified relative to the average. In corporate taxation, exceptional preferences are considered unauthorized assets. One way of stopping tax competition may be to properly harmonize national tax systems, which in many cases is met with resistance.

With the advancement of technology and the effects of globalization investors have become much more flexible, therefor the composition of the corporate tax base and tax benefits and rate of tax in a given country are a priority consideration when investing. Therefore, in our study examines in detail the opportunities for profit tax reduction on development.

Support for developments through direct taxes

Certain of the benefits provided for in the Hungarian Corporate Tax Act (LXXXI. *Act*) in year 1996 are only available if the enterprise or its activity meets the conditions of the applicable EU regulation. In the case of investments by small and medium-sized enterprises (if the investment is not primary agricultural production serve), enforceable the aid content of the depreciable amount is available to undertakings in accordance with EU State aid rules in purchase of new tangible assets(*Corporate Tax Act,* 7. § (12)), interest on an investment loan from a financial institution (*Corporate Tax Act,* 22/A. § (4)) and the commissioning of some new tangible assets in the most disadvantaged areas (*Corporate Tax Act,* 1. *Annex* 14. *point*).

These subsidies provided through the tax system:

- Articles 107 and 108 of the Treaty on the Functioning of the European Union, the "de minimis" Regulation on small amount subsidies (*Commission Regulation (EU) No* 1407/2013), or
- be considered to be aid within the meaning of the General Block Exemption Regulation for the purposes of Articles 107 and 108 of the Treaty (*Commission Regulation (EU) No* 651/2014).

Investment-related benefits in the Hungarian corporate tax

There are basically two groups of ''de minimis'' benefits:

- on the one hand, the so-called. indirect subsidies group, those subsidies that are enforced by the enterprise under the tax system (*Corporate Tax Act,* 7. § (1) *y*),
- on the other hand, the so-called. direct subsidies group,This group includes grants received through various support programs, applications, grant agreements (*Corporate Tax Act,* 7. § (1), (17) – (18)).

The business must be mindful of it that indirect and direct aid must be taken into account when calculating the different thresholds together. Based on validated tax base and tax reliefs corporation tax, constitute State aid under certain Community regulations, their aid content thus qualifies as de minimis benefits.

The following concessions qualify as de minimis aid under the applicable Corporate Tax Act:

- tax base benefits for number of employees growth for micro-enterprises (*Corporate Tax Act,* 7. § (1) *zs*),
- tax base benefits on R&D carried out jointly with research institutes(*Corporate Tax Act,* 22/A. §).

The Corporate Tax Act provides an option to include the benefit as ''de minimis'' aid in the following cases:

- tax base benefit for small and medium-sized enterprises,
- tax benefit related to interest on investment loans taken by small and medium-sized enterprises,
- one-amount depreciation for small and medium-sized enterprises in the most disadvantaged micro-regions.

A condition for accessing the benefit in addition to the threshold, the activity carried out by the enterprise or related activity to the procurement. The small amount of aid granted to undertakings engaged in the commercial transport of goods by road for the purposes of Article 3. of the „de minimis" Regulation is not eligible for the purchase of lorries, but it is important to note that the rule only prohibits the acquisition of lorries.

Under the „de minimis" Regulation, the subsidy threshold is fixed at 3 years. Under each of the three tax years, the amount of aid granted to one and the same undertaking shall not exceed EUR 200 000 per Member State whereas for commercial road hauliers the ceiling is EUR 100 000/3 years.

Allowance under the General Block Exemption Regulation

The General Block Exemption Regulation Chapter III.include contains specific provisions for the different categories of aid. The maximum extent of aid intensity is 20% of the describable costs for a small enterprises,and 10 % of the describable costs for a medium enterprises.

The SME is not a taxable person operating in one of the excluded sectors and its investment is not in primary agricultural production, it may decide to comply with the ''de minimis'' Regulation or the General Block Exemption Regulation. If you choose the latter, you may also decide to consider the benefit as regional investment support or SME investment support.

Regional investment support

For regional investment support used under Article 14. of the General Block Exemption Regulation, the maximum support intensity may be further increased: by up to 20 percentage points for small enterprises and 10 percentage points for medium-sized enterprises (37/2011. Government Decree). As regards the Central Hungary region, it should be noted that the maximum aid intensities do not apply to part of Budapest and Pest counties, so no regional investment aid can be granted in these areas.

Investment support for SMEs

The maximum support intensity is 20% of the eligible costs for small enterprises and 10% of the eligible costs for medium-sized enterprises.

Benefit under the de minimis Regulation

As long as an entrepreneur take de minimis aid under the de minimis Regulation, he have to take into account the maximum aid amounts laid down in the de minimis Regulation. The amount of de minimis aid granted to any one undertaking shall not exceed EUR 200 000 per Member State over any period of three fiscal years.

It is important to emphasize that in addition to the EU regulation, the hungarian regulation also sets a value limit in relation to the application of benefits. In fact, the Hungarian corporate tax legislation does not allow an enterprise to reduce its income tax liability to zero in order to protect its tax revenue. As a result, the companies must comply with the following thresholds for tax benefits:

- a development tax benefit of up to maximum 80 % of the calculated corporation tax
- reduced tax with development tax benefit of maximum 70% can be used as follows:
  - tax benefit for the support of cinematographic and performing arts organizations,
  - tax benefit for sponsorship of spectacular team sports,

- tax benefit for small and medium-sized enterprises,
- tax benefit for live music services,
- tax benefit for investment for energy efficiency purposes.

The focus of our study is on tax and tax bases benefits to investments and developments, so we will review the corporate tax rules for these purposes in the following.

Tax base benefit for R&D carried out jointly with research institutes

The direct cost of basic research, applied research and experimental development (R&D) is a recognized expense in corporate tax if it is related to the entrepreneurial, commercial activity. However, according to the provisions of the Act, only an R&D activity carried out in its own field of activity is eligible for a discount, and therefore, the taxpayer must carry out R&D using his or her own assets and employees for his or her own profit and risk. A reduction in the tax base equal to the direct cost of the R&D activity is available in the tax year in which the costs are incurred or in the tax year in which the depreciation is charged (if the cost is activated as a pilot development by the taxpayer). However, it is important rule that, in order to avoid the accumulation of an advantage, no consideration may be deducted for R&D services used directly or indirectly from another undertaking, nor for the amount of the costs covered by the aid (*Corporate Tax Act,* 7. § (17)).

Tax base benefit for small and medium-sized enterprises

On the last day of the tax year, the pre-tax profit of an SME(qualifying taxpayer) can be reduced:

- earlier not yet used object recognized for the commissioning of property, technical equipment, machinery, vehicles the value of the investment accounted for for the commissioning of property, plant and equipment included in the tax year, insofar as they are directly linked to the business, as well as tax year renovation to increase the cost of the property, expansion, purpose-change, conversion value,
- included in intangible assets in the tax year into substance, a new intellectual product that has not been used before, the right to use software products at historical cost,
- the value of the investment and renovation made and activated by the lessee on the leased property.

It is important to underline that the tax base benefit is in any case related to new tangible and intangible assets that have not been used before. A further condition is that the taxpayer may only apply the above in the tax year in which all members were exclusively private individuals. The annual limit on the tax base benefit governs the condition that the reduction should not exceed the profit before tax of the business. The amount of the reduction, calculated at the rate applicable to the company (9% of the tax base benefit), qualifies as de minimis aid (*Corporate Tax Act*, 7. § (1) *zs*).

Tax benefit related to interest on investment loans taken by small and medium-sized enterprises

On the last day of the tax year of the conclusion of the loan or lease agreement, an enterprise qualifying as an SME may obtain a tax benefit for the interest on a loan or lease from a financial institution for the acquisition or production of a tangible asset (*Corporate Tax Act*,

22/A. §). To qualify for the tax benefit, it must be put into operation within 4 years of purchase and cannot be alienated of within 3 years.The tax benefit is equivalent to the interest rate on the loan and is considered to be de minimis (*Corporate Tax Act*, 22/A. §).

One-amount depreciation for small and medium-sized enterprises in the most disadvantaged micro-regions

On the last day of the tax year, an entrepreneur who qualifies as an SME may apply a depreciation charge of up to 100 percent of the historical cost of a tangible asset not previously used that is recorded between technical machinery, equipment and vehicles (except cars), is placed in the territory of a free enterprise zone designated by law. Tangible assets have been taken into account as a pre-tax profit reduction 1% of its historical cost, for a vehicle, 3% qualifies as de minimis aid (*Corporate Tax Act*, 1. *Annex* 14. *point*).

Development tax benefit

On the basis of a development tax benefit ("Decree 165/2014 on Development Tax Allowance" (VII. 17.)), the following investments may be used for commissioning and operation:

- investment with a present value of at least HUF 3 billion,
- an investment of at least HUF 1 billion at present value, put into operation and operated in the administrative territory of the beneficiary municipality as defined in the Government Decree on Development Tax Benefit,
- investment to create the food hygiene conditions of the animal food establishment previously used for the purpose of present value of at least HUF 100 million,
- independent environmental investment worth at least HUF 100 million at present value,
- an investment of at least HUF 100 million in present value for basic research, applied research or experimental development,
- investment in film and video production at present value of at least HUF 100 million,
- investment to create jobs,
- an investment of at least HUF 100 million in present value commenced after the date of introduction of the shares issued in connection with the increase of the subscribed capital, but not later than the last day of the third year after that date,
- investments made by small and medium-sized enterprises with a present value of at least HUF 500 million,
- investments in the value of at least HUF 100 million, put into operation and operated in the free enterprise zone.

In addition, a development tax benefit is available for an investment of at least HUF 6 billion at present value or commissioning and operation of an investment of at least HUF 3 billion at present value.

The taxpayer may apply a tax benefit for 13 tax years in the tax year following the commissioning of the investment, up to the16. tax year following the tax year in which the application was submitted. Up to 80 percent of the development tax benefit can be deducted for the calculated tax (*Corporate Tax Act*, 22/B. §). In the future development tax benefit

entitlement limit of value for small and medium sized enterprises becomes better over 3 years, as the investment limit of value above of HUF 500 million currently in force:

- from 2020 to HUF 300 million for small businesses and HUF 400 million for medium-sized companies decrease,
- from 2021 to HUF 200 million for small businesses and HUF 300 million for medium-sized companies decrease,
- from 2022 to HUF 50 million for small businesses and HUF 100 million for medium-sized companies decrease, it will be use expected that tax benefit (Ministry of National Economy, 2019).

Tax benefit for investment for energy efficiency purposes

An investment for energy efficiency shall be considered to be an investment which leads to an increase in energy efficiency which results in energy savings that result in a reduction of final energy consumption (*Corporate Tax Act*, 4. §. 11a.).

The tax benefit can be claimed for up to 70% of the calculated tax deducted by the development tax credit for 6 tax years. The extent of the tax reduction may not exceed 30% of the eligible cost of the investment together with the total amount of state aid required for the investment, but not more than HUF 15 million. The aid intensity may be increased by 20 percentage points for small enterprises and by 10 percentage points for medium-sized enterprises (*Corporate Tax Act*, 22/E. § (2)-(3)). To qualify for the tax benefit, a taxpayer must have a certificate in the first tax year of the tax benefit until the tax return for the tax year is filed, certifying that his investment qualifies as an investment for energy efficiency purposes. A further condition for entitlement to the tax benefit is that the taxpayer must have used and used all assets forming part of the investment for at least 5 years. The tax benefit is applicable to investments for energy efficiency purposes started after 1 January 2017. Not all energy efficiency investments are eligible for the discount. For example, it is not available if the taxpayer is carrying out the development in order to meet EU standards already adopted when the investment is commenced. It is important to note that, for the same investment, the tax benefit for an investment for energy efficiency purposes cannot be combined with the development tax benefit mentioned above.

R & D related benefits in other taxes

In addition to corporation tax, the local business tax and the innovation contribution can be considered directly as part of the corporate income tax, and both liabilities include R&D related benefits.

Local business tax

The tax effect of R&D activities affects the local business tax liability, as the net taxable income for permanent commercial activities is the tax base, reducible

- the sum of the cost of goods sold and the value of intermediated services,
- the value of subcontractor compliance,
- the cost of materials,
- the direct cost of basic research, applied research and experimental development in the tax year (*Local Business* 1990. C. *Act.* 39. §)

The general rate of the local business tax in Hungary is 2%, therefore the total tax effect of the discount can be considered as 2% of the direct cost of R&D.

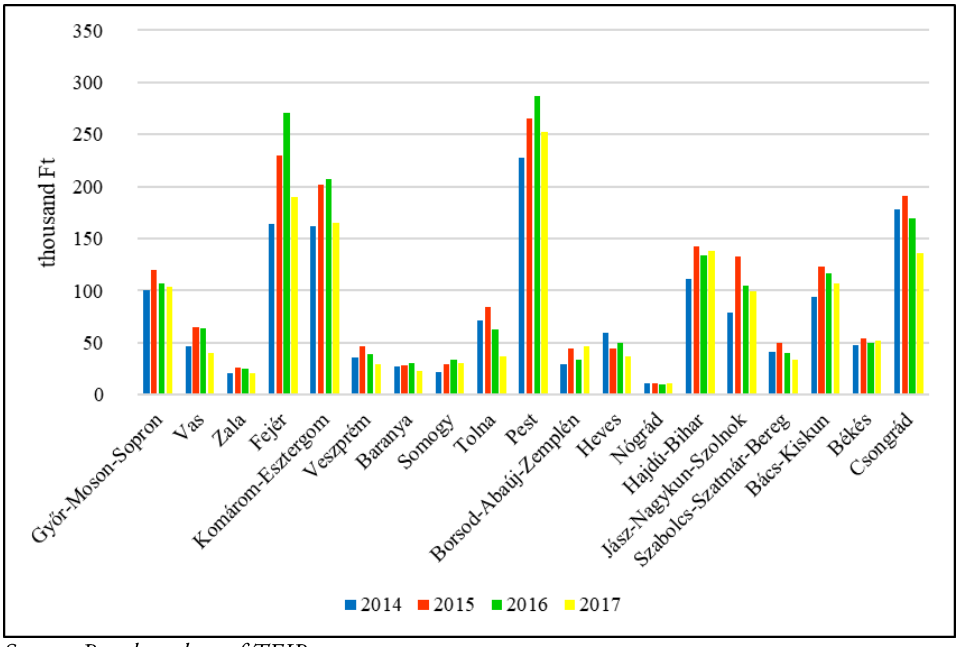
Innovation contribution

LXXVI. of 2014. Under the Innovation Act, companies are required to pay an innovation contribution, with the exception of SMEs. The liability base is set at the same level as the local business tax base, so indirectly, R&D projects also reduce the amount of the innovation contribution. The rate of innovation contribution is 0.3%, so 0.3% of the direct cost of R&D can be considered as the tax effect of the discount.

In the first part of our analysis, we examined the actual Hungarian tax burden between 2014 and 2017 on average in the settlements on counties (*Figure 1*).

Figure 1

Average tax payable per settlements by region, (2014-2017)



Source: Based on data of TEIR

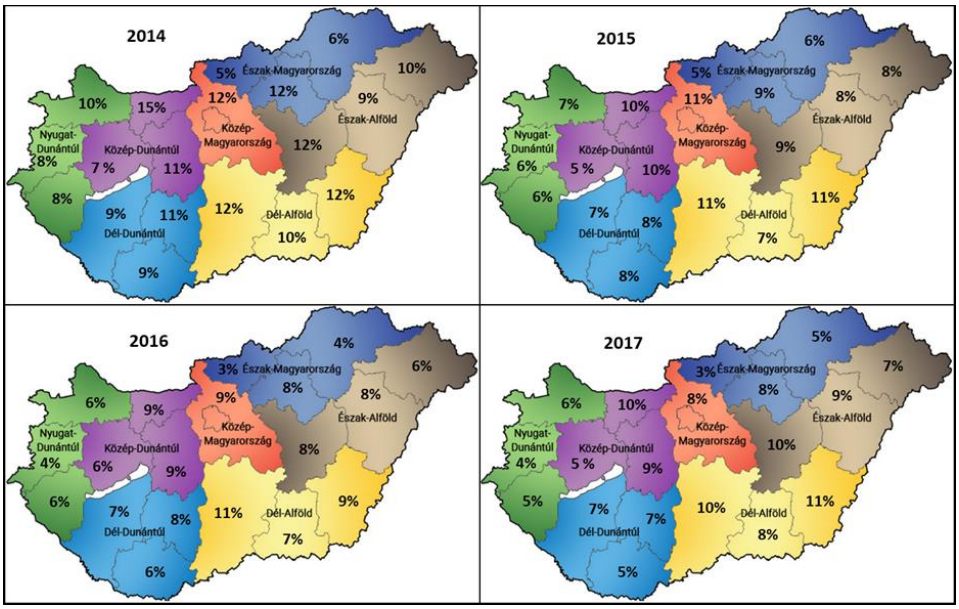
In our results, we experienced territorial disparities in the actual tax payable size per settlement. As the number of settlements and the amount of tax payable by enterprises in each county are different as well as large companies and SMEs in our database, their relative standard deviation is so much. It can be clearly seen that in more developed counties like Pest, Fejér, Komárom-Esztergom the amount of tax payable every year is much higher, while in less developed counties the amount of tax payable by enterprises is ten times less. An important aspect is the abolition of the lane tax rate, as of 1 January 2017 the corporate tax rate is 9%. Thus, the decrease in the result of the last year under review is not comparable to that of

previous years in terms of tax, and results continue to be affected by changes in the number of enterprises, the tax benefits applied and the pre-tax profit.

We further investigated the extent of all tax allowances affecting the amount of tax payable relative to the calculated tax (*Figure 2*).

Figure 2

The proportion of use of tax benefits in Hungary (2014-2017)



Source: Based on data of TEIR

Our results also show a large difference in the settlements distribution of tax benefits. Enterprises in developed areas are taking greater advantage of the tax benefits provided by law. The terms of the Corporate Tax Act, such as the tax benefit for investment loan interest from a credit institution or the de minimis regulation, are preferable to enterprise themselves.

Further examining the tax benefits, we examined the utilization rate of development tax benefits between 2014 and 2017 (*Table 1*).

During the period under review, we found that the data of economically and territorially more developed regions is extremely high in the Southern Transdanubia Region, no companies or settlements in the Tolna County claimed development tax incentives, that is to say, such investments were not made, while in the counties Komárom-Esztergom, Győr-Moson-Sopron, Jász-Nagykun-Szolnok, Fejér, Heves the proportion of tax benefits devoted to development was quite high. We examined the relationship between the development tax benefit used in settlements and the number of employees in the settlements. In the examined years correlation analysis was used to determine the relationship between the variables (*Figure 3*).

Table 1

The proportion of development tax benefits depending on tax benefits used (2014-2017)

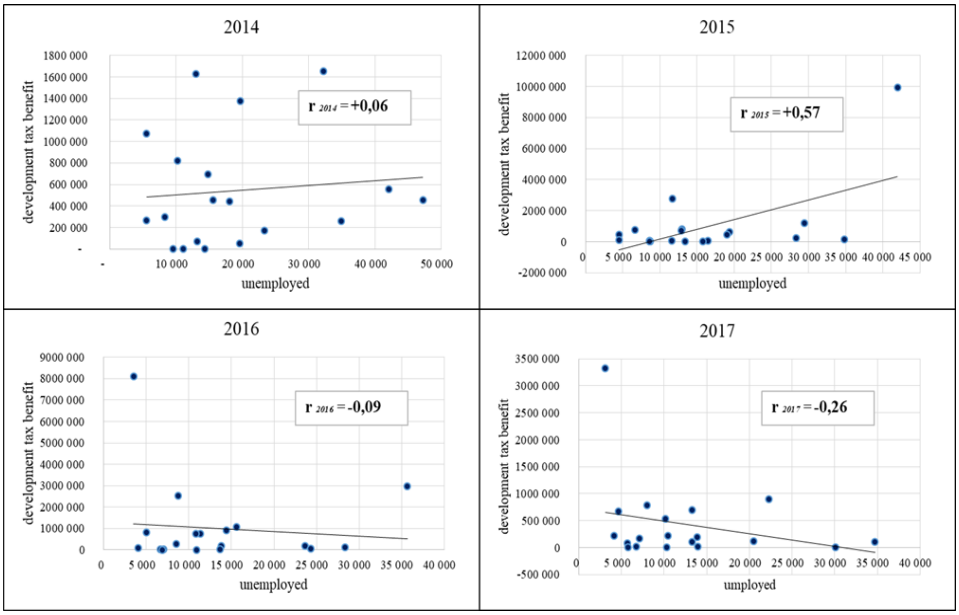
regions	*counties*	2014	2015	2016	2017
NYUGAT-DUNÁNTÚL	Győr-Moson-Sopron	22%	28%	81%	65%
	Vas	56%	7%	12%	58%
	Zala	0%	6%	6%	9%
KÖZÉP-DUNÁNTÚL	Fejér	63%	66%	78%	52%
	Komárom-Esztergom	40%	77%	82%	82%
	Veszprém	25%	0%	1%	6%
DÉL-DUNÁNTÚL	Baranya	25%	6%	22%	26%
	Somogy	7%	4%	5%	19%
	Tolna	0%	0%	0%	0%
KÖZÉP-MAGYARORSZÁG	Pest	22%	37%	37%	27%
ÉSZAK-MAGYARORSZÁG	Borsod-Abaúj-Zemplén	20%	71%	73%	24%
	Heves	55%	79%	76%	49%
	Nógrád	0%	0%	7%	14%
ÉSZAK-ALFÖLD	Hajdú-Bihar	34%	72%	11%	69%
	Jász-Nagykun-Szolnok	50%	64%	78%	38%
	Szabolcs-Szatmár-Bereg	39%	20%	35%	39%
DÉL-ALFÖLD	Bács-Kiskun	8%	24%	59%	50%
	Békés	33%	44%	62%	47%
	Csongrád	2%	4%	25%	22%

Source: Based on data of TEIR

The result of the examination account for that there is a loose connection between the development tax benefit and the number of registered job seekers, in 2015 it was only moderate. It can be stated that the relationship between the number of people employed in the settlements and the development tax benefit is not emphatic. It is important to note that in each region the utilization of the tax benefit affects only the county seat and 3-14 settlements in the region. The year-by-year analysis confirms that the rate of use of development tax benefits is on the rise, and another important factor is that the number of registered unemployed has decreased by 35% from 2014 to 2017. In the case of the development tax benefit, most of the investments are not "just" used job-creating, but are permitted by law, for example, by environmental or investment by small and medium-sized enterprises. Related to the period under review is Jászfényszaru as a settlement of the underdeveloped region, where for years due to targeted investments the number of registered jobseekers could be reduced from the surrounding settlements.

Figure 3

Relationship between the level of development tax benefit and the number of people employment in the settlement (2014-2017)



Source: Based on data of TEIR

CONCLUSIONS

Based on LXXXI of 1996 on Corporate Tax Act in Hungary we conducted our analysis in accordance with the tax benefits allowed by law, including tax benefits related to developments. The database on which the research is based was filtered from the TEIR system between 2014 and 2017, which contains the pre-tax profit, tax payable, total tax benefit, development tax benefit and registered jobseekers' data of companies operating in Hungary.

In the settlements examined during the analysis, we found exceptionally high standard deviations in terms of both the actual tax burden and the total tax benefits used. Most enterprises are concentrated according to their territorial distribution in the economically developed regions, around the capital and county headquarters. The results of the relative standard deviation prove that the data set is extremist, database including all enterprise category (large companies and SME's).

We also found that in the economically developed counties, Komárom-Esztergom, Győr-Moson-Sopron, Jász-Nagykun-Szolnok, Fejér, Heves, the opportunities for development investments are applied through the tax benefit. In the framework of the Hungarian Economic Policy Action Plan, the possibilities of development benefits will be expanded in the future.

Examination of the relationship between the amount of development tax benefits used on settlements and on the settlement's employment as no clear close relationship but has an

impact on employment. In the years under review, the use of development tax benefits increased, and unemployment decreased by 35 percent as between 2014 and 2017. Nowadays only certain companies take advantage of the development tax benefit, the goal remains economic growth and employment increasing, while providing broad support for the government.

ACKNOWLEDGEMENT

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THE FINANCING OF THE AGRICULTURAL ENTERPRISES IN HUNGARY BETWEEN 2012 AND 2016

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ABSTRACT

Many financial institutions assist the Hungarian agricultural sector with adapted financial services, but agricultural sector has many special characteristics, which the financial system does little to accommodate. Such as high transaction costs to reach remote rural populations, covariance of production, market, and price risks, and absence of adequate instruments to manage risks. Our article's starting point: it is useful to examine specific factors determining the financing of the agricultural enterprises. In addition to the traditional sources of agricultural financing, such as bank loans; we examine usage trend of accounts payables, loans of integrators; leasing and factoring financial sector. Our objective to take into account agricultural producers' foreign liabilities and their own capital. This helps the economic efficiency of business operations; the indebtedness of Hungarian agricultural enterprise, as well as to take a full picture of financing options. The study analyses the domestic agricultural enterprises based on the FADN Test Farm Information System's database operated by the Hungarian Research Institute of Agricultural Economics (AKI). The analysis works with the data of the statistically closed years 2012-2016. This case studie makes a useful contribution to the rapidly expanding literature on financial institutions in Hungary by clarifying the old and some new finance actors in agricultural finance. Which makes this paper indispensable for those involved in financing as well as policy makers.
Keywords: agricultural finance

INTRODUCTION

Our goal is to examine the way these companies can get funding. From these methods which are the most common in Hungary and whether is this way of getting financing effective? Before that, however, it is important to be able to take stock the farmers' external liabilities besides their equity properly.

As in *Nyárs* (2009), *Udovecz – Nyárs* (2009), *Popp et al.* (2015) wrote that technology (primarily mechanization) investments are not in themselves, they increase profitability, they have to be supplemented by efficiency measures. However, it is important to look at the source of the investments. (*Varga et al.*, 2015)

First, the indebtedness of the agricultural enterprises are need to examine, namely the ratio of how many enterprise use external liabilities and to what extent.

The relative position of individual farms has changed positively in the past five years. In the case of joint ventures the rate of the agricultural enterprises with high indebtedness decreased significantly from 22% to 11%, the share of enterprises with at least low indebtedness grew considerably, they are almost half of the joint ventures. There is a similar trend for Individual farms. The main driver of the improving equity ratio is due to the improved profitability of the sector during the period under review (*Sipiczki et. al.*, 2019).

Table 1

The indebtedness of agricultural enterprise in 2012 and 2016 (percentage)

Individual farms	**2012**	**2013**	**2014**	**2015**	**2016**
Without liabilities	31%	32%	34%	43%	58%
Low indebtedness (<20%)	50%	47%	49%	41%	29%
Medium indebtedness	16%	16%	14%	12%	9%
High indebtedness (>50%)	3%	4%	3%	3%	4%
Joint ventures	**2012**	**2013**	**2014**	**2015**	**2016**
Without liabilities	5%	6%	1%	13%	14%
Low indebtedness (<20%)	45%	44%	49%	41%	45%
Medium indebtedness	28%	34%	31%	30%	30%
High indebtedness (>50%)	22%	16%	18%	16%	11%

Source: AKI

MATERIAL AND METHODS

There is no collective data on funding opportunities for agricultural firms, so we worked from two sources: on the one hand, we made use of the test farm system's queries of the Research Institute of Agricultural Economics (AKI), on the other hand, the finding of agricultural studies were used to determine the liabilities.

The entire database is representative of region, size and activity. The Hungarian test farm system covers 2 percent of the population (*Keszthelyi*, 2017), the monitored factories provide data per year. The data provided includes data on the workforce, the balance sheet, the profit and loss account and land.

The test farm system of the AKI concluded on the functioning of the domestic agricultural enterprises from the regular monitoring of 1984 business units during the year 2012 (in 2016 2167 units). Because of the representativity of the sample it means 116.335 observed enterprises altogether from the basic population.

RESULTS AND DISCUSSION

Direct bank financing

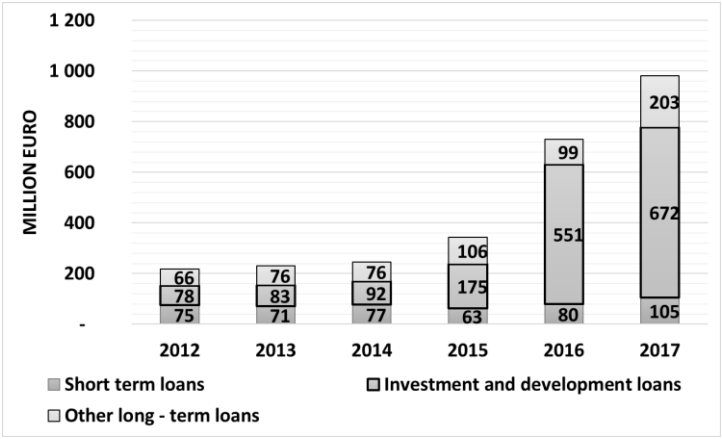
The first and most common form of agricultural financing is direct bank financing. The total loan stock of the national economy increased following the trend that started at the beginning of the year. Beside market priced interest rates are decreased, there was additional loan expansion because the Hungarian National Bank started a new loan program The Growth Credit Program (hereinafter: NHP). During 2015, the loan portfolio expanded dramatically from 2015 onwards. According to *Bareith – Csonka* (2019) There is an distorting effect could be the Growth Credit Program launched in 2013 and the favorable credit facilities available almost continuously to the food industry (Growth Credit Program agro-working capital loan program, agricultural investment loans, Széchenyi Card, etc.) One of the main conditions of direct bank financing the profitability of farms nevertheless without subsidies a significant part of the farms generating loss (*Bareith – Koponicsné Györke*, 2017).

Loans to agricultural sector private farms increased significantly in each year (*Figure 1*). It is noteworthy that the loan of agricultural private sector increased strongly in 2016, compared to the previous years, mainly due to the Hungarian Development Bank and - Growth Loan Program (NHP - National Bank) Land Credit Loan Program in the fourth quarter of 2016.

Along the impact of the Credit Loan Program, the low interest rates were also an incentive on credit expansion. The increase was mainly attributable to investment loans, which increased by 121 million Euro form 2016 to 2017.

Figure 1

Direct bank loan to private farms 2012-2017 (Million EUR)



Source: AKI

In 2016, the value of loans within one year remained at the lowest level in the last five years. This is probably due to the fact that short loans are increasingly maturing from in year over one year (1-3 years).

Until 2014, corporate loans in the agricultural sector were dynamically expanding over one year. Compared to the previous year, 17.0 percent. The expansion is due to forint-based loans. However, after 2015, credit expansion stopped and began to decline (*Figure 2*).

Unlike long-term loans, the value of short-term loans has been decreasing continuously since 2012, their share at the end of 2014 has not even reached 30.0 percent.

Indirect bank financing

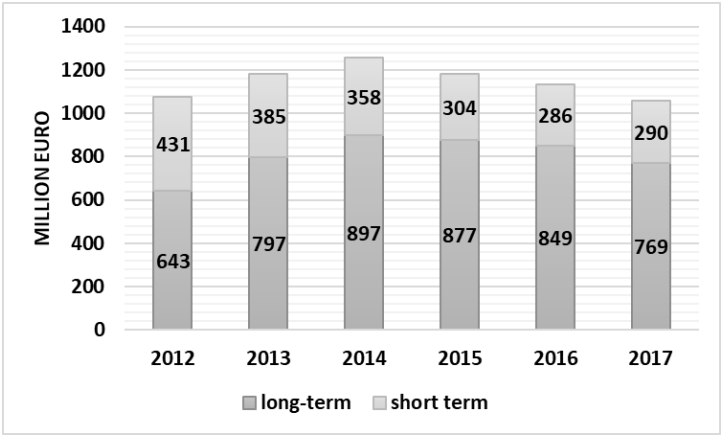
In 2012 the banking system performed 53% of the agricultural financing and in 2017 48% directly (*AKI*, 2018), that's why it's necessary to examine the indirect methods of agricultural financing besides the direct financing channels. However, it should be noted that in this question is not easy to see clearly, because the banking system is not only lending the agricultural sector directly, but also through some intermediary channels. Some of farmers are not creditable for the banking system. For them other financing channels remain: the

financing of integrators and the subordinated liabilities (member loan) play a highlighted role in the case of individual farms and the accounts payable is significant for joint ventures.

The subject of this section is therefore the analysis of the non-banking and the indirect banking channels, which mean a crucial part (about 50%) of the agricultural financing.

Figure 2

Direct bank loan: Joint ventures farms loans 2012-2017 (Million EUR)



Source: AKI

Leasing financing

The leasing constructions in the agriculture have a role in investments, within this in machine leasing. From the financing opportunities for the relatively smaller agricultural producers it is an ideal solution for their problems of getting capital. The agricultural leading is basically viable on the market of agricultural machinery, because agricultural machines have a relatively well-operating secondary market, the ownership of the machine is almost in every cases enough collateral for the lessors. In the case of any possible payment difficulties the farmer lose its production tool, but he is still in an incomparable better situation as if the credit institution enforce its right to the mortgage on the property. Another advantage of the agricultural leasing is that the leasing companies take the sector specific seasonality into consideration (*Lízingszövetség*, 2015). The leasing stock compared to the total external liabilities was 8% in 2012 and 11% in 2017. We call attention to a slightly increasing trend from 2012 to 2017 (*Figure 3*).

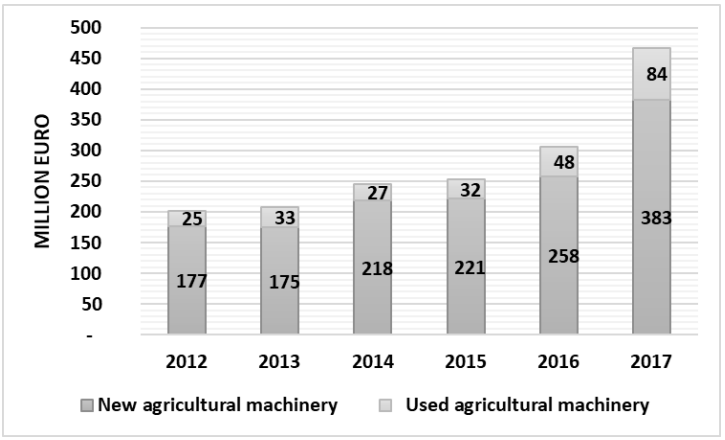
According to the Leasing Association, 2016 (*Leasing Association*, 2016) was the third year in a row that the amount of funding was gradually increased, exceeding the 2013 placements by 63 percent in the current quarter.

New agricultural machinery leasing stock increased year-on-year, continuing to represent a significant share of second-hand agricultural machinery, accounting for 84.3 percent in 2016.

Under the NHP, more than one third of the amount invested in financing investments was to finance agricultural machinery. The increase in leasing financing for agricultural machinery under the NHP underlines the success of the program.

Figure 3

The leasing-stock of agricultural enterprises



Source: AKI

Factoring

Unfortunately within the turnover of the domestic factoring houses the factoring with agricultural aims produces a marginal turnover, it was 119 million EUR in 2012.

The role of factoring shows *Figure 4* below, which contains the turnover of the Hungarian factoring houses between 2012 and 2017, within this the measure of the agricultural factoring is shown separately. Compared with 2012 in the few last year the turnover of the agricultural factoring doubled in 2017.

Factoring is basically appropriate for the circle of agricultural entrepreneurs for whom on the one hand because of their size bigger sources cannot be granted to handle their trade debtors and on the other hand they cannot meet the requirements of the banks' rigorous credit review. Both factors make factoring for an important financing tool for small enterprises.

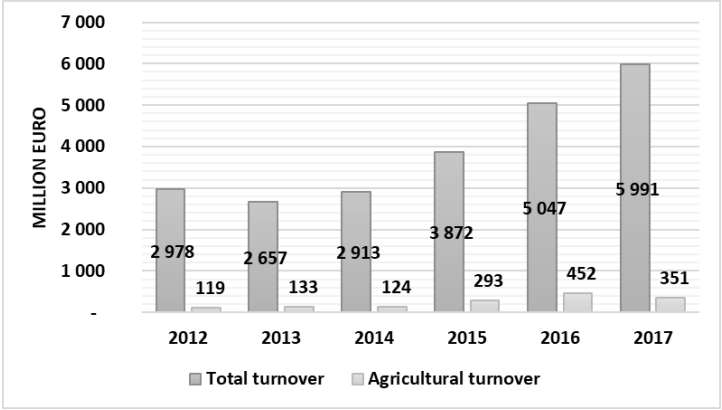
Factored gross assets doubled also in the last few year. The number of registered clients also increased spectacularly, the number of active partners increased by 57 percent to 3,332 in 2017.

The top five factoring company accounted for 91 percent of the turnover last year, with the top ten practically covering the entire market with 99 percent. The dominance of banks and providers of banking backgrounds remains strong among service providers: last year, the largest three players - OTP Bank, UniCredit Bank, CIB Bank - belong to this group Medium and large companies still account for most of the turnover, while smaller domestic companies use factoring less as a form of financing. Mainly the factoring of government subsidies and investments are significant.

To sum it up we can say that the 5-10% of agricultural factoring in 2012-2017 plays a small role in financing the agriculture.

Figure 4

The total turnover of the factoring houses in Hungary



Source: AKI

Non-bank financing methods

In our point (indirect agricultural financing) of view the following indirect financing sources can be identified:

- Accounts payable;
- Advances;
- Subordinated liabilities (member loan).

Accounts payable

The accounts payable is the unpaid amount of the purchase of goods and services. The accounts payable has reached this seize, because agricultural suppliers compete primarily with price, but they are working out longer and longer-term deferred pay schemes.

Analyzing the relevance of the accounts payable further, we can notice, that by the bigger, typically joint ventures the role of the accounts payable is more important inside all of the funding. The smaller entrepreneurs don't get supplier credit on the one hand (they can purchase only with prompt payment), on the other hand their accounts payable is smaller because they avail themselves the channel of the financing of integrators.

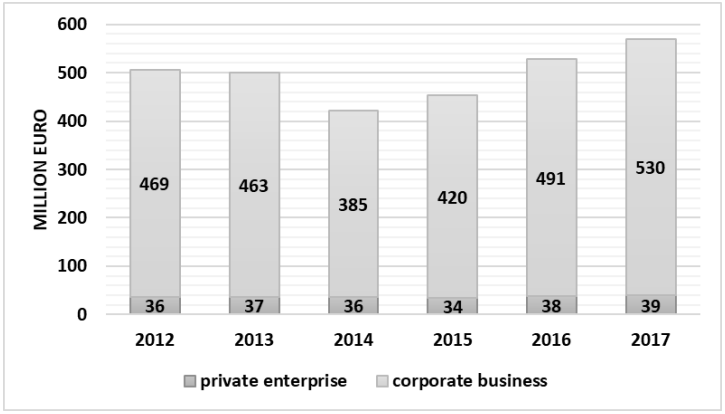
Advances

In the case of customer advances, the customer perform the payment before the product is placed in possession during the purchase. The role of advances were significant before 1990, since then because of the food industry's crisis this role is small. The financially strong retailer chains would be able to lend advances, but – because of their dominant position – the funding position is reversed: farmers finance the retail chains.

The ratio of customer advances is insignificant: in the average of the years 2012-2017 in the case of individual farms the short term liabilities are about 1%, in the case of joint ventures it is 0.5-1.7% (*Figure5*). (*AKI*, 2017)

Figure 5

Accounts payable of agricultural farms 2012-2017



Source: AKI

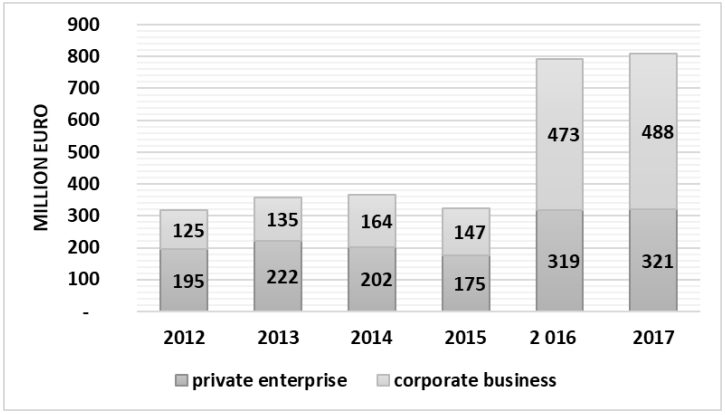
Subordinated liabilities (member loan)

The member loan is classified logically to the equity, but formally it's a liability, however it doesn't come from an external source. The subordinated liabilities and the member loan can be handled as almost the same category in the point of our topic's view, because based on the FADN data base of AKI 90-99% of the subordinated liabilities are member loans.

The subordinated liabilities (member loan) are significant items with their 13-20% of all liabilities. Especially for individual farmers it is an important financing item (*Figure 6*). (*AKI*, 2010)

Figure 6

The distribution of subordinated liabilities



Source: AKI

From *Figure 6* the same conclusion can be drawn: the subordinated liabilities are essential for micro enterprises, for the small enterprises they become important financing method, but goverment land purchase opportunity mixed up the situation is 2016. Who unable or unwilling to took bank loans in 2016 for state land sales, took member loans, even corporate businesses too.

CONCLUSIONS

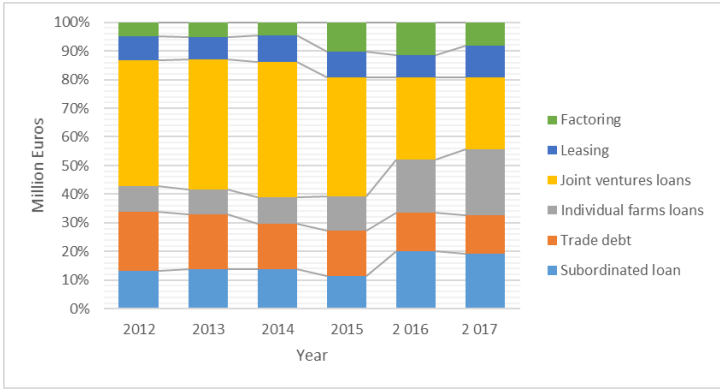
The public and private sources must be mobilized, the lending techniques must be developed and it must be achieved that the banking sector (public and private) and other financial intermediaries get involved to a greater extent into the rural development in order to reduce the financial disadvantages of the SMEs, to stimulate the productive investments and to develop the rural economy versatile.

The expansion points (compared with their weak position in the present agricultural financing) of the credit supply of Hungarian agricultural sector, which has fragmented ownership structure and management system, can be the savings cooperatives with increased, to the EU norms fitting capital stock, after a significant concentration process, because on the one hand geographically, on the other hand in mentality, based on their attitude to agricultural activity, these institutions are closest to the establishment of agricultural enterprises. This requires that they can raise their future liabilities and rationalize the operation.

For summing it up the structure of agricultural financing. From the *Figure 7* and *Figure 8* we can see, that a vast majority of financing is bank financing, however its ratio decreased from 2012 to 2017. Trade dept role decreased, but uther non conventional financing methods role increased dramaticly. Above mentioned there is a high ratio, for the leasing and factoring and especially for member loan.

Figure 7

The financing structure in percent of agriculture in 2012 and 2017 (in %)

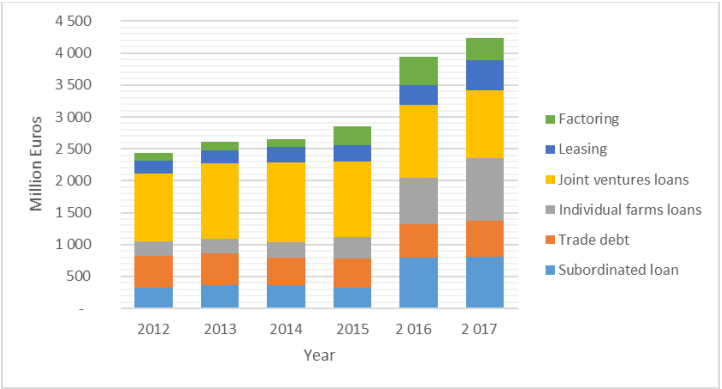


Source: AKI

The direct bank financing means the most important item of financing. The second biggest item was the trade dept, but it loses rank. Now the second biggest item is the subordinated loans. Factoring and leasing financing can be found in low annual turnover, but increasing rapidly.

Figure 8

The financing structure of agriculture in 2012 and 2017 (in million Euros)



Source: AKI

These values can be partly only estimated, overall, the main capital funders of the agriculture are in order: banks, suppliers, leasing companies and factoring companies. However, if we count the companies offering professional bank loan, we can conclude that the weight of the bank financing is much higher because financial intermediaries such as the leasing and factoring companies as well finance their customers partly from direct bank sources.

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DETERMINANTS OF GLOBAL MAIZE EXPORT: THE GRAVITY MODEL APPROACH

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ABSTRACT

The maize is one of the most important agricultural export product in world. In our globalized agriculture the main maize exporters and importers are trading increasing volume between eachother. The paper investigates the trade costs and economic characteristics in the pattern of global maize exports over the period 1996-2015. We employ standard gravity model to explain the drivers of global maize exports at the world market. In the study we use two PPML model with different fixed effects and our results show the effect economic development, distance, trade costs on the global maize market.
Keywords: agriculture, grain trading, agribusiness, maize, gravity model
JEL codes: Q11, Q13, Q17

INTRODUCTION

The world maize trade is traditionally subject for the trade intervention. The number of major players on the global market is restricted. On the export side, the exporter countries apply different promotion programs, while at the menatime importer countries use wide range of trade barriers in order to protect the domestic markets. These trading policies are playing important role in determining maize trading flows (*Koo and Karemera*,1991). Despite of the importance of maize in the global agriculture, the research on maize trade is relatively limited (e.g. *Jayasinghe et al.*, 2010; *Fertő and Szerb*, 2017). There are some studies focusing on the international grain trade (ex.: agriculture in general, wheat, rise, ect.) with special emphasis on the global players (e.g. *Sarker and Jayasinghe*, 2007; *Erdem and Nazlioglu*, 2008; *Haq et al.*, 2013). This neglection is partly understandable in light of some important features at the global maize market (*Heady*, 2011). First of all, the United States dominates the global maize market, accounting for around 60 percent of world exports, consequently trade restrictions elsewhere have less important to influence international price. On the second place, maize is also used mostly as livestock feed in much of the world (comparing to other products like rice and wheat which are tipically produced for human use) thus the demand for maize is relatively elastic; implying less sensitivity to trade shocks. Third, earlies studies confirm that rising oil prices added considerably to maize production and transportation costs (*Headey and Fan*, 2008; *Mitchell*, 2008). Last but not least, the growing use of maize to biofuels indicating large impact on the global maize market, that trade-based explanations of rising maize prices would seem less attractive.

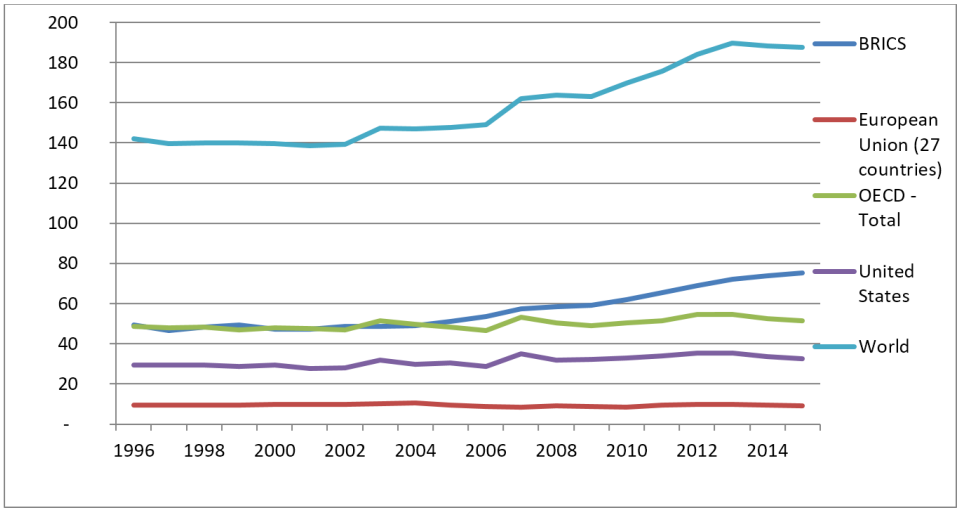
This paper tries to fill this gap investigate the determinants of trade flows in the maize exports. The aim of the paper is to analyze the impacts of trade costs in the world market in a two decades of time between 1996 and 2015. The structure of paper is following. First, we provide a brief overview on the global maize market. Next section decribes empricial methodology following by presentation of results. Final section concludes.

THE WORLD MAIZE MARKET

International maize market statistics show that the global maize area increased from 142 million hectares to over 187 million hectares in the 20-year period analized in this study, an increase of more than 31% (*Figure 1*). During the period under review, the US increased its sown area, which determines its global market, by 10% from 29 million hectares to over 32 million hectares. While the EU's maize sown area fluctuated between 8.3 million and 10.4 million, the BRICS (Brazil, Russia, India, China, South Africa) group of countries has increased its sown area by one and a half times over the past decades.

Figure 1

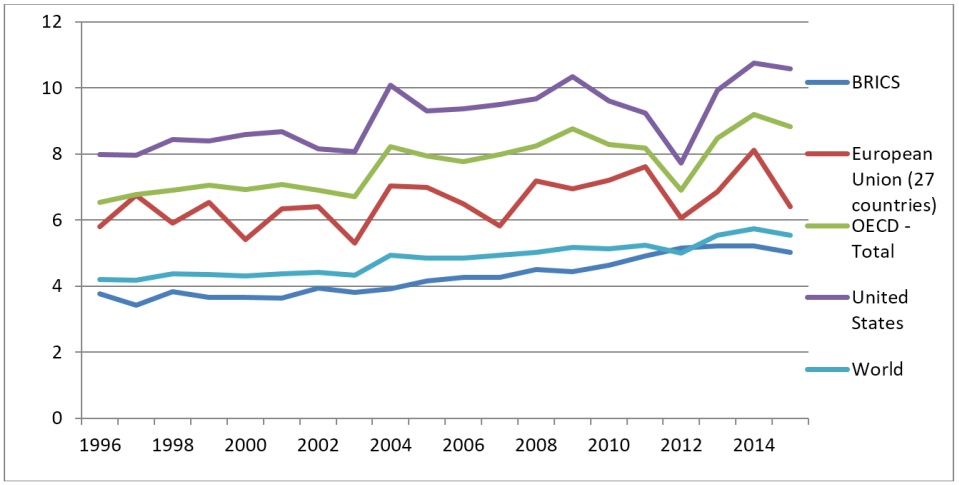
The harvested area of maize between 1996-2015 (million hectare)



In terms of global maize yields (tons / hectare), we can see an increase in averages due to the constant development of technology and more efficient use of plant protection products. While in 1996 the average yield in the world market was 4.19 tons / ha, in 2015 farmers harvested more than 30% higher average yield of 5.53 tons / ha. In terms of average yields, the US market, which dominated the world market, had the highest yields, but the highest increase in the average yield was observed for the BRICS country group over the period (*Figure 2*). It is important to mention the strong fluctuation in yields, which is mainly due to climatic changes by years, which effects the stocks available for the market.

Figure 2

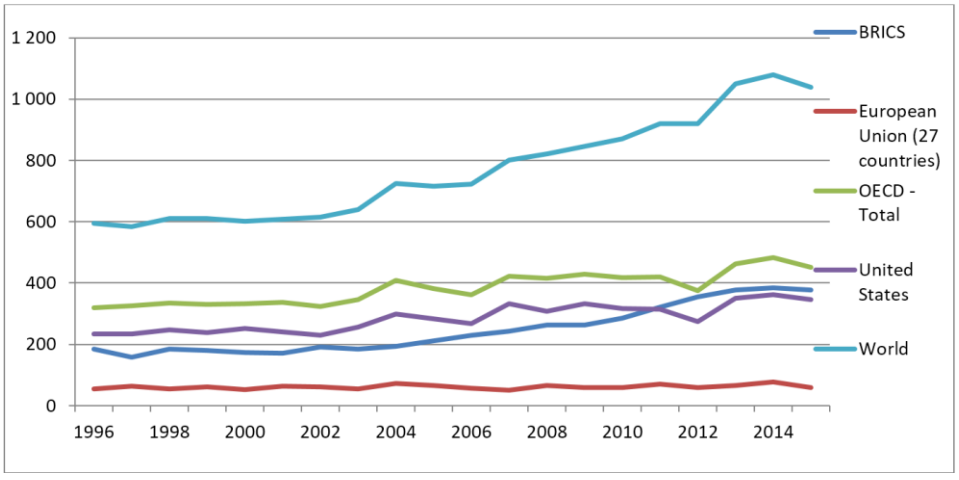
The average harveste yield/hectare of maize between 1996-2015 (tons)



Globally available stocks increased impressively between 1996 and 2015 (*Figure 3*). While global production was below 600 million tonnes at the start of the period, it has steadily exceeded 1,000 million tonnes since 2013, which is an increase of 74%, which has been paralleled by growing sown area in many regions and rising global average yields (tonnes / ha). The US continued to dominate the markets and its own stock increased by 31%, while the BRISC country group doubled its available stock in the two decades under investigation. The EU has production values between 50 and 77 million tonnes.

Figure 3

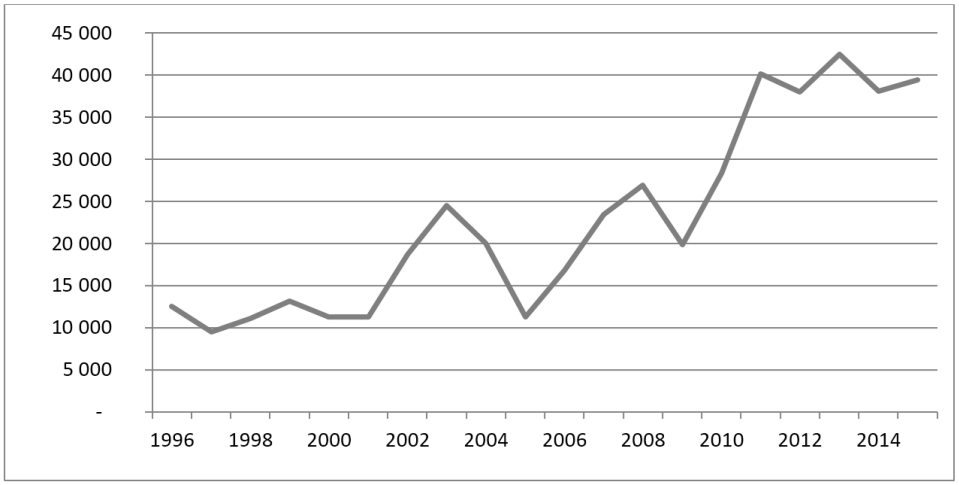
The harvested volume of maize between 1996-2015 (million tons)



The world maize market is a constantly globalizing sector. According to data from the *World Bank* (2017), significant expansion was observed over the two decades under investigation. While exports of maize barely exceeded 12,000 billion $ in 1996, the trade repeatedly exceeded 40,000 billion $ since 2011, representing a more than threefold increase in trade (*Figure 4*).

Figure 4

Global trade between 1996-2015 (billion $)



Regarding the main maize exporting countries, *Figure 5* shows that there have been significant changes in the market. In 1996, the US was almost the only one to determine what happened on export markets. Far behind were the trade flows of Argentina, France and Germany. By 2015, the emergence of new dominant players has already emerged among the top 15 countries. While US dominance has continued, Brazil, France, Argentina, Russia and Ukraine are catching up with their trading volume. In terms of the average export trade in the two decades examined, behind the US, and besides Argentina and France, which continued to produce high volumes all over the period, Brazil and Ukraine were the most important among the top 5 countries. However, CEE countries with significantly smaller sown areas, such as Hungary, Austria or Romania, can be observed among the top 15 countries.

The market concentration of maize export betwee 1996 and 2015 is visible on *Figure 6*. The herfindahl index shows the first decade the geographical concentration of maize export has been much higher than at the end of the period. The geographical concentration has decreased with higher export value in the second half of the period.

Figure 5

The world top 15 maize exporters (thousand $)

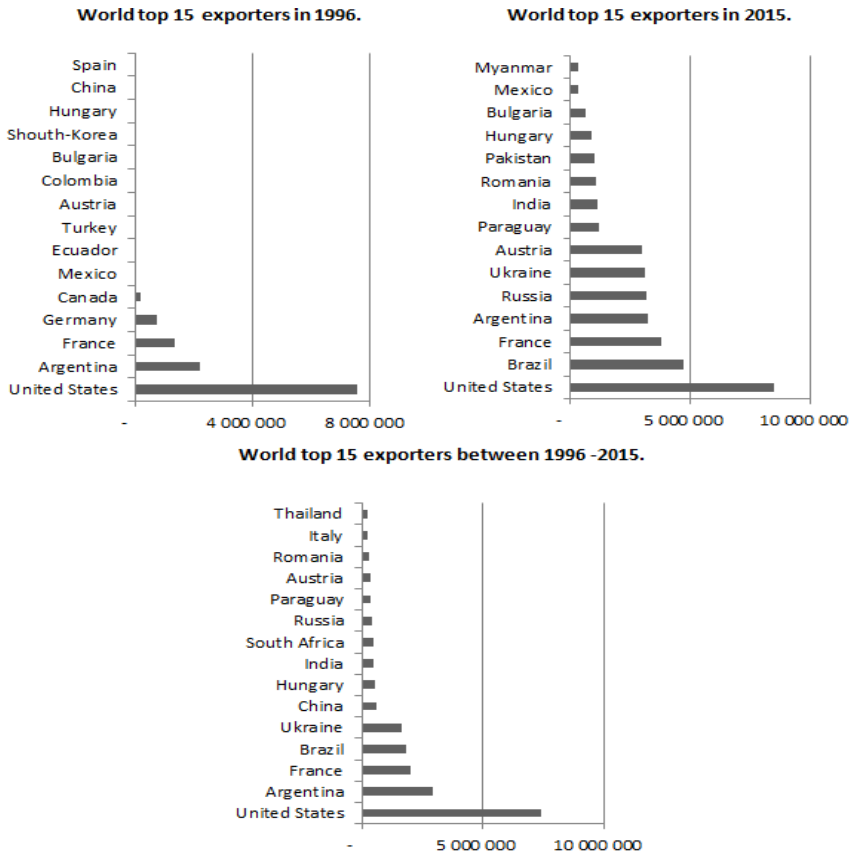
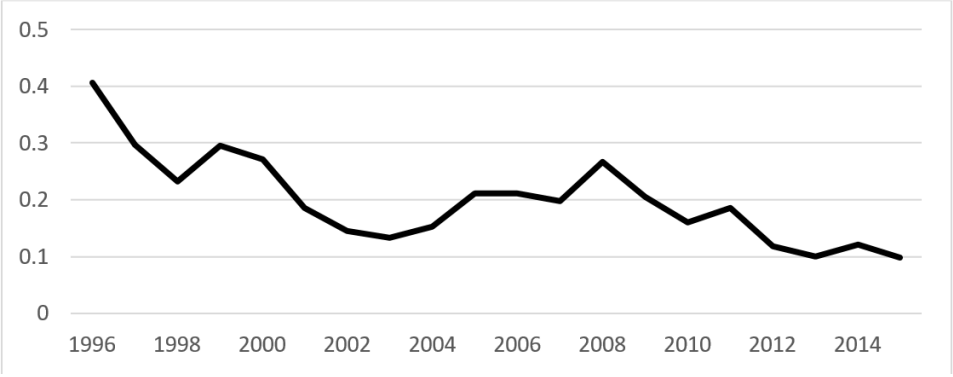


Figure 6

Herfindahl-Hirsch index



MATERIAL AND METHODS

Following the international trade literature the gravity model has became as a standard toolkits in empirical agricultural trade analysis highlihgting some special features of agricultural trade. According to *Ghazalian* (2015) the effect of distance on trade reveal significant differences in countries belonging to different economic and geo-economic groups. For example in case of European countries' trade, the magnitude effect of distance is higher than in case of North American countries'. In addition, he reveals that the magnitude effect of trade of landlocked countries was considerably higher than in case of coastal countries. Next to geographical distance, various study examines the potential effects of the different trade policies on the agricultural and agro-food trade in the different regions. According to *WTO* (2017) the number of regional trade agreements (RTA) is currently over 430 which is granting preferential access to trade of a certain countries. There is an increasing research to evaluate the impact of RTAs on the agricultural trade. *Koo et al*, (2006) highlight that RTAs induce an increase of traded volume generally among the members, but do not necessarily cause trade diversion. *Ghazalian et al.* (2011) find that the tariff preferences have more significant effect on the EU's intraregional trade creation than to the nontariff prferences. *Serrano and Pinilla* (2012) emphasise that the role of RTAs' is the EU exert much bigger effect on the agricultural products than in case of others.

We focus on the the trade costs, the culutral differences and the role of RTA on the world maize export employing the gravity framework. More specifically, we concentrate on the period 1996-2015, using export data from the UN Comtrade database with the World Integrated Trade Solution (WITS) software developed by the *World Bank* (2017a), in close collaboration and consultation with various international organisations including United Nations Conference on Trade and Development (UNCTAD), International Trade Center (ITC), United Nations Statistical Division (UNSD) and WTO is used. The distance (*DS*) between the BRIC and importing bilateral countries is obtained from the CEPII database (*Mayer and Zignago*, 2006).

We aim to investigate determinants of the world maize exports developments using structural gravity trade model and advance econometric panel data analysis. The baseline econometric model explanation starts from traditional gravity theory, which points out that bilateral trade between countries is positively associated with their national economic sizes (incomes) and negatively associated with their geographical distance (e.g. *Anderson*, 1979; *Frankel and Rose*, 2002; *Anderson and van Wincoop*, 2003; *Bojnec and Fertő*, 2010). According to *Yotov et al.* (2017) we used the following ppml model in our paper:

$$lnX_{ij,t} = \exp\left[\pi_{i,t} + \chi_{j,t} + \beta_1 lnDIST_{ij} + \beta_2 CNTG_{ij} + \beta_3 LANG_{ij} + \beta_4 CLNY_{ij} + \beta_5 RTA_{ij,t}\right] \times \varepsilon_{ij,t} \quad (1)$$

In the model the *Distance (DIST)* and the *Contingency (CNTG)* are the most widely used and robust gravity proxies in case of trade costs (*Yotov et al.*, 2017). Distance means the physical distance between national capitals for country pairs. Contigency is an indicator variable which shows the common borders between the countries. The *Common language (LANG)* and the *Colonial relationship (CLNY)* are dummy variables that have the value of one for common official language and presence of colonial ties between the countries. *Regiononal Trade Agreement (RTA)* is also a dummy variable which shows the presence of a

trading policy agreement between the trading partners. In our case WTO membership was under investigation as an RTA variable.

Following *Anderson and Yotov* (2016), the gravity specification is re-estimated by expanding the sample to include *intra-national* trade flows data in addition to *international* trade flows in our ppml-intra model. The idea is that RTAs may be diverting trade from domestic to inter- national sales and, therefore, the estimates of the variable *RTA* that are based on *international* trade only may be biased downward. The most comprehensive gravity specification considered for the purpose of this application is modified to include country-specific fixed effects for intra-national trade (μ_{ii}):

$$lnX_{ij,t} = \exp\left[\mu_{ii} + \pi_{i,t} + \chi_{j,t} + \sum_{T=1996}^{2015} \beta_T \, lnDIST\_T_{ij} + \beta_2 CNTG_{ij} + \beta_3 LANG_{ij} + \beta_4 CLNY_{ij} + \beta_5 RTA_{ij,t}\right] \times \varepsilon_{ij,t} \quad (2)$$

The country-specific fixed effects μ_{ii} are defined as dummy variables taking the value of one for intra-national trade and zero otherwise. the fixed effects μ_{ii} control for country-specific intra-national trade costs and "home-bias" effects, as well as any other country-specific time-invariant characteristics that may drive a wedge between internal and international trade.

A failure to address the potential endogeneity of RTAs may bias the gravity estimates. According to *Baier and Bergstrand* (2007), the gravity specification is modified to include pair fixed effects (μij) in addition to the theoretically-motivated importer-time and exporter-time fixed effects (pairfe modell):

$$lnX_{ij,t} = \exp\left[\pi_{i,t} + \chi_{j,t} + \mu_{ij} + \beta_5 RTA_{ij,t}\right] \times \varepsilon_{ij,t} \quad (3)$$

Because of perfect collinearity, using pair fixed effects (μ_{ij}) does not allow to include in the model, and therefore estimate, any of the standard gravity variables that do not vary over time (distance, contiguity, common language and colonial ties). Additionally, one of the bilateral fixed effects has to be dropped from the model specification.

RESULTS AND DISCUSSION

The baseline econometric model specification shows that the maize trade flows are negatively associated with the *Distance* between the countries (*Table 1*) in case of both models. These results are consistent with the gravity theory model. Coefficient of *Contigency* is significantly positive in the models. From the cultural dummies we applied the *Common language* and the *Colonial relationship* dummies. Common language has a positive but insignificant coefficient in the models. The colony dummy shows negative and significant result. From the free trade agreements, we applied the *WTO membership* dummy in our models which show significantly positive result.

As reported in column "ppml_intra model" of Table 1, the estimates of the standard gravity variables based on the sample with international and intra-national trade are statistically not different from the corresponding estimated parameters based on the sample with international trade only and listed in column "ppml model". This result means that RTA is not diverting trade from domestic to inter- national sales and, therefore, the estimates of the variable RTA that are based on international trade only are not biased downward.

Table 1

Estimation results

Variable	ppml model	ppml-intra model	pairfe
Distance (DIST)	-0.925**	-0.925**	
Contigency (CNTG)	0.715**	0.713**	
Common language (CLNG)	0.367	0.359	
Colonial relationship (CLNY)	-1.055***	-1.051***	
WTO membership (RTA)	1.163***	1.168***	0.097
Observations	76441	76722	75574
R^2	0.594	0.594	0.941
Exporter fixed effect	yes	yes	yes
Importer fixed effect	yes	yes	yes
Year fixed effect	yes	yes	yes

Note: ****, **, * denote significance at 1%, 5% and 10% level*

In our third model ("pairfe") including pair fixed effects, the variable RTA is not significant, reflecting the fact that the pair fixed effects absorb the impact of free trade agreement on the maize export. The not significant RTA coefficient in this model is in accordance with *Baier and Bergstrand's* (2007) predictions that the estimates of# the RTAs impact on trade obtained without proper account for endogeneity are biased downward.

CONCLUSIONS

The paper investigates the determinants of the world maize exports over the period 1996-2015. We employ sturctural gravity model to explain the drivers of maize export flows at the global market. The global maize exports has increased over the examined period with strong fluctuation between 2003 and 2010. Our results show that the geographical distance has a negative influence on the trade flows while the common border between the trading partners are positively effecting the maize export which results are consistent with our expectation and earlier studies. The membership a free trade agreement (WTO) has also a positive influence on the global maize export.

ACKNOWLEDGEMENT

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Searching for Management and Leadership Excellence in Age of Sustainability

CSR LEADERSHIP

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ABSTRACT

Sustainability, Leadership and CSR, are the major subjects of now days Businesses, they are combined together in system and values, to cohere at the end in the world of Sustainable polices implementation. Leadership serves the Social Responsible goals and Sustainable Environmental strategies. In this article we will talk about the CSR Leadership, its concept, Characteristics, and values, steps for implementing it, and the reasons why CSR needs good Leadership.
Keywords: CSR, Sustainability, Leadership, CSR Leadership.

INTRODUCTION

The fundamental challenge facing business in the 21st century will be meeting the needs of consumers and shareholders, in a way that balances economic, environment, and social requirements. Companies must behave differently in the next century, and will require new leadership (*Defee, Esper, and Mollenkopf*, 2009).

In the world of Sustainability and CSR, Leadership is the key for attaining social and environmental welfare, where leaders play an essential role of setting the organizations goals and strategies in order to change business practices from maximizing economic gains and enlarging profits towards sustainable future. On the other hand, CSR becomes an important business performance indicator for organizations, that changes the mangers views towards society and environment, more over it changes their attitudes and priorities.

Analyzing the intersection of leadership and CSR is difficult because both CSR and leadership are broad, very complex and hard to define concepts (*Strand*, 2011). *Bass* in 1990 has viewed this intersection that "there are about as many different definitions of leadership as there are persons who have attempted to define the concept". On the other hand, *Matten and Moon* noticed the CSR phenomenon that "defining CSR is not easy" (2008).

Leadership mission works to achieve CSR and Sustainable targets," It always takes an active individual that is both a good leader and a good manager to transform a company into a sustainable and socially responsible enterprise (*Szekely and Knirsch*, 2005).

1. What is the nature of CSR Leadership?
2. How to implement CSR Leadership?
3. Why CSR does require Leadership?
4. How Does CSR and Leadership intersect?

METHODOLOGY

Thinking of a philosophy in terms of it being better or worse than others is a trap to avoid. It is rather a question of a philosophy being suitable or not to provide answers to the

research questions (*Saunders et al.*, 2012). Where Knowledge is the key for research development and it reflects the philosophies of topics.

Qualitative data provides a deeper understanding of social phenomena than quantitative does (*Silverman*, 2000). Thus, the data type used in this study is of qualitative nature. Moreover, since leadership is extremely sensitive to context and qualitative research has made a distinctive contribution to leadership studies in this sense (*Bryman and Stephens*, 1996). The secondary data is collected through relevant video debates, books, journals, articles, emails, companies' annual reports, blogs and websites all related to the CSR and Leadership topics.

LITERATURE REVIEW

CSR vary in Definition 2004 - 2008

Many concepts arises talking about CSR , where it differs from a country to another and from a culture to another, thus it is hard to have one definition as moon states " The concept of CSR varies in terms of its underlying meanings and the issues to which it is addressed across the world (*Matten and Moon*, 2008)". Moreover, *Gobbels and Schwartz* in 2002 talks about this terminology "All-embracing definition of CSR and subsequent diversity and overlap in terminology, definitions and conceptual models hampers academic debate and ongoing research" (*Gobbels*, 2002, as cited in *Schwartz*, 2008, p. 151). It is, therefore, a difficult concept to pin down (*Moon*, 2004, in *Broomhill*, 2007).

According to *COM* (2011), he viewed CSR: "A process of Companies integration in social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis". Where CSR in many countries cross the concept of being voluntary and starts being a part of legal requirement obliged by laws, Indian country is a good example concerning this issue.

CSR Schools 2007:

Bromhill in his studies had classifies CSR in three main schools: the neoliberal, neo-Keynesian, and the radical political economy (*Broomhill*, 2007). Each of these schools has its own way of defining CSR. For instance the neoliberals see it as the adoption of a set of voluntary policies, codes or guidelines, initiated and driven by the corporation (*Broomhill*, 2007). While the neo-Keynesian school gives a big role for the stakeholders and their essential role in Society. The last School, the radical one that rejects the voluntary approach to CSR and advocate an alternative strategy described as "corporate accountability" that deals with human rights, labor rights, and the environments, it means holding corporations accountable and responsible for the social and environmental impacts of their decisions and practices (*Broomhill*, 2007).

Heterogeneous system CSR, Leadership, Sustainability

Houston's (2001) opinion the real world is composed by heterogeneous systems that comprise of different mechanisms. Instead of arguing that the interaction between these different mechanisms produces a predictable outcome, it is more useful to try to understand and explain the tendencies produced by them (*Houston*, 2001). CSR, Leadership, Sustainability intersect and differ in concept and implementation, and it is very hard to explain those systems how do they work and communicate may be because world is changing, or either people, also *Houston* states that "People transform and are being transformed by their social world rather

than just being "at the mercy" of certain mechanisms. Different researches played a role in trying to understand those systems and the changing process. *Saunders et al* in 2012 talks about the social world changes and this is very much in line with the purpose of business and management research, which is to understand why certain phenomena occur in order to recommend change.

Intersection between CSR and Leadership

Leadership and CSR combine in targets, but differ in mechanism and values. CSR is a part of good Leadership Umbrella, leadership as *Van Velsor* in 2009 notably points out: "There is obviously already a wealth of literature on leadership, and there is a good deal of literature, both conceptual and research-based, on corporate social responsibility, but we know relatively less about the intersection of the two". In today´s society there is a growing interest for corporate leaders who demonstrate both leadership that goes beyond preventing their corporations from front page scandals (*Strand*, 2011) and also a commitment to CSR through "actions that appear to further some social good, beyond the interests of the firm and that which is required by law" (*McWilliams and Siegel*, 2001, in *Strand*, 2011). Moreover, in many systems leadership is being an essential key factor for CSR in side companies where it guards the commitment of managements and develops a system of incentives to reward leaders and courage them , who develop and push for the adoption of sustainability practices at all levels (*Szekely and Knirsch*, 2005).

Burns in 2003 talked about the leadership and CSR, and the type of relation bonded both of them, and how much CSR need leadership: "The key distinctive role of leadership at the outset is that leaders take the initiative. They address their creative insights to potential followers, seize their attention, and spark further interaction. The first act is decisive because it breaks up a static situation and establishes a relationship. It is, in every sense, a creative act". Some mangers deal with CSR as a strategic decision or choice as *Waldman* states in 2008, but there is other view made by Basu and Palazzo in 2008 "Decisions regarding CSR activities are made by managers and stem from their mental models regarding their sense of who they are in the world" (*Basu and Palazzo*, 2008) and from "their own perceptions of what they think is important or their own moral values" (*Waldman*, 2008).

DISCUSSION

Nature of CSR Leadership

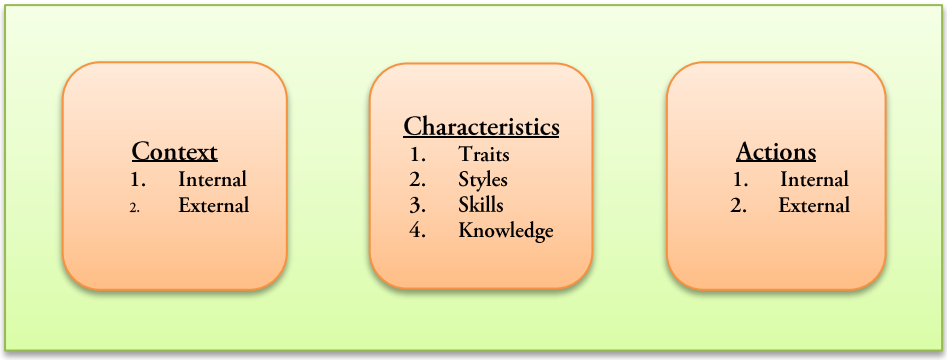
If we want to simplify the meaning of CSR Leadership in two words it is the "Good Leadership "as *Strand* stated in 2011, moreover *Visser* wrote about this theory that it is s a mix of individual leadership characteristics applied within a specific context, he also differentiate the different types of Leadership: "CSR leadership is not a separate school of leadership, but rather a particular blend of individual leadership characteristics applied within a definitive context. On the other hand, he analyzed the importance of actions in CSR leadership "A CSR leader is someone who inspires and supports action towards a better world", moreover *Visser* (2011) proposes three basic elements for this kind of Leadership (*Figure 1*).

In the Context of external and internal actions, *Visser* talked about the matters related to social welfare actions, also about the education and health care, moreover the actions

affecting the climate change and environment. In the characteristic Umbrella it contains the CSR Leader needed values as the emotional intelligence and caring attitude, value orientation that shapes culture, compelling vision for making a difference, inclusive style that engenders trust, innovative approach, and long term perspective. He states that those characteristics resulted from the interaction between the individual leaders' characteristics and the social, environmental and economic context of the organization, and can only be seen and judged by the actions that leaders take (*Visser*, 2011).

Figure 1

CSR Leadership



Source: *Visser*, 2011

CSR implementation and Constraints

Many countries have witnessed a successful CSR approach, while others are still trying. This was one of the reasons why CSR starts changing towards a voluntary concept. India experienced this concept: "At a time when most of the world has moved beyond defensive and philanthropic modes of CSR, toward promotional, strategic and transformative approaches, India's policy virtually guarantees that's its companies will remain stuck in an out-dated charitable mind set (*Visser*, 2013)".

CSR in the social fragment tries to solve many serious issues as poverty and human rights, but it requires too the cooperation of community itself and the citizens, without their help it will be hard problem to solve. As *Grint* (2010) said "you cannot force people to follow you in addressing a wicked problem because the nature of the problem demands that followers want to help" (p. 20). Cooperation represents a better approach to solving wicked problems related to CSR (*Strand*, 2013). In the same view, companies are encouraged to engage in partnerships with nongovernmental and governmental organizations to address social and environmental problems that require specific competences, which companies do not possess (*Strand*, 2013). More over *Heenan and Bennis* in 1999 has mentioned the importance of collaboration between leader and society and also with the help of community and government and nongovernmental organizations "The shrewd leaders of the future are those who recognize the significance of creating alliances with others whose fates are correlated with

their own (*Heenan and Bennis*, 1999)". Also with the help of people themselves, When people are actively involved in problem solving and action planning they show a greater commitment in implementing the proposed solutions (*Rada*, 1999, in *Kellerman and Webster*, 2001).

CSR implementations in Companies depend on CEO and manager's strategic decisions and financial resources of the company. On the other hand, it touches their ethical thinking and social values, as *Friedman* in 1980 points out that "only human kindness, not the much stronger and more dependable spur of self-interest, assures that they will spend the money in the way most beneficial to the recipients". Regardless those issues , many factors encourage and constrain the CSR implications, on the positive side many stakeholders are moving towards society and environment, more over many funds are flowing towards CSR, and as we noticed now days there is a great awareness towards Social and Environmental matters. On the Negative sides, focusing on gaining profits, Bureaucracy, corruption, creativity and innovation barriers, companies' role and goal far away from CSR, all those reasons limits CSR implementation.

On the other hand, the Leadership types effect the CSR practice and oblige leaders to be committed and act effectively towards society as *Guthey and Jackson* observed in 2011:" Charismatic leadership, servant leadership, quiet leadership, all of these approaches involve in some way or another the notion of taking initiative, inspiring commitment, mobilizing action, promoting legitimacy, or exerting influence". Although that there are many constraints that forbid leadership implementation as laws and regulations and systems.

Steps For Implementing CSR Leadership

Grint in 2005 has identified four lines in defining Leadership namely:

1. Leadership as position – where leaders operate that makes them leaders?
2. Leadership as person – who leaders are that makes them leaders?
3. Leadership as result – what leaders achieve that makes them leaders?
4. Leadership as process – how leaders get things done that makes them leaders?

CSR leadership combines and differs, and for CSR there are many suitable traits leadership in order to implement it. CSR focus on the "how" question in order to explain the relation between them, leadership tackles corporate social responsibility issues and how certain companies become leaders in this field. The way corporations define leadership helps us understand how they work or fail, who is to reward or to punish (*Grint*, 2010).

There are many procedures in order to practice CSR Leadership, starting with asking questions and caring enough (*Strand*, 2013), this step helps in bridging the gap between organizations and stakeholders by becoming aware of the impact and potential impact corporations have on the outside world (Strand, 2011). Asking questions helps in reducing distance, and more over companies are able to set out a list of demands when asking about their products and to know about the society real needs.

On the Second step for CSR Leadership is to raise the awareness of stakeholders focusing on the advantages of CSR and once matters are obvious and demand is clarified here leadership starts taking role of "Change agent", with the help of effective communication. Communicating the CSR issue to different parties is what helps raising awareness. Thus, communication becomes the most important tool of leadership in addressing CSR (*Strand*, 2013).

On the Third step, the task of leadership in this case is to engage with uncertainty and develop possible answers (*Strand*, 2013). As *Strand* (2013) points it out engaging with uncertainty requires humility to recognize that one does not possess all possible answers to a CSR problem. Hence, CSR is a wicked problem and its solution needs a wise solution, and may be this solution will not solve the problem, with the help and cooperation with Stakeholders, Once CSR issue is well understood and being transparent and obvious to companies, all will be practice it well.

On the Fourth step, the leadership mission is determining the appropriate mix of hard and soft power for the mobilization of support inside corporations. Hard power comprises both inducements and threats, while soft power relies on the ability to obtain certain outcomes by shaping the preferences of others without using threats or payment (*Strand*, 2013). While soft power is earned through an effective framing of the CSR issues at hand, hard power is connected with management positions. The higher one's position in the hierarchy the greater the level of hard power (*Strand*, 2013).

The final step, in order to practice CSR Leadership is actually a continuous process of engaging with the CSR issue. Social and environmental problems evolve over time and the previous steps have to be repeated on a continuous basis (*Strand*, 2013).

CSR requires Leadership

Leaders who integrate and promote ethics in their organizations and who are aware of their possible impact on influencing followers' behavior in this sense are very likely to ensure an ethical organizational culture (*Lager*, 2010), where leaders are the most influencer a good CSR company Culture, that is translated in their vision and mission. Leaders introduce values and a culture that support innovation, service, quality and caring for all stakeholders (*Peters and Waterman*, 1982). Moreover, leadership relates to direction setting, novelty, change, movement and persuasion (*Grint*, 2005).

Concerning the CSR Values, it is related to the person itself, where the CSR leadership refers to the good leader values. Every person must start being a good leader in his home and company and university, if you have good values you can be a good leader. So how can you be good leaders if you do not have values? You are not integrated, it´s all about your engagement, your commitment, it comes from within. (*NEF Representative*, 2012)

Our vision says that we must make a qualitative difference to the lives of the underprivileged in proximity to our plants (*Pragniya Ram*, 2013), you require a leader who can actually propagate this vision across the organization so that every employee thinks like that. CSR Leadership requires having a good vision in order to care about the society and environment and put a strategic plans concerning this issue, and do business responsibly from inside the company to outside, to care about employers and their rights and salaries rather than gaining more and more profit this is the CSR leader.

Sophie Desvaux de Marigny – CSR Manager at Medine Ltd. in 2012, has also talks about the CSR Leadership and about the sense making value that every leader must have, "I think it takes a deep knowledge of what it is to be a good corporate citizen, of (…) small initiatives, quick wins that you can start and to take on colleagues and the overall management of a company, to explain to people that giving money, making donations to NGOs, starting projects to benefit the society, projects that are not directly linked to making profits, can

actually help making profits in the long term. So it takes leadership to explain this because this [CSR] is a new concept, it was a new concept back then, now is becoming a tax so people won't think twice about it". (*Sophie Desvaux de Marigny*, 2012). As mentioned in her studies that it is hard to put a plan concerning society inside companies and it is hard to be committed to this plan, it is hard to convince employers rather than community, so this task needs an affirmative leader who really cares about social and environmental problems.

Related to direct actions and fast one, companies has to make her own CSR programs and launch them it will be more effective than being forced by outside organizations and obliged by them. When some people saw CSR as an intruder from outside the company, and something people are obliged to do and act as if it is imposed on them, it will most probably generate a negative attitude towards it and corporate actors might try to find ways of disguising their CSR expenditure in a way to best suit their business interests. "Before the CSR tax if we saw a problem in one region, Bambous for example, were there would be no NGOs working on this specific problem we would ourselves start something to initiate an action to resolve this problem. Now we can´t do it. We have to give the money to an NGO or we have to have a project validated with the National CSR Committee which makes things almost impossible so no, we just resolve ourselves to make contributions and follow the guidelines". (*Sophie Desvaux de Marigny*, 2012).

CSR needed a good leadership and specific type of leadership in order to be implemented in companies, "Leadership would mean that you have first the freedom to be creative, to find solutions and to share this creativity, these ideas with others and create a momentum that many foundations for instance or many NGOs would take on this destination trip together and is the ability to set the example as well and share good practices for them to lead. But I am not sure the term of leadership is the correct one in a tax context". (*Sophie*, 2012).

CSR Leadership Characteristics:

1. Be Authentic – Act as CSR leader, talk about CSR in all company levels, Commit for CSR activities, be a CSR Volunteer, lead by example, lead by acknowledging publicly, be a real CSR leader.

2. Learn to say No –Many social problems handle in our society as hunger and poverty, but as CSR leader and with the limited company funds, we must focus on one problem and try to find solution for it rather on focusing on many folders on the same time without solution for the long term**.**

3. Build Responsible Culture – Not Charity: Build a social responsible culture from the first year in your company rather than waiting year after year in order to start or to gain many profits, this helps in building CSR culture inside the company and set up a five year sustainable plan, "Think Sustainable – Act Responsible."

4. Rewire and Reinvent: I have to have creative ideas regarding CSR with the help of Information and technology and invite the kids and schools for company CSR programs, in order to encourage them.

5. it's Everyone's job – A true CSR company is a company that all its family Members understand CSR commitment and targets, moreover they have a sense of social and

environmental responsibility. Thus, this commitment attracts more and more customers from outside.

6. Run it like a business function – don't look at CSR as a philanthropy issue, but do it as a business function. For CSR to be sustainable, we should communicate how it is good for the business and the community.

7. Communicate to Motivate- And finally, always communicate and motivate: Sound CSR practices are also about making a sound, resonating, driving dialogue and conversations to deliver return –in terms of social progress, the bottom line (profit) and brand perception.(Brillo, lessons for CSR leadership).

CONCLUSION

Ghandi conveyed this wisdom in the following words: "Be the change you wish to see in the world". Leaders must launch their own CSR projects that fit more their capabilities and social needs and their funds, where it will be more successful and creative and flexible. Companies must have an organized management system and departments in order to adapt a CSR program and help it to work, as technology, management skills, IT, research and development issues. Money and charity is not the only instrument for doing corporate social responsibility. So to mandate, to mandate a 2% CSR on the basis of the money that is being set aside is the wrong way of approaching this whole concept of CSR. (*Vikram Singh Mehta*, 2013)

CSR Leadership is the good leader; it requires a specific leader characteristics, attitudes, vision, mission, actions, funds, courage, moreover the help of NGO'S and government and citizens them self. As NEF states "We are now calling for a triangular partnership between the social sector, the private sector and government. So private sector has the money, the government is here to put all the mechanism and facilitator, put the rules and the regulations, the CSR guidelines and all this, and then the civil society has the resources to implement programs towards poverty alleviation and all this" (*NEF Representative*, 2012)

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LEADERSHIP MODELS AND LEADERSHIP STYLES AS SUCCESS FACTORS IN SMALL AND MEDIUM-SIZED ENTERPRISES

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ABSTRACT

The present paper investigates the challenges companies in the field of trade and craft face when it comes to leadership and people management. These challenges are described and discussed in the light of scientific literature stemming mostly from other branches, which implies the main research gap addressed by this work. Following an empirical approach based on expert interviews the main leadership challenges were derived. Experts agreed that companies in this field struggle with the war for talent and are facing new challenges as a younger generation of employees pushes into the market. These employees demand a more transformational leadership approach than the currently more transactional one found in most companies in this field. This, the experts further agree on, is mostly due to the promotion of highly-skilled technical specialists into leadership positions. These positions, thus, are often not filled with those most fitted for leadership-jobs but with those who earned it the most by being excellent workers.

INTRODUCTION

Craft and trade enterprises are facing challenges that are barely addressed by management and leadership literature. Not unlike their non-crafts counterparts they face the challenges of digital transformation and its consequences on society (*Bonfour*, 2016) as well as demographic change (*Bieling, Stock & Dorozalla*, 2015). The *war for talent* (*Ulrich*, 2015) as it was coined mostly for the field of IT seems just as relevant for crafts, as *Hogeforster* (2001) points out: There is a considerably lack of skilled employees in German trade and craft, a development that is growing stronger in recent years..

Among the reactions to these mega-trends (*Marin & Verdier*, 2012) are often discussed developments on the company side like transformational leadership (*Bass*, 1997) or sustainable HR management. Both these approaches try to introduce more modern and thus more adequate leadership and management in companies. This is not only a reaction to the general search for highly skilled workers but also to their raising and changing requirements and demands. Authors such as *Klaffke* (2014) point out that for the new generation of employees, the pay alone is not enough to be a motivational factor anymore. *Rather, Klaffke* (2014) identified a number of value clusters that influence young employee's wellbeing and motivation in the worksetting: „Affiliation and Authenticity", „Transparency and Networking", „Performance", „Meaningfulness", „Development" and „Enjoyment" (*Klaffke*, 2014, p. 64). In order to motivate and attract young employees, companies have to react to these changing developments and adapt not only their leadership but also their HR management.

Examples how modern management reacts to these requirements are given by *Bhattacharya, Sen and Korschun* (2008). On the example of modern IT companies the authors

explain the usage of transformational management methods which try to combine the vision and goals of the company with the requirements given by the employees. Socially responsible behavior of the company is described as important asset in the war for talent – it makes the company more attractive to highly skilled employees, thus playing into the company's emploryer branding and also minimizes turnover. Summarizing, authors such as *Noe, Hollenbeck, Gerhart and Wright* (2017) describe that companies who make use of such approaches in their HR management gain a strategic advantage over other companies and will in a long-term be the succeeding ones.

At the same time, these managament approaches – while apparently useful in all fields (*Ferris, Russ, Albanese & Marlocchio*, 1990) – seem not to be implemented everywhere with the same success. *Brandenburg, Haas and Byrom* (2006) argue that the construction industry, not unlike many industries in the field of crafts – are not "as diligent in imple-menting strategic HRM programs as other industries" (p. 89). In general the authors complain that in this industry barely any formal HRM programs or leadership approaches exist, workforce planning and identification of key talents are not yet fully considered to be important tasks of managers and leaders in this field. The results of their empirical evaluation however proves that modern HRM approaches would be beneficial also in this field in which big parts of the workforce are less formally educated but still highly-skilled: „The construction industry has experienced a shortage of skilled craft workers and will continue to experience the shortage unless revolutionary methods are put in place to address the problem" (*Brandenburg, Haas & Byrom*, 2006, p. 94).

In a similar vein, *Behrens* (2001) describes the problematic situation of crafts in Germany – while young employees are hard to motivate for employement in this field, the aging society provides a new challenge for companies in this field. Unlike typical office jobs, with growing age many tasks become harder or even impossible for employees, thus effectively limiting the staff availability even further – not only seems there to be a lack of young employees but also the older ones cannot fully perform for as long as in other fields. This, *Behrens* (2001) argues it not only due to physical limitations of the employees but also a result of discouraging management – older employees in crafts are often viewed as more fragile than they feel themselves, thus further contributing to the problem.

The selection of these results opens up the research gap of this paper. While the bulk of management literature agrees that management or leadership style strongly impacts employees motivation and well-being and thus, subsequently company performance, much less is known about the challanges that hinder sustainable and transformational leadership in small and medium enterprises in the field of crafts. These companies however seem to be in dire need of workforce and talents as well as other fields, while lacking partially the resources to attract and manage them. The leading research question of this work, thus, is: With which leadership styles can managers in this field react to the changing and growing challenges?

MATERIAL AND METHODS

An empirical study based on expert interviews was conducted to answer this research question. In order to obtain many different points of view and thus be able to answer the research question comprehensively, the experts of this study were recruited from six different groups: business executives, heads of consultancies, university and continuing education

institutions, and heads of the Chamber of Commerce and Industry. The survey took the form of a guided interview. In order to increase the participation of the study participants, each prospective participant was personally asked in advance of the study if they would be willing to participate in the study. The concept of a personal address in advance was very successful, all the experts mentioned agreed.

Furthermore, each respondent received an e-mail with the interview questions on „Leadership Styles and Methods of Human Resource Management in SMEs". This ensured that all experts had a common understanding of leadership and, above all, of the aspects of interest in this work. Analysis was conducted following the method proposed by *Mayring* (1988).

RESULTS AND DISCUSSION

All interviewees confirmed a change - possibly a paradigm shift in the leadership of high potentials. Very often, the executives were certified by the interviewees lack of interpersonal as well as substantive depth of leadership. The best technician, master or engineer becomes a leader, without the necessary leadership, with poor key qualifications and often with low character strength, the experts agreed. Deficits in self-restraint, the self-reflection of one's own leadership style and one's own role understanding were often mentioned. In addition, executives in SMEs are often trapped in what the experts labelled the „management sandwich". Constant stress, hectic, pressure from above and below require a stable mental state, a „thick coat" and finger-tip feeling in everyday life. More than half of the respondents stated that middle management in particular is involved in the so-called acceleration trap. Characteristic of companies in which the acceleration trap is strong, have a short-term focus on numbers, revenue and earnings. Characteristic of these companies is the high performance pressure, low identification and the low promotion of the employees. Here, in most cases leadership happens in a one-dimensional, that is transactional way, whereas transformational aspects are not considered. Especially the interviewees from the training and education stated to be under excessive „collective overheating". Aggression, emotional exhaustion and a reduction in performance are often the result.

Furthermore the experts pointed out that the generational shift – as initially described here by *Klaffke* (2014) – is very visible to them. Approaches that were effective in the leadership of *baby boomers* seem to work less or not at all for the younger generation. While most leaders and managers of KMUs in the craft and trade field stem from the baby boomer generation still, young employees – so the experts – have a hard time connecting to them. They value participation in leadership situations and insist on their own values – much more than the generations before them, the experts conclude. Thus, one of the core challenges of SMEs in this field lays in the leadership communication and leadership styles. Leaders are a) usually not chosen based on their leadership qualities but on seniority and craft skills and are b) on average far older than big parts of the staff. Both of these aspects lead to a growing challenge for companies in these fields, the experts point out. Conflicts arise from this specific situation that can in turn lead to lower motivation (thus impacting performance negatively) and to higher turnover-rates due to the dissatisfaction with the management.

Another core challenge lays in the structure of trade and craft SMEs in general: Leaders are usually not only active in their position as leaders but are also actively working on other projects

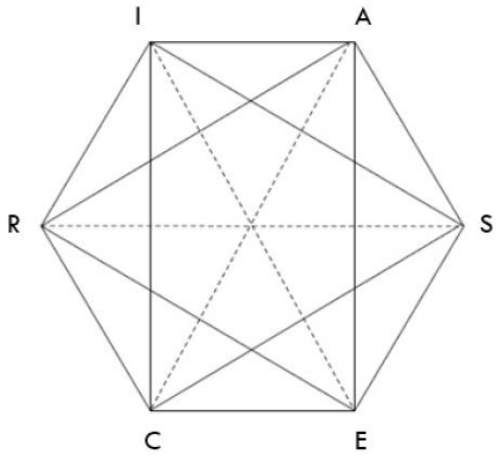
and are often involved in a multitude of different assignments and tasks. This was described by many of the experts as the *leadership sandwich*: Leaders often lack the time, energy and resources to actively focus on their leadership. Rather they are forced to fulfill other roles at the same time, often even with conflicting goals. While – so the experts agreed – many of the leaders in this field would be happy to focus more strongly on leadership and people development they simply lack the resources to do so. Especially in companies that deal with tight deadlines and short-sighted development goals – partially due to the competitive market situation that puts a stronger pressure on fast and cheap fulfillment of projects – leaders can only devot a small fraction of their time and resources on actual leadership. Rather they are forced into an urgency-importance tradeoff (see *Lowy & Hood*, 2011). While important long-term goal such as new leadership approaches and a stronger focus on the values and goals of the employees are considered, time pressure forces leaders into focusing on urgent matters instead.

The results found in this empirical, exploratory study go in strong alignment with many findings from the literature. Especially what the experts agreed on about the values and goals of the younger generation of (potential) employees, goes along with the findings from *Klaffke* (2014). Payment alone is not enough as a motivator for young employees, rather they want to be heard and considered. Transformational leadership – as initially proposed by *Bass* (1997) – was one of the earliest developments to take this into consideration – long before the so called generation Y or Z were pushing into the employment market. Transformational leadership can be considered to be a reaction to these developments, as it – unlike transactional leadership – is not only based on a reward system that values good performance by offering (monetary) rewards but on a on-going and positive relationship between leaders and employees. A core challenge of transformational leadership, thus, is communication and the building of a positive relationship between them and their employees. While this approach is shown to be a successful one (*Dumdum, Lowe & Avolio*, 2013) it also puts a strong emphasis on the leaders' personalities: Transformational leaders should be characterized by charisma (*Jiang*, 2018), integrity (*Simons*, 1999) and experience (*Echevarria, Patterson & Krouse*, 2017). These characterizations, coincidentally, are the factors that many real-world leaders in small enterprises in the fields of craft and trade are lacking, the experts of the empirical study pointed out. As they are often not chosen based on their leadership or communication skills but rather on their qualities and skills in their actual field, this can be problematic. This also goes in alignment with a challenge of small and/or young companies that is described by the work of *Rauch and Frese* (2007). The authors point out that designated roles are often not yet a possibility for companies smaller than a certain threshold. Thus, single persons often have to take on multiple roles at the same time, which can lead to both conflicts and faster burn-out due to overwhelming requirements.

In this vein also the work on vocational interests has to be noted (*Holland*, 1997). The impactful RIASEC model proposed by Holland describes six categories of vocational interests – realistic, investigative, artistic, social, enterprising and conventional. People in the field of crafts are typically characterized by a strong realistic vocational interest, which described an interest in working with ones hands, with different materials and technological solutions. People with this dominating interest type are typically less interested in entrepreneurial or enterprising activities such as management or leadership, as the graphical representation of the model (*Figure 1*) makes clear.

Figure 1

RIASEC model of vocational interests



Source: *Tarnai & Hartmann* (2015, p.16)

The closer two interest types are on the hexagonal model, the more related they are and the more likely they are according to *Tarnai and Hartmann* (2015) to be strongly developed in the same person. This implies that those strong in the field of crafts and trade might not even be very interested in leadership and management activities.

According to a meta-analysis of *Van Iddekinge, Roth, Putka and Lanivich* (2011) or the more recent work of *Neubauer* (2018) vocational interests or rather the match between one's vocational interest and the requirements of the job, predict performance outcomes. Concludingly *Neubauer* (2018) states, the more interested someone is, in what he does, the more successful he on average should be in this. This is a possible explanation for the results found throughout this work: Leaders in the field of craft and trade might be less interested in developing leadership approaches and would rather focus on the technical side of their work. This goes in alignment with the proposal of *Hogeforster* (2001) that horizontal career pathways in trades should exist – not every career change needs to be a promotion towards a managerial position, but rather different career steps in the trade positions itself should exist to allow for perspectives. This should – as the expert interviews showed – allow for motivation while avoiding pushing *good workers* into leadership positions they might neither want nor succeed in.

CONCLUSIONS

Concludingly this work was able to show that the craft and trade sector faces a multitude of challenges that other branches are facing as well – although often neglected by scientific research. The challenges even seem accentuated in this field, as the empirical analyses show: While the war for talent and the consequences of digital transformation and changing values in the younger generation impact SMEs in this field as much as in others, this field at the same time is often characterized by a lack of resources that can be devoted to management

and leadership. Thus, leadership, people development and similar long-term goals are often only handled as side-notes instead of as a priority, which is most strongly explained by a focus on urgent matters instead of important ones. At the same time, leadership positions are often filled as a result of promotions of good and skilled workers, who might lack the leadership qualities and education. This problem only grows with the influx of employees of the younger generation who demand a more transformational leadership approach.

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FOURTH INDUSTRIAL REVOLUTION ECONOMICAL AND LABOUR MARKET IMPACTS OUTLOOK

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ABSTRACT

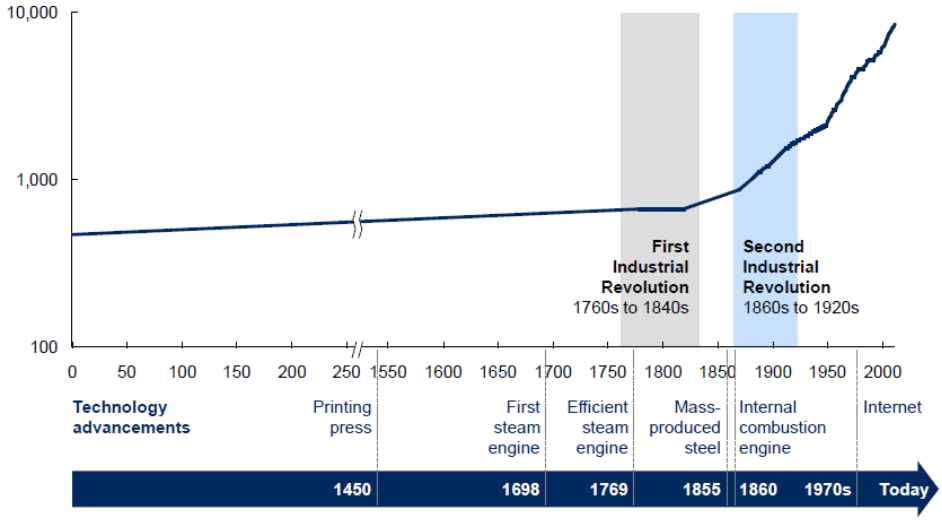
The fourth industrial revolution have the potential to bring one of the most significant economical and labour market changes in the near future. The size and scale of these factors depend on a variety of factors, including the speed of adaptation, legal framework, the preparedness and attitude of governments, companies and employees all play a role on the possible outcomes of these changes. In this paper we take an outlook on the possible labour market changes, the employee attitude towards robots and automation, and the possibility of Universal Basic Income, as a possible solution to offset job losses.

INDUSTRIAL REVOLUTIONS

Before taking a look at the possibilities of the Fourth Industrial revolutions, it's reasonable to take a look back, and evaluate the changes that the happened during the first 3 industrial revolutions. For economical impacts, we will use a figure shown in MGI's 2013 paper, Disruptive technologies: Advances that will transform life, business, and the global economy.

Figure 1

GDP per capita, world, $



Source: *MGI* (2013)

The *Figure 1* shows the global GDP/capita change throughout our history. After a slow and steady growth for centuries, and enormous rise can be seen at the time, and after the first Industrial revolution, with the development of the steam engine. The rise to grow with the Second Insudtrial revolution, thanks to the spread of mass production, and the development of the internal combustion engine. The growth continues to get even more significant at the time of the Third Indsutrial revolutions, with the of programmable logic controllers in 1969. These mentioned technologies are all General Purpose Technologies (GPTs) that are "a small group of technological innovations that are so significant, they can change/transform the speed of the normal economic growth". (*Brynjolfsson and McAfee*, 2011; *Varga and Cseh*, 2019) The technologies of the Fourth Industrial Revolutions also have the potential to become GPTs. Articifal Intelligence, Machine to machine communication, Big Data and the Internet of Things all have the capability to become factors of economic growth. These technologices are constantlie being advanced, making their potential ever greater. But using these technologies to drive economic growth won't come without a price. And that price will be the loss of human jobs.

WORKFORCE CHANGES

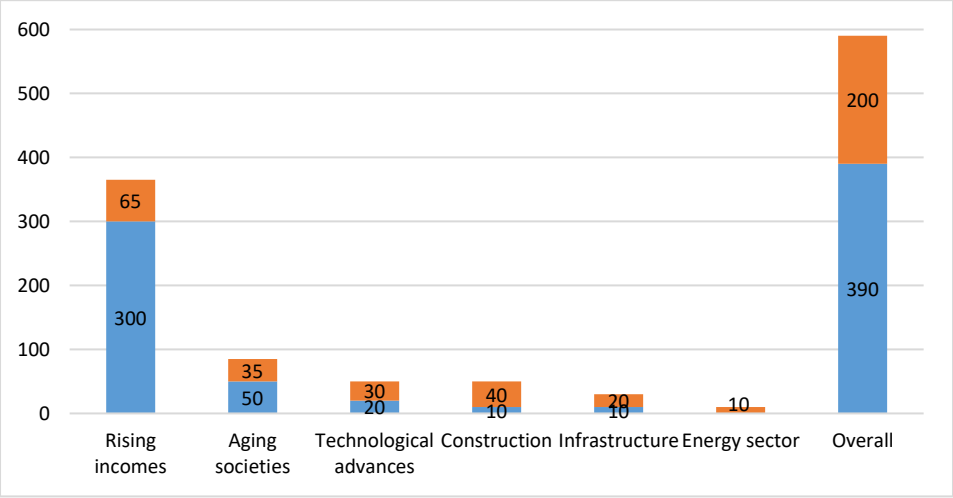
As the mentioned technologies become better, cheaper, and thus videly available for companies, we arrive at the human labor side of the Fourth Industrial Revolution: Automation, and alongside that, job losses. As machines continue to be better at tasks and jobs that humans are currently doing, and at the same time, becoming cheaper and cheaper, more and more companies will realise the benefits automation can provide to them. Growing productivity, no fluctuation and no labour costs are just some of many. Today, workforce automation does more good than harm (*IFR*, 2017), because most machines are working on jobs and tasks that would be dangerous or unhealthy for human labour, such as welding and automotive painting. Alongside with that, Industry 4.0 has some solutions that benefit works and companies, such as VR training, that provides a method for new employees to learn the the tasks they should do later, with reducing the potentical accidents of this learning process to zero., or sensor driven quality control on production lines, that makes a monotone tasks easier and more efficient (*Danaher*, 2017; *Ghislieri, Molino and Cortese*, 2018). While most of the changes benefit us a whole, the amount of jobs lost to automation is already significant. Between 2010 and 2016, more than 1.6 million jobs were lost to automation in manufacturing alone, and if the trend continues, as much as 20 million jobs could be destroyed just in this sector. (*Oxford Economics*, 2019)

Jobs lost to technological advancements were also seen in the first three Industrial Revolutions. During the First Industrial Revolutions, the Luddite movement were destroying machines that were made to replace them in the textile industry (*Frey and Osborne*, 2013). The movement was repelled, and those who lost their jobs seeked employment in other sectors, and the same happened during the changes of the Second and Third Inustrial Revolutions. For the Fourth Insudtrial Revolution, this can be vastly different. There is a huge potential to create jobs, as stated in "Jobs lost, jobs gained: Workforce transitions in a time of automation,by McKinsey Global Institute": By 2030, 800 millions jobs could be lost, but nearly as much can be created through factors such as

rising incomes in developing economies, technological advances, and new health care related jobs to adjust to aging societies (*MGI*, 2017), as shown in *Figure* 2.

Figure 2

Possible job creation, 2016-2030, million jobs



Source: *MGI* (2017)

But the creation of jobs won't mean everyone can get a new jobs as soon as they got pushed out from the workforce by automation. The transition period can be huge, with hundreds of millions of people having to go through retraining and find employment in other sectors. This transition period can be even longer in case of technology related and high value added jobs, which will require even more learning and retraining. Most jobs created in the EU will fall into this high skill category (*CitiGPS*, 2016) This can mean a period of technological unemployments, which was established by Keynes is 1933, defined as "unemployment due to our discovery of economising the use of labour outrunning the pace at which we can find new uses for labour" (*Keynes*, 1933), meaning that we can automate jobs faster than we can create new ones to offset the job losses.

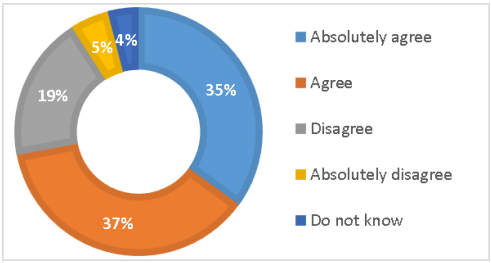
EMPLOYEE ATTITUDE

While the period of destroying machines that take jobs are not relevant since the Luddite times, employee attitude remains an important factor for the upcoming changes. While it is not the greatest focus of the literature of the Fourth Industrial Revolution, taking a look at how employees think of robots, automation, and potential job losses can provide valuable information for companies and policy makers, and further educating employees on the topic can make the process of workforce automation easier and faster. One of the most extensive studies was conducted by the *European Commision* in 2017, as Special Eurobarometer 460, asking European citizens about automation, robots, digitalisation and digital skills. The

findings of the survey show an overall positive picture about how Europeans watch automation and digitalization, with 75% of the respondents saying that digital technologies have a positive impact on the economy, and 61% having a positive view on robots and artificial intelligence, and with 84% saying that robots are needed, because they can do jobs that would be dangerous or physically demanding for humans. While the respondents saw the positive side of automation, they were aware of the negative impacts it can bring, with 72% agreeing that robots and artificial intelligence are destroying jobs, as shown in *Figure 3*.

Figure 3

Robots and artificial intelligence steal peoples' jobs (% - EU)



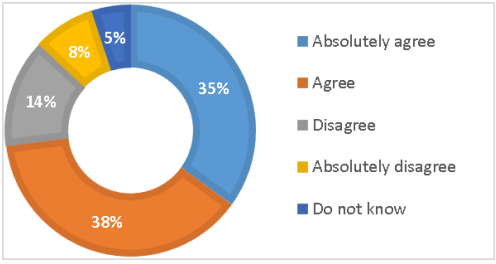
Source: *European Commission* (2017)

Another important part of the survey was about digital competence. With robots taking on repetitive and rutin-based jobs and tasks, employees will have to gain competence in unstructured and digital work tasks. As stated earlier, most jobs will be in the high skill area, meaning these skills can have an even greater importance. Companies will also focus more on soft skills, such as problem solving, communication skills, and decision making, and digital skills will become more and more important in every sector of the labour market. (*IFR*, 2018).

The question asked in the survey was about the competence in digital skills, asking respondents if they have enough digital competence to take on a new job, if needed, in the next 12 months, with 73% of them saying they are competent enough to handle the situation presented.

Figure 4

You consider yourself to be sufficiently skilled in the use of digital technologies to do a future job if you were to find a job or to change jobs within the next twelve months (% - EU)



Source: *European Commission* (2017)

While most people are aware of the job losses that automation can bring, the majority are not concerned about their own job security. A study conducted in the United States by PewResearch specified a number of jobs, and an option as "my own job" for a question about which of those jobs are at risk. Most of the responders selected a variety of jobs at being at risk, but only 30% percent said that their own jobs are at risk. (*PewResearch*, 2017) Another study, by Ipsos asked people about the negative and positive sides about automation, in which 67% said automation makes our life easier, while 48% thought that automation has more benefits, than drawbacks. Only 26% was worried about losing their jobs to automation. (*Ipsos*, 2017)

UNIVERSAL BASIC INCOME

An important question of the job losses brought by automation is how to handle them. As discussed earlier, there is a great potential to create hundreds of millions of jobs, which can nearly, if not totally offset the jobs lost, but for employees, the transition into these new jobs can be a long, hard, and costly process. This is where Universal Basic Income comes into the picture.

Universal basix income is "A regular fixed cash transfer payment provided by the government – or another institution in the public sphere – to every citizen or resident, regardless of whether he or she is rich or poor and/or wishing to be engaged in paid employment." (*Raventós*, 2007; *Csonka and Kőműves*, 2011) It could soften the impact of job losses suffered by employes, while providing a regular income in a time where job security becomes increasingly worse. At the time of the earlier Industrial Revolutions, people who were affected by the job losses found employment in jobs that required the same skill level, and they could easily get back to working again, getting the income they needed. This won't be the case for the upcoming changes, for the reasons stated earlier. Some people could need months, or years to get the skillset needed for the new jobs created, and some might not even find jobs anymore, if the number of jobs created falls short to the number of jobs lost. Universal Basic Income can create a benefit system that provides equally for everyone.

While it may sound like an utopistic dream, it could become a solution for a problem that can bring never-before seen impacts. We do not have enough information on the implementation and the effects of Universal Incomes, testing it could provide valuable information on its effects.

The closest thing we have to Universal Basic Income is the Alaskan Permanent Fund, which provides a yearly income for every Alaskan citizen, but it's not a fixed amount, and it's pegged to the oil revenues of the state. Universal Basic Income was also proposed in Switzerland in 2016, but it failed in a referendum, with 77% voting against it. Other important cases of Universal Basic Income is the Kenyan testing, where the government provided Universal Bascin Income for the citizens of 120 villages, and the most recent test in Finland, where a monthly payment of 580 Euros were given to 2000 participants, who were on unemployment benefit before the test. The study that were running between January 2017 and December 2018, and while the full results of the study will only be published early 2020, some of the results were already shared in a paper published by the Ministry of Social Affairs

and Health of Finland, in 2019 (*Kangas et al.*, 2019). The 2000 benefiters were asked about their look of their own future, financial situations, and their employment situations and outlooks. The results were compared with a control group of 173.000 (5000 for the employment questions). The results are shown in *Table 1* and *Table 2*.

Table 1

Level of confidence in one's own future and one's own financial situation

	Confidence in one's own future (%)		**Confidence in one's own financial situation** (%)	
	Test	**Control**	**Test**	**Control**
Poor	6.8%	9.8%	13.0%	19.4%
Rather poor	7.8%	13.2%	11.8%	16.8%
Moderate	25.8%	30.1%	32.4%	32.4%
Quite strong	34.8%	30.0%	26.3%	19.4%
Strong	23.4%	16.2%	15.9%	10.9%
Cannot say	1.4%	0.7%	0.7%	1.1%

Source: *Kangas et al.* (2019)

As we can see, the test group (those who received Universal Basic Income) had a more positive look about their own future, with 58.2% having a positive view, with 46.2% in the control group. The case is similar when it comes to financial situation, 42.2% felt confident in their financial situation, against 30.3% in the control group. (*Kangas et al.*, 2019)

Table 2

Full-time and part-time employment and a wish to work full-time instead of part-time

If a wage earner, is currently in (%)		
	Test group	Control group
Full time employment	38.0%	30.3%
Part time employment	62.0%	69.7%
If working part-time, would rather work full-time (%)		
	Test group	Control group
Yes	68.6%	58.2%
No	31.4%	41.8%

Source: *Kangas et al.* (2019)

As for the employment status and confidence, the results are shown in table 31% had a job at the time of the survey, with 25% in the controll group. A bigger percentage of the test group was working full time, and from those who were employed part time, a bigger percentage wanted to enter full time employment. From those who were not employed at

the time, Universal Basic Income recepients were also more confident in their chances of finding a job in the next 12 months. (56% against 45%).

As mentioned earlier, the full result is not yet published, but we are hopeful that they will showcase the positive impacts Universal Basic Income can bring, providing an incentive for further testing.

CONCLUSION

New technologies can upset economic growth as well as the labour market. Employees, companies, and governments all have to take steps to ensure that the labour market transition can happen smoothly, without millions of people being forced into technological unemployment. People seem to have a false sense of confidence when it comes to their own job, thinking that it can withstand the transformation that automation can bring, and while the general attitude towards automation looks to be positive, people should be made aware of the negative scenarios that can happen, granting them a more thorough view on automation as a whole. People in the most endangered professions should receive help from governments, their employers, and educational institutions, to help them adjust to the new and upcoming job opportunities. While it seems like newly created jobs can offset the job losses that are bound to happen, it's better to be safe than sorry – and helping people get ready for a possible labour market transition serves that purpose. The possibilities of Universal Basic Income remain to be seen, but further testing, as well as building on what we know so far can help us better understand this most controversial phenomenon.

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FAMILY BUSINESSES BETWEEN CHALLENGES AND CONTINUITY

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ABSTRACT

As we noticed most family owned business don't grow and they took themselves to be failed and destroyed in the field they work in (Danco, 1980). On the other hand despite many challenges family business could have the chance to expand and develop. In this article, we will study the challenges linked to a growing firm and propose solutions to overcome them. For this reason, we will search for the best management and leadership practices adopted to ensure family business growth and development. We sought to understand and interpret these challenges and draw out best solutions for it, through analyzing of diverse data sources, to reach at the end the factors behind family business continuity.
Keywords: Family Bussiness, Challenge, Succession planning, continuity, leadership practice.

INTRODUCTION

The importance of the continuity of family businesses is reflected beyond the scope of the family. Family businesses are a great pillar of the economy as they contribute more than 70% of global GDP and 60% of employment worldwide, the family business are the key factors for growth and innovation in today's economy. Despite of its great actor in the economy, family businesses has several weak points such as the difficulty of maintaining effective management across generations, and sometimes leaders of family firms try to postpone or avoid succession planning for the company's management, and the new generation lack to the experience or desire to manage the business. Moreover, family businesses may need corporate governance, studies have shown that boards of directors in family firms are less diversified and influential, compared with those of the company of non-family - are often struggling to attract and retain talent. Studies and researchers emphasizes the importance of applying policies, procedures, succession planning and best practices to support the working mechanisms of the family business prosperity for the long term and to avoid their challenges and gaps between generations.

RESEARCH QUESTION

What are the factors of leadership practices behind the continuity and business performance of family business?

How family businesses succeed to avoid challenges and how they passed through the generations?

What are the differences and what is the correlations between family business leadership practices and business performance indicators among generation?

MATERIAL AND METHODS

This article shows the different types of challenges in family business. And analyzing the best management and leadership practices adopted to ensure family business growth and development. We sought to understand and interpret these challenges and draw out best solutions for it, through analyzing of diverse data sources, to reach at the end the factors behind family business continuity.

Methods applied:

Secondary data: analysis of documents. The secondary data it will be collected from a well-known published books and articles and from some consistent journals

Theoretical Background

As a matter of fact, many cases expresses the survival of family business from a one generation to another. For instance, the data in the United States reveals that only 1% of family firm leader member run the business, while 80% managed by entrepreneurial owner. Most of the family business members search for more profitability with less debts and more family wealth (*Greenwald*, 1995).

Studies also revealed that 15% of family firms has their own business. Two third has succeeded to pass from one generation to another. This also found in European countries (*Benson, Crego, and Drucker*, 1990).

Growth's Challenges:

Challenges that faces the family business growth and don't survive among generations:
Family owned business characterized by their responsibilities, cultures and traditions, good relationships with employees (*Dyer, Jr.*, 1988).

One more problem is that family business leaders own just one business, and they just take care of it and don't think on new growth possibilities (*Lansberg*, 1988). After the maturity of business and no changes and development occurred, this lead to a declining and downward cycle. Less leadership practice due to less energy and few resources.

a) Less capital

According to *Ward* (1987), family firms must take into account the requirements of business growth, and this conveys the family business leader to pay family owners death tax and liabilities and their capital represents 80% of business assets. After the death of the owner some siblings left the ownership position and fetch outside employment and prefer personal independence. The rest of the members are ready to carry on their responsibilities (*Ayers*, 1990).

b) Failure of Second generation successors:

Many family firms can't pass their business to the next generation because they don't have a successors to hold the business (Arthur Anderson, 1995). Many successors don't take a risk because it's not their own money it's the wealth of the family members (*Kets de Vries*, 1993).

c) Less will to change

Ignoring a planning strategy doesn't encourage business growth (*Ploster*, 1994). Owners traits changes with time and becoming more conservative and less risk taker (*Backley*, 1994).

d) Family siblings' conflicts:
Research reveals that US family firms has many family members, and the owners of this family business try to pass the ownership and leadership to one or two or more of their siblings (*Nelton*, 1996). Most of the partnership inside family business ended in a split-up because of conflicts that exists in ownership structure (*Ward and Aronoff*, 1992). Partnership between siblings success if they invest in this relationship and sharing thoughts, understand each other. For these siblings the family interaction is more important than the business itself and this will give them the strength to overcome business crisis and risks (*Ward and Aronoff*, 1992). Sharing thoughts and decisions in family business reflects a health family and a healthy relationships (*Aronoff and Astrachan*, 1996). With health family relationship and mature siblings conflicts will decrease and they will together work on business growth.

Most of family business owner, think that the way of success is one of the stagnation. Choosing a one successor leader is the most important action the family business do rather than business held by more than one family member, which will increases the chances of growth and to pass through generations. Moreover, most family business leader successor avoids such challenges (*Ward*, 1987). With each other new leadership generation, new ideas is generated, new strategic plans is known (*Hamel, Jr.*, 1994).

LEADERSHIP PRACTICES

Family business through generations, address some goals and practices to overcome challenges it may face, in most family firms strategies set by family business leaders must be usually updated to assure family business growth for long period, and creating an opened door for new ideas.

Some family firms assures strategic budget in order to have a continuous development (*Mintzberg and Waters*, 1990). The usage of independent directors: successful family business leader rely on external independent directors to assure new ideas and who are able to face challenges. *Galo and Point* (1994) found that the most successful family business leader is the one who had an international work experience or continued their study abroad, this is a good source for new ideas.

Family business are not sure to rely on non-family managers, so family business leader don't think they can attract these managers. But this idea has changed because the non-family manager are in need to be appreciated, valued, and to be trusted and get empowered by the owner, or compensated (*Carlson and Nager*, 1993).

Non-family managers need these feelings and need to feel belongness and to belong to a professional career. Moreover, sharing business information openly and allow the sharing of new ideas and positive thinking is a great approach for development, innovation and long term growth.

As the CEOs of old age have a desire to move away from the day-to-day management of the company, it is necessary to prepare for the selection of family business leader of the new generation.

How to prepare the successors for leadership: now is the chance for the successor in family firms to lead the business growth, starting from his skills (*Cohn*, 1992). Successors invest the experiences gained by him from several resources in the succession of the business,

either from education or outside the family business. Strategies are very important for the long run family business, its development and continuity.

WHY WE NEED A SUCCESSION PLAN

Most of the family firms try to survive and pass through the next generation. They use to set a strategic plan for their business growth and wealth. Strategic planning must take in consideration family attributes and issues in their thinking (*Ward*, 1987). Ward insist the importance of formal strategic planning which is necessary for most family business. Some failures may face the family firms when transferring the leadership from one generation to another. Many family firms are small and have a small number of employees and less financial strength than big family firms. Some conflicts happened inside a family firm between family members.

a) Strategic Planning

Business plan facilitates the share of decisions and values orientation in which they are required for family business success.

Commitments encourage family members to reinvest fund in succession plan. Knowing that good business strategic planning is the key of success. The transformational level from a business strategy to a profitable growth known by strategic planning. It provides the company with answers about questions it may face, and helps the business to overcome challenges happened due to business practices, and increases customer satisfaction, profits and prepare the family firm for the next generation.

Strategic plan which must be formal is very important to achieve company's mission and it helps in achieving its growth and business success. Moreover it support in determining the steps behind business growth and process by fetching which market we want to compete? And how we can compete market? Family strategic plan is required for long term goals.

These goals encourages to keep the company and hang on the family business from one generation to another. The advantages and disadvantages presence of many active family member in their relationships and resolve problems and conflicts. Shall the family members work together or separately? Those challenges of family business will decide the degree of commitment between family members.

Some family business member prefer to separate the business from family issues starting from ignoring the self-interest of the family in their decisions.

b) The need of planning:

When losses happen in family business, the business leader called a specialist to solve the problem. The first thing he will detect is the strategic planning of the company through asking managers certain questions related to financial or competitive analysis. Such results will reveal family business health, is that employees doesn't rely on family business issues or characteristics to achieve success, and there is a difference between position and performance. So the planner is asked by the specialist to engage a process that makes the strategic planning going. **First step** in solving the problems, is to increase the level of commitment to secure the future of the family business. The family member should invest money in the business and to work together and lead the business with a leadership attributes.

So, family member should sign a written commitment for long term business.

Next step is to assess the net income of the company, this should reveal if the family has a concern in the future of their family business through saving and reinvesting in the business because they want it to live and succeed while other who reinvest their money elsewhere they will weaken their family firm.

Third step is to recognize the alternative where one must check new geographical areas, improve the quality of their service to accomplish company's productivity. Good family business has an interest to benefit from long term orientation, with high performance in sales and earnings they can reinvest in business to concentrate on their vision in the future. They have their own family name.

Formal written strategic plan helps in decreasing conflicts inside family firm. Insist the commitment from family members to companies' strategies in reinvesting, assessing net income, confirming to keep money for future use. This business plan provide family members with the necessary knowledge and training program, and this will help in choosing the successor and the new family leader member of the firm. Conflicts happens due to the difference in salaries, values, treatment among family members.

KEY FACTORS BEHIND SUCCESSION

Deloitte and Touche (1999) study, *Lansberg, Perrow, and Rogolsky* (1988) with increasing number of population and demographic change, the succession of family business leaders will increase in the next coming years. 90% of the US family leaders follow family owners in their vision (*American Family Business Survey*, 1997). Many research shows that approximate 30% of family business succeeded to 2nd generation and 10% to the third generation (*Beckhard and Dyer*, 1983; *Ward*, 1987). The model we are going to study is the process of leadership transition inside family business from one family to another.

Succession planning is very important for the transition from one generation to another, without any conflicts between family members will occur (e.g., *Lansberg*, 1988). Succession strategic planning enhances the good relation between family business leaders (*American Family Business Survey*, 1997).

Some family members will not continue their family business, those family members do not need a succession planning and their heirs will search outside employment. While others consider succession planning is a great step to continue their business.

As we believe family business do not have one single goal as maximizing profit, family business is a good source of employment to make sure of maintaining good relationship between family members, and achieving financial performance. Responsibility is one of the main requirement by the family business leader to implementing firm's vision through management and good governance (*Chua, Chrisman, and Sharma*, 1999). Good relation is a good sign for family members to continue their business.

Roles and responsibilities should be defined clearly by individuals, this will helps them to show their commitments and contributions. According to *Handler* (1989), when each member of the family knows and understands his role and responsibilities conflicts, possibility of jealousy decreases, consequently succession chances increases.

Family relationships which build on respect, trust, and understanding among siblings shows a family harmony with an open lines of communications (*Lansberg and Astrachan*,

1994; Lundberg, 1994). Mutual acceptance of the role that is built on trust, respect and understanding, these helps in accepting the business roles between siblings.

Family relationship and organizational traits and attributes affect the satisfaction with succession process. Success is a tool of satisfaction of family business leaders and the effectiveness on organizational performance (*Sharma et al.*, 2001).

RESULTS AND DISCUSSION

Why Family Businesses Fail?

Internal challenges:

- Weakness of founding spirit in the absence of founders.
- Poor preparation of generations.
- Conditions of incorporation and mutations.
- Differences resulting from differing typography and abilities.
- Lack of clarification and transparency of many information among family members regarding companies.
- Acquiring family members to important positions and not allowing non-family members - not necessarily a good owner, a good manager (trust).
- Weakness in generations and in the power transfer from one generation to another.
- The breadth of the investment and the size of the investment depends on the capabilities of the family members (continuity is necessary).
- Expansion of investment fields and lack of competencies.
- The breadth of family members from several branches.
- Effective roles for children other than the family.
- The role of women and their husbands.
- Non-maturity of the organization (infrastructure - investment phase).

External challenges:

- Speed of variables (technical - environmental - organizational ... etc).
- Implications of global and regional crises.
- Evolution of local systems
- Maturity of competition and entry of foreign investors.
- The nature of the new investor (the creative small investor).
- Beneficiary awareness and maturity.

Benefits of corporate continuity

- The continued growth of wealth in the family and its effective impact on the family in general (Greater than if they were sporadic).
- The development of the family members in light of the wealth and environment.
- Contain more generations under the umbrella of the company (employment).
- The preservation of wealth in the spirit of the community and not individuality.
- Family bonding.
- The survival of the family's commercial status in society.
- Providing opportunities for the distinguished family members to highlight their potential and creativity.

- Provide a collective spirit and participate in decision-making and risk, thus relieving the burden on family members.

How to maintain continuity?

- Formulating and building the appropriate legal framework for the family environment.
- The establishment of an integrated institutional family system that manages the relations between the family members among themselves regarding the internal and investment affairs of the family.
- Commitment to vision and strategy for the course of investment of family funds.
- Vision and strategy take into account the aspirations and expectations of family members.
- Accept the principle of sacrifice of some family members to achieve the ultimate goal of the strategy.
- Transform the strategy into medium- and short-term operational plans.
- Agree on the mechanism of auditing and follow-up of the above through the creation of strong and homogeneous administrative boards.
- Continuing the developmental and monitoring process to update and direct the work periodically.
- Providing an environment conducive to attracting specialists and competencies from outside the family in leadership positions and delegating authority to them.

CONCLUSION

Despite of the limited number of family business strives for long term growth, modest number of them have developed and grown for a long term. Two prospects are important for long term growth which are the leadership practice and the commitment of the family business leaders to support their business growth. Moreover, family business leaders follow the best practices. These are called masters of growth who save several characteristics and personal missions as stated by *Tagiuri and Davis* (1992). Now they are concentrating on the goals and needs of family members to check their desire and commitment to best practices and business growth through the process to define family business goals and mission. Business plan facilitates the share of decisions and values orientation in which they are required for family business success.

There is a need to plan for succession which must be written to overcome any future conflicts that may occur.

Skills, motivation and some traits with the succession plan are needed by the successor to run and develop the business. Successful leader with a succession planning strategy become familiar with success (*Danco*, 1975).

Commitments encourage family members to reinvest fund in succession plan. Knowing that good business strategic planning is the key of success.

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Sustainability models (Mathematical, IT, Statistical, Technical Aspects)

STUDY OF TIME SERIES FINANCIAL DATA OF BIG GAME MANAGEMENT BETWEEN 1994 AND 2018 IN SOMOGY COUNTY

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ABSTRACT

The financial data of Somogy County found in the game management reports were collected from the National Game Management Database's yearly mass of facts and were scheduled. The data contains incomes (paid hunting by foreigners and the related services, paid hunting by Hungarian hunters and the related services, the revenue of live game, income from the harvested game, other incomes) and costs (wages, game management, agricultural and forest game damage (caused by game), and other expenses). The data were studied by time series statistical methods.

INTRODUCTION

Similar to agricultural production, agroforestry activities and its profitability can be greatly affected by game damages. The aim of the paper is to find out the correlation between income and expenses of game management with Agricultural Game Damage data.

MATERIAL AND METHOD

The financial data of Hungarian counties found in the game management reports [1] were collected from the National Game Management Database's yearly mass of facts [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], and were scheduled. The data are available from 1994 to 2019.
The financial data contains revenues and expenses (*Table 1*).

Table 1

The financial data of game management

Revenues	Expenses
- Paid hunting by foreigners - Services for foreigners - Paid hunting by domestic hunters - Services for domestic hunters - Incomes of harvested game - Incomes of live game - Other incomes (e.g. member fees) - Tenders and subsidies	- Wages - Game management - Agricultural damage - Forest damage - Other expenses (e.g. membership fee for the Chamber of Hunters)

The financial data are just informative, they have cash flow approach, and are not made for balance sheet or profit and loss account. They apply for hunting year and not for economic year.

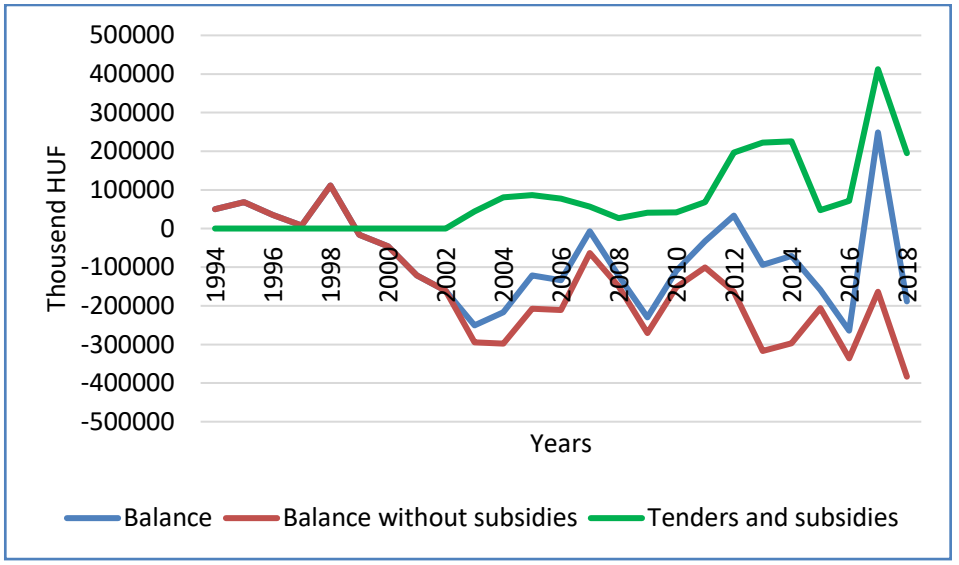
RESULT

At first we examined the balance of game management to all counties in examined period. During the analysis, the balance were examined with and without the resources gained by tenders and subsidies.

After wages and game management expenses the largest expense is agricultural game damage, which is the highest at the national level in Somogy County. After 2002, the sector also received subsidies and support, which improved the balance of game management (*Figure 1*). However, after 1998, Somogy's balance was positive only in 2012 and 2017.

Figure 1

The effect of subsidies

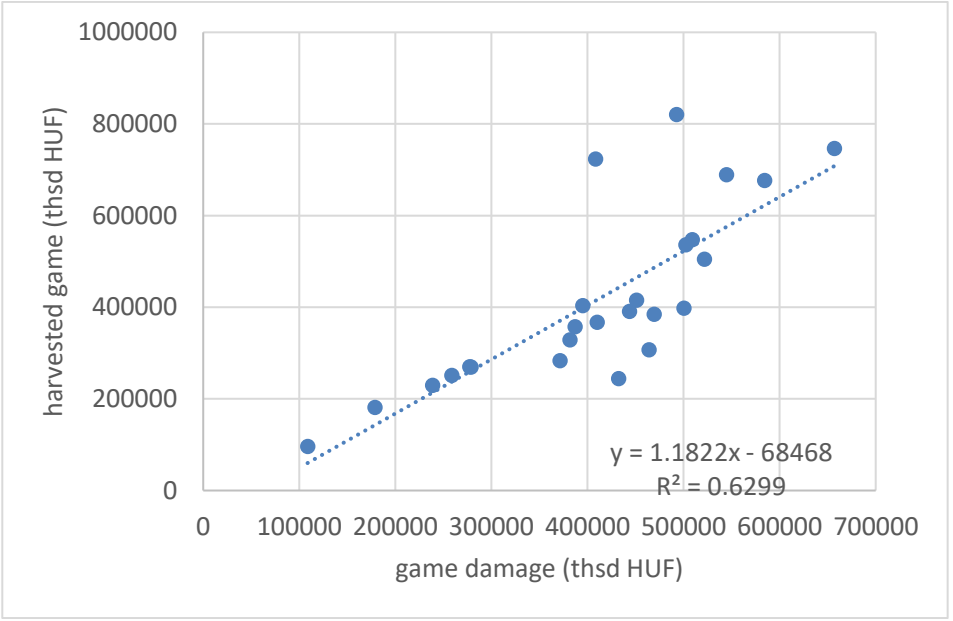


We examined, whether there was a relationship between agricultural game damage and revenue from the incomes of harvested game (*Figure 2*).

Figure 2 shows that 63% of the agricultural game damage is explained by incomes of harvested game. Multiple regression analyses were performed to explore deeper interdependencies. It is expected that in average the harvested game increases by 1182 HUF (95% interval 791 – 1573 HUF) if the game damages increases by 1000 HUF (p=0.00).

Figure 2

Correlation between harvested game and agricultural game damage



Multiple regression analysis showed a significant relationship between Agricultural Game Damage with incomes of paid hunting by foreigners, paid hunting by domestic hunters, incomes of live and harvested game (*Table 2*).

Table 2

Multiple regression statistics

r value	0.92
r^2 value	0.84
observations	25
F significance	0.00

Dependent value: Agricultural Game Damage

Independent values		p-value
x1 Paid hunting by foreigners	0.41	0.00
x2 Paid hunting by domestic hunters	0.41	0.00
x3 Incomes of live game	0.38	0.59
x4 Incomes of harvested game	0.24	0.01

Y = 0.41*x1+041x2 + 0.38 x3 +0.24 x4 - 45468.73

The explanatory variables together (incomes of paid hunting by foreigners, paid hunting by domestic hunters, incomes of live and harvested game) explain 84 percent of the variation of agricultural game damage, the multiple correlation coefficient shows positive strong correlation (p=0.00). Except for income of live game the parameters are significant (p<0.05). Live game income amounted zero in some for the years and was lower than the other variables during the period analyzed.

Examining the expenses, we found that there is a significant relationship between agricultural game damage and wages and game management (*Table 3*).

Table 3

Multiple regression statistics

r value	0.87
r^2 value	0.76
observations	25
F significance	0.00

Dependent value: Agricultural Game Damage

Independent values		p-value
x1 Wages	-0.35	0.18
x2 Game management	0.56	0.00

Y = -0.35 x1+ 056 x2 +68732.88

The explanatory variables together (wages and game management expenses) explain 76 percent of the variation of agricultural game damage, the multiple correlation coefficient shows positive strong correlation (p=0.00). Variable Wages was found not have significant effect on game damage, but game management expenses were (p=0.00).

CONCLUSION

The game management financial data of 1994 to 2019 proved that some of the income and expenses of game management are strongly correlated to Agricultural Game Damage data. Further directions of analysis can be the inclusion of harvested game number, estimated game stock and forest area. Also survey can be extended for the whole country in order to reveal spatial patterns.

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TEACHING PROGRAMMING SKILLS THROUGH ROBOTICS IN UPPER SECONDARY SCHOOL

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ABSTRACT

By the 21st century, the explosive development of technology has led to almost every student holding smartphone, tablet in their pockets or hands to even communicate in real time with their friends, be present on social media, conduct conference calls, take pictures, share videos of your daily activities, post videos on YouTube… They have up-to-date information on events around the world at almost any moment. However, in order to be able to use various applications without barriers, continuous development is required, which requires IT specialists. According to a 2019 survey, there are 22,000 IT shortages in Hungary. (ZED, 2019) However, in order to solve this problem, it is not enough to deal with specialization courses and university trainings, and much earlier, we can start raising the interest of the IT profession even in the first years. One of the most important questions in education today is whether we should teach and, if we teach, how to teach our students to program. A couple of years ago, this question may have seemed irrelevant, because at that time, we still had to deal with students learning how to use office applications. They will learn how to use the software they need for their daily work, eg. word processing, spreadsheets, presentation. Today, however, this is proving to be limited.

THE STATE OF IT EDUCATION TODAY

Technology is not only present in the lives of adults, it is part of our lives from a young age. From pre-schoolers through to elementary and high school children, we use our smart devices. The use of smartphones, tablets and laptops is essential today. We use them to conduct banking transactions, watch live broadcasts, and develop self-driving cars. However, in order to use the tools properly, we need to make the right improvements and create the right IT culture for our users. Not only can the devices be used for fun, but they should also explore other possibilities, such as educational apps, video, online apps, and more. . There is also a section on the National Fund Curriculum that is intended to be introduced and developed.

According to the National Fund Curriculum (NAT), sections 5-8. Grade A is one of the main topics of the year:

- Algorithmization and block programming;
- Online communication;
- Robotics;
- Word Processing;
- Presentation Creation;
- Creating multimedia elements;
- Spreadsheets;

- Information society (e-world);
- Using digital devices. (*Oktatás 2030 Tanulástudományi Kutatócsoport*, 2018.)

The inclusion of these topics in NAT also demonstrates the need for robotics and programming specifically from primary school onwards. I think one of the possible ways we can achieve the most competence development is to use the project method. The project method develops the following competencies:

- Solidarity;
- Collaboration;
- Responsibility;
- Self;
- Foreign language communication;
- IT skills;
- Teamwork.

These competences will also be used in the labor market in the future.
NAT emphasizes the development of the following 9 key competencies:

- Communication in the mother tongue;
- Foreign language communication;
- Mathematical competence;
- Competence in science;
- Digital competence;
- Effective, independent learning;
- Social and civic competence;
- Sense of initiative and entrepreneurial competence;
- Aesthetic-artistic awareness and expression. (*Oktatás 2030 Tanulástudományi Kutatócsoport*, 2018)

IT competencies include:

- Algorithmic thinking;
- Data Modeling;
- Modeling the real world;
- Problem solving;
- Communication skills;
- Employability;
- Teamwork, ability to cooperate;
- Creative ability;
- Information orientation and information ability;
- Systemic thinking. (*Zsakó, Horváth, & Szlávi*, 2010)

PROJECT METHOD AND ROBOTICS

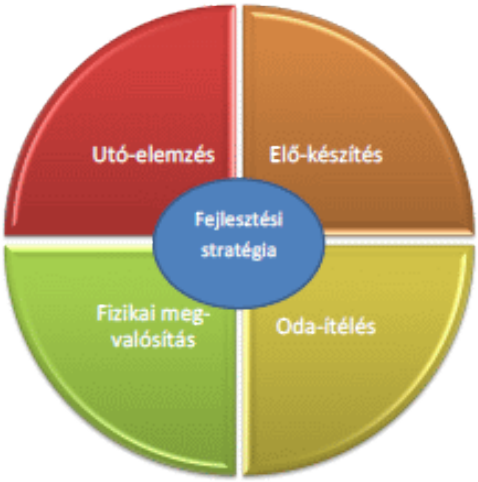
Today's students have changed their learning habits. For them, it is no longer lexical knowledge that counts, but rapid access to data, and immediate access to all knowledge. They are able to focus on more than one thing at a time, multitasking. Literature refers to today's

students as digital natives. They are the ones who sit on the desks and become the workers of the future. They are born with smart devices and have no trouble managing the devices. They are very receptive to new things, and they are particularly fond of the rich environment. They like to learn playfully, from educational material containing many graphic elements. They want to be active participants in events. (*Tóth-Mózer*, 2018)

With all this in mind, I think we can make programming teaching colourful, varied, and fun. As a teaching method, I consider the project method to be the most optimal. The method allows students to research and get answers to important questions during the project process. You can meet individual and group needs. The project follows a certain workflow, which is the project cycle. In the real world they can experience this process cycle when developing a job, a workflow.

Figure 1

Project cycles



Source:
http://www.jgypk.hu/tamop15e/tananyag_html/Menedzsment_alapjai/43_a_projektek_fzisai.html

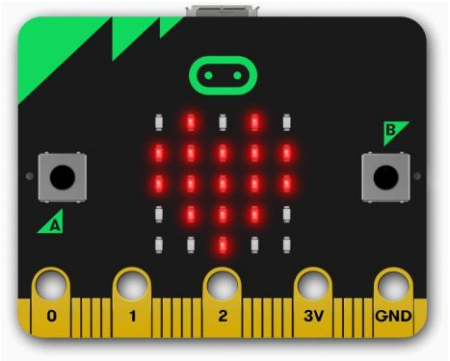
PRACTICAL EXAMPLE

Nowadays, there are more and more places about the various robots that are used in education. From completely basic programming to the professional level, we can find the right tool for you. For lower grades, simpler flooring robots are also suitable. They have an eye-catching effect, they can move, dance, talk, blink. Robots, while providing a good foundation for programming, can also be used for special pedagogical development. (*Fődi*, 2018) At a higher level we can deal with more serious robots, such as Micro: bit, Arduino, or ArTech. Not only can these devices be programmed using push buttons or block programming, they

are also capable of learning more advanced programming languages, such as Python. It is important to have continuity and opportunity for development. Each of these tools is capable of solving real-world problems with IT tools.

Figure 2

Micro:bit



Source: https://microbit.org/images/beating-heart.gif

From October 2019 to December 2019, I used ArTech robots from the competition announced by Abacusan Studio for 10 weeks for 10 weeks. My goal was to make teaching programming skills more interesting and effective for students. The whole topic was solved as a big project.

About ArTech Robot:
The main component of the robot is a brick containing an Arduino Uno motherboard. The brick has 2 analog motors, 8 servo motors, 8 input / output ports and 4 push buttons. It can handle up to 2 analog + 4 servos or 1 analog + 6 servo or 8 servo motors and 8 input / output elements (sensors, buttons, LEDs, speakers) at a time. Works with 3 pencil cells, extremely economical. A battery pack can last for months. The program written on the computer can be loaded onto the robot using a standard mini USB cable. (abacusan studio, dátum nélk.) Schools can join the program by filling out an application form called VándoRobot, which will provide ten kits for Abacusan Studio to use for ten weeks.

Project work with ArTech Robots:
At school, computing is a compulsory class of one lesson per week, which is just 45 minutes. Because of the short time, I thought I'd use the project method to process the topic. We planned and researched every time, which we started together in class. During the first two hours, the source code for the entire program was jointly prepared, and later the major control points were agreed upon, and they had to complete, test, and repair the entire program at home. Deadlines were set for solving the partial tasks, which were also milestones in the project. The deadlines were one or two weeks depending on the difficulty of the tasks.

Figure 3

ArTech Robot

Source: https://toys4brain.com/en/artec-robotist-transforming-robot/

Lesson Plan:

1: What does problem-solving thinking mean in everyday life, how IT tools, Studuino and ArTech robots help solve problems. Getting to know the Studuino environment, assembling robots, trying out a pre-built robot in groups of 3-4 people.

2: Create a simple robot program. Building robots in groups of 3 to 4, creating a program for traversing a square, circle, regular triangle, regular pentagon, guiding a robot along a maze.

3. Using LEDs, Speaker (Buzzer). Programming of police lamp, siren, melody in the established groups.

4. Robotrally Competition I. Building a course, designing a program to cross the course, testing robots on the course, improving movement.

5. Robotrally Competition II. Refining robot movements.

6. Robot construction, further uses of DC motor. Crane, lift, construction. Castle construction can be raised with flag, bridge.

7. Using touch sensors. Programming a button, building a ram, building a remote controlled car, making a piano.

8. Use of sensors (IR photoreflector). Flying robot, making a robot staying in orbit.

9-10. Self-realization of a complex task. Construction of a robot in a tunnel.

REFLECTION

The mood of the lessons was more relaxed and relaxed. In each informatics class, students worked in groups created during the first lesson. The grouping was done by

themselves, they were placed in the same groups on the basis of sympathy. After the basics, they had to work on their own in class. You could also ask me for help and use online resources. After presenting the basics, I was only present as a moderator. They were given homework hour by hour, which had to be completed on time. They could contact me via messenger and email if they could not solve a problem. There was no problem with meeting the deadlines and solving the set tasks. Teacher-student and student-student relationships were strengthened. Poorer students were successful and had a positive impact on their later activities. I found that they could use their creativity to achieve more serious results, to be more active in and out of class. Because the practical examples were lifelike, they were able to experience themselves in real situations, which also developed their creativity.

On the whole, we ended our project with positive experiences from both teachers and students. There was continuous documentation of the students' work, saved source files, pictures and videos of the workflows, and a report on the school event on city TV. At the end of the school year, a robotics competition was held at GE Electric for students to participate in the VándoRobot program. We participated with a team of five successfully, with more experience and enthusiastic programming students.

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Sustainable Consumption Behavior

STEP BY STEP WITH THE CARBON FOOTPRINT: HOW IMPORTANT IS SUSTAINABILITY IN CATERING?

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ABSTRACT

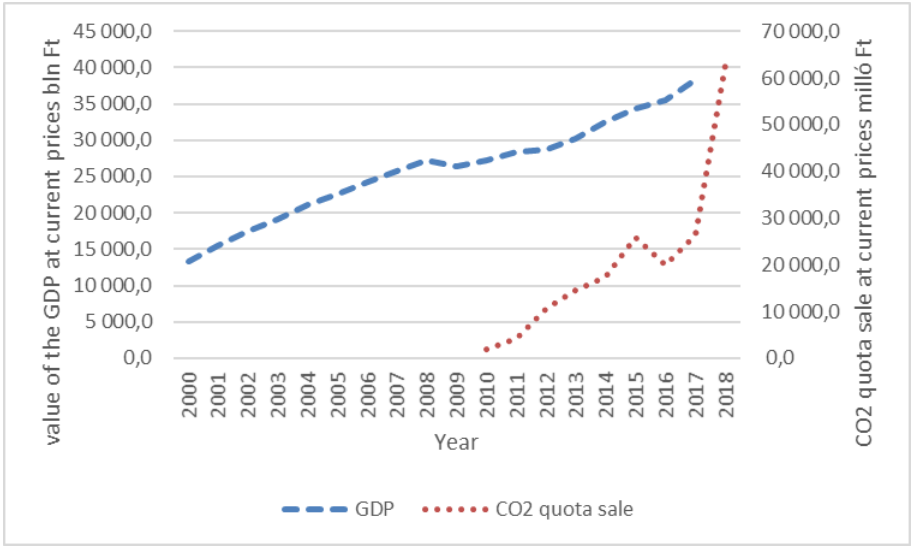
Can be a menu design employed as a customer 'nudging' tool? How environmentally conscious are the restaurateurs? We investigate carbon footprint sensitivity, and link sustainable to healthy eating via developing a signaling system.

INTRODUCTION

The evidence of natural resource depletion and environmental pollution is growing. Although their direct impact on national economy is not yet significant (see *Figure 1* the CO2 quota sales rate is very low, yet it rises sharply), the environmental issues have become complementary to economic goals (*Hertwich et al.*, 2009).

Figure 1

Value indices of gross domestic product and CO2 quota



Agriculture and food industry, just as well catering supply humans with food, and were considered to be a crucial source of artifical greenhouse gas emission, in addition to households (*Jeong et al.*, 2018). Since the mid-20th century anthropogenic greenhouse gas

(GHG) emissions are believed to be the dominant cause of global warning (*Grasso*, 2017). Agriculture contributed about 10-12% of anthropogenic GHG emissions, and accounted for 56% of global anthropogenic non-CO2 GHGs (*Xu et al.*, 2016).

Reduction of negative effects of human activities on the environment are now required, together with satisfactory economic performance. These tendencies demand different approaches, methods, and complex indicators. Our research team in Budapest Business School at Faculty of Commerce, Hospitality and Tourism is intent on investigating the sustainable hospitality via carbon footprint connected to other aspects (like healthiness and fitness) as well.

The role of food consumption, as well as the factors influencing it, have gained importance (*Sandep et al.*, 2016, *Miller et al.*, 2015). In the domestic restaurant industry competition is increasing, so consumer satisfaction and other marketing tools have become more and more relevant and important as regards increasing customer loyality (*Tonkin et al.*, 2016). One of the most prominent among these tools could be sustainability, which has key priority for our exploration. How important is environmental protection in Hungary for certain groups of consumers who visit a restaurant? Can be a menu design employed as a customer 'nudging' tool? Restaurant guests are becoming more and more familiar with the concept of carbon footprint, but this aspect is still not among the most important ones.

Restaurateurs have a crucial role to play as architects of consumer choice since the menus they create can effectively influence the decision-making process of consumers. How environmentally conscious are the restaurateurs? This survey is still ongoing.

Using a computer program, we plan to investigate carbon footprint sensitivity, and link sustainable eating to healthy eating via developing a signaling system similar to a traffic light.

MATERIALS AND METHODS

Our three-member research team consider it to be extremely important to examine the carbon footprint and its impact on the guests' decisions via online questionnaire. Furthermore, we are also interested in how well the guests know what carbon footprint means and to what extent it has an impact on their decisions. Because of the multidisciplinary character of consumer behaviour, several studies of many scientific fields have examined the factors that can have an effedt on individual choices. Consumer preference, as a complex behaviour, is influenced by numerous factors, such as resident environment, family, relationships (external factors), and perception, motivation, attitude (internal factors). It is known that consumers can overrate product information otherwise unnecessary. They prefer relying on external information such as reputation of the brand, prestige, promotional messages, warranty and guarantee. Some external information significantly influence the consumers' picture about the quality and shelf-life. These can be the price, brand, commercial unit and the origin of the product. Nowadays three determining consumption trends form the trade turnover of consumer goods: pursuit of healthy living, convenience factors and importance of price to value.

A survey was used to

1. Measure consumer awareness of sustainability (carbon footprint)
2. Asses the use of smart labels
3. Identify guest groups on the basis of the importance of environmental and other aspects

The study sample included university students, fulls and adults. The online questionnaire survey was conducted from 19.09.2019 to 04.10.2019. In total, 129 usable questionnaires were collected. The questions are based on two previous surveys (see the literature: both in 2015, in the UK) (*Filimonau et al.*, 2017). In these literatures were identifying customers perceived importance of nutritional and sustainability aspects. Step by Step qustionnaire's part 1 assessed the participants with respect to how often they visit a restaurant (which consumer group they can be positioned; questions no. 1,2). Part 2 asked for the respondents' opinion on the importance of aspects of choosing items (questions no. 3-10). Part 3 measured the use of smart labels (question no. 11). Part 4 of the questionnaire concerned demographic data (questions no. 12-15).

All items for Part 2 were assess on a Likert scale of 1-5 ranging from extremely relevant to not relevant the importance of the aspects.

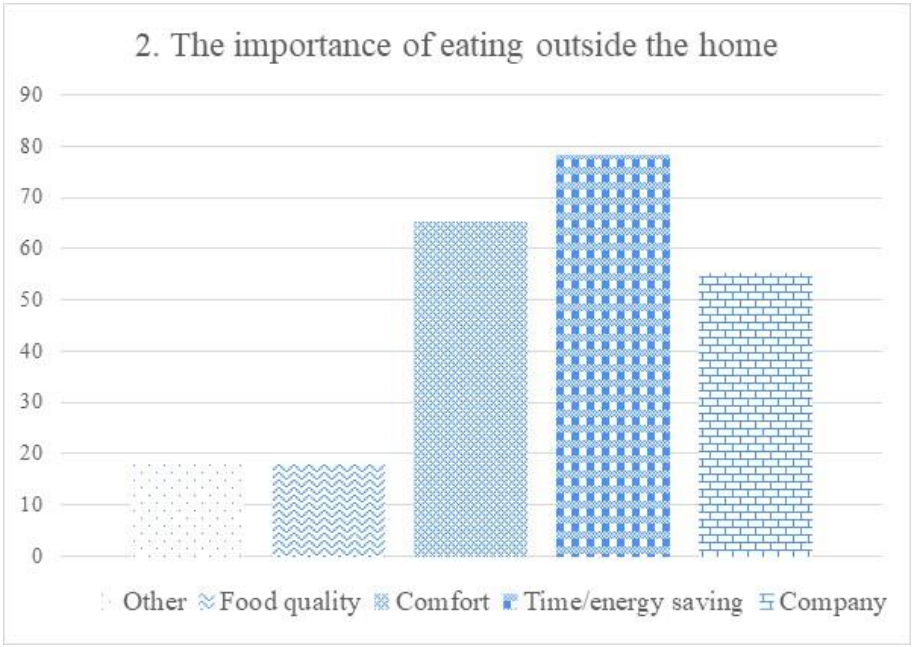
For data analysis, SPSS 24 for Windows and Excel 2016 were employed.

The Step by Step sample (not representative) comprised of: 74.4% females, 82.2% between age of 20-29 years, 79.8% with secondary/high school education, 90% urban (living in Budapest/county seat or other city).

The descriptive analysis (*Figure 2*) of the answers shows that 94.5% eats out 5 times or less a week so as to save time or energy and for comfort reasons.

Figure 2

Causes of eating outside home



RESULTS AND DISCUSSION

The respondents were asked how important the aspects listed are when choosing food (*Table 1*).

Table 1

The importance of the aspects in the two questionnaire

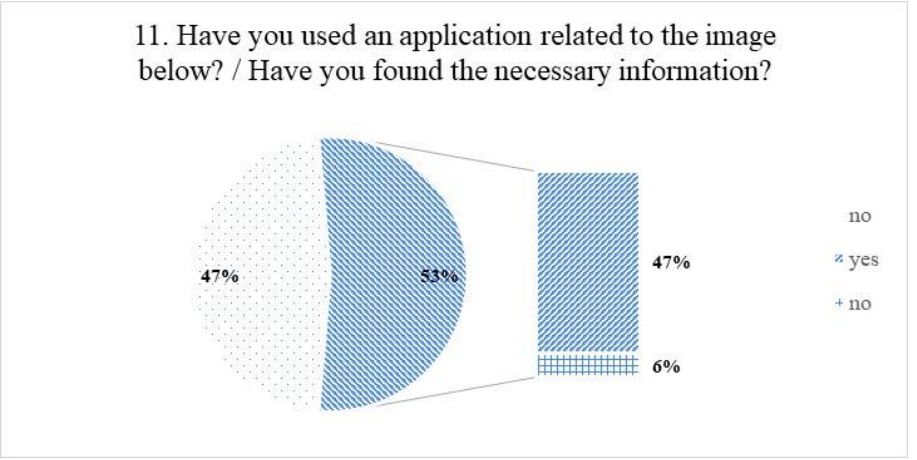
Aspects	Rank of importance	
	Step by Step	UK 2015
Ingredients (additives, preservatives, emulsifiers,…)	1	1
Nutritional value (energy, fat, protein, carbohydrate, fiber...)	2	2
Allergens	3	6
Animal wellfare	4	5
CO2 footprint	5	7
Method of preparation	6	4
Price	7	3

The Mann-Whitney test could not be performed because the original data of the 2015 questionnaire was not available. According to Spearman's rank correlation coefficient, the direction of the priority order of different aspects is the same. The strength of the correlation is in the middle. Awareness has grown among the respondents to this questionnaire and the sustainability aspect has become more important.

In question 11 of the Step by Step questionnaire, we inquired about the participants' opinion on the use of smart labels and QR codes (*Figure 3*).

Figure 3

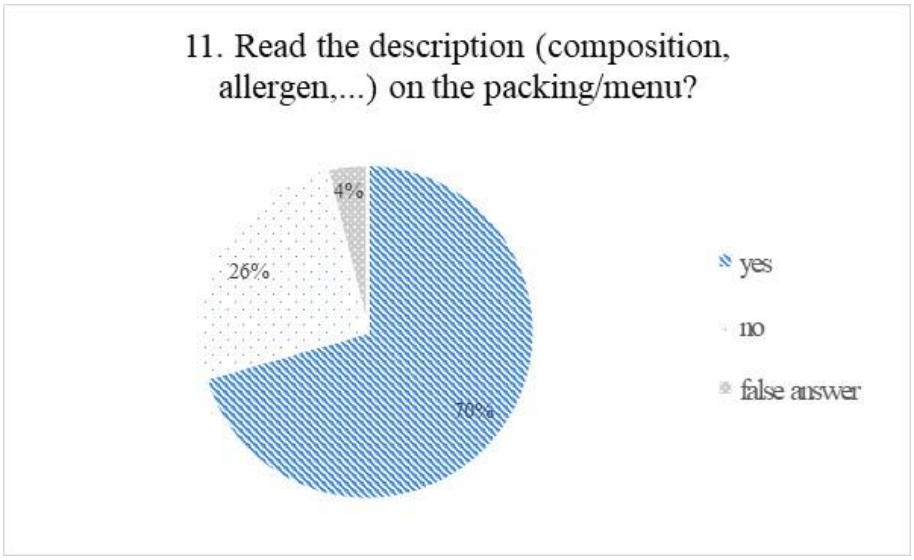
The use of QR-code



The QR-code has already been used by half of the respondents (to obtain information) and most of the labels have proved useful (*Figure 4*).

Figure 4

The use of smart labels



The majority of responses was positive (used and proved useful).

To measure the relationship between smart label use and respondent parameters (*Table 2*) Khi2 tests were conducted. By completing the tests, the relationship with educational level proved to be significant.

Table 2

Relationships between smart labels responses and respondent parameters.

Parameters	QR-code use	Smart label use	Show CO2 value
Gender	non-significant	non-significant	non-significant
Age	non-significant	non-significant	non-significant
Education level	non-significant	**significant, weak**	non-significant
Residence	non-significant	non-significant	non-significant

The validity of the KMO test is significant in both cases (see*Table 3*), so the method of factoring divided the respondents into 3 groups on the basis of how important they thought the individual aspects to be (see *Table 4*).

Table 3

Testing the factor analysises

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,672
Bartlett's Test of Sphericity	Approx. Chi-Square	298,854
	df	28
	Sig.	,000

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,548
Bartlett's Test of Sphericity	Approx. Chi-Square	64,767
	df	15
	Sig.	,000

Table 4

Results of the factor analysises (a: based on question no3 left, b: questions n.4-10. right)

Rotated Component Matrix[a]

	Component 1	2	3
Származhely	,613	,032	,225
Tápérték	-,003	,063	,896
Összetevők	,261	,486	,668
Allergén	,391	-,568	,443
Állatkísérlet	,865	,065	,011
Karbonlábnyom	,871	-,192	,009
Ár	-,251	,822	,144
Elkészítésimód	,378	,752	,234

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

Rotated Component Matrix[a]

	Component 1	2	3
Árszempont	,052	,014	,971
Származhelyszempont	,826	-,148	-,025
Tápértékszempont	,288	,648	,033
Összetételszempont	,528	,548	-,319
Karbonszempont	,683	,187	,108
Éghajlatvált_ember	,249	-,730	-,027

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

In both cases the profiles of the respondents are very similar to the following:

1. Group number 1 is green, eco-conscious and not price-sensitive. In both cases, the quality of the food (origin and environmental effects) was considered important. The price proved the least positiv aspect.
2. To group number 2 (in left table, number 3 in the right) belong those whose financial situation and health condition are worse than that of those in group 1. This means they are less eco-conscious and less green.
3. As for the 3rd group (in left table, number 2 in the right), respondents enjoy their life. They regard ingredients and the nutritional value information as the most important factors, and they pay less attention to being green (animal testing, the sustainability of food production and so on).

CONCLUSIONS

Sustainability and eco-consciousness have emerged worldwide. Therefore, it may also be worth investigating consumers' behaviour with respect to these areas (including the use of smart labels). The purposes of this study were to investigate the aspects when choosing food, in particular with regard to sustainability.

The respondents' awareness of carbon footprint differs by their behaviour. The importance of carbon footprint is low since the proportion of the consumer group for whom it is important is low. There is a demand for information (description or explanation) on the carbon footprint.

Labelling is an important information source for guests as pepople are increasingly becoming interested in product or production quality (Weinrich et al., 2016). It has to be taken into consideraion that a multi-level labelling system could result an "information overload" (Neal et al., 2017, Roseman et al., 2018), and so it has additional costs. However, consumers are aware of sustainable and environmentally friendly products and they are willing to prefer restaurants that support such initiatives (Fakih et al., 2016). Menu labels can help communicate information about food and beverage products on restaurant menus.

The guests do not attach equal importance to the cues that communicate the nutritional as sustainability attributes of the menu items (Lo et al., 2017). Although menu labeling may only indirectly influence the selection of healthier and sustainable menu items (*Lawless et al.*, 2016), it may increase the availability and awareness of menu choises. The more educated the consumer, the more green they are (due to their knowledge and financial conditions).

Carbon footprint is not yet well known, but there is an increaseing demand for information about it. It could be a useful and effective marketing and communication tool for greener catering.

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WHO IS INTERESTED IN BUYING AGROFORESTRY PRODUCTS?

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ABSTRACT

Nature conservation and the preservation of natural resources belong to the most important current issues. There is no doubt that they are relevant at the level of individuals, but the question is whether they appear in consumer behaviour, especially in the awareness of forest and forest products. In our study we are looking for an answer to this research question. Our online questionnaire was filled in by 219 respondents of 20-40 years of age who will be the next consumer generation. Our results show that 80% of our respondents are aware of the forest products and 66% regularly purchase some of them; mainly honey, mushrooms or game. As for the purchase places, personal and direct forms are especially preferred: they buy these products at the farmers' market or from friends. We can conclude that there is a demand definitely for agroforestry products and also that the population could be involved into environment-conscious purchasing more efficiently by making the sale of agroforestry products organised.

INTRODUCTION

Nowadays we can read about agroforestry more and more often as the brand-new confusion of agriculture and forestry methods. Which shouldn't have the power of novelty, because our ancestors also knew this sort of forestry method. Just as time passes it has deeply fallen into the obscurity of oblivion.

We can make use of applying agroforestry methods regarding both in economic and environmental areas. (*Grado*, 2001) Agroforestry provides solutions to preserve and recondition our natural resources for the future generations, by the help of inter alia augmentation of salinity and water table control and soil erosion control.

Agroforestry connects different production methods which can mean a solution for the climatic and natural problems of the future. Agroforestry calls the attention to the well balanced and harmonious production with nature and not to its exploitation.

Agroforestry systems which are in use currently (*Figure 1*):

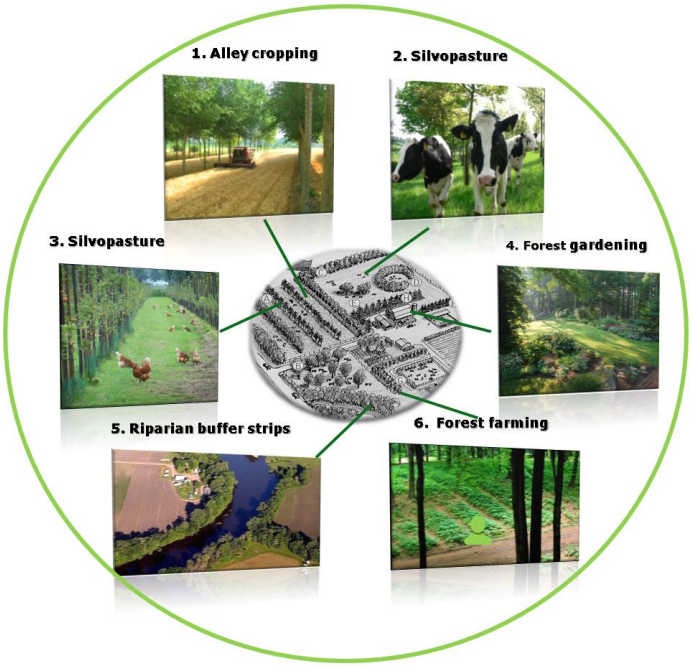
- silvoarable (forest and plough land in one land),
- silvopasture (forest and pasture in one land),
- forest farming,
- riparian buffer strips,
- forest garden (*Honfy et al.*, 2016).

Products which could origin from agroforestry production system:

- honey,
- game,
- mushroom,
- herb, medical plant
- wood, fuel wood (*Vityi et al*, 2014)

Figure 1

Currently used Agroforestry systems



Our purpose is to get to know this kind of forestry system with the consumers. Furthermore, which has to be more prevalent is to popularize and to put an emphasis on this production method amongst farmers doing different agricultural activity. By enhancing the agroforestry product range, farmers could reap substantial benefits.

With the help of analysing a consumer survey, we can ascertain which group of the consumers should be targeted. (*Malhotra*, 2008) Besides this we can specify which channels should we use to reach consumers and even what sort of marketing tools are necessary for the communication and promotion. Finally, we can make the positioning of the newly created consumer group.

MATERIALS AND METHODS

The research is based on both primary and secondary methods. Our secondary researches included scientifical articles on the internet and majorly analyzing a questionnaire and statistical data collected by a previous quantitative research, which was applied for both scientific and social problems.

We carried out an empirical research in case of purchasing agroforestry products. The Questionaire was filled by 219 respondents. This was an unipoll typed form, which was available online in 2019 in Hungary. Six question (closed, scale) of twenty-two was related to our topic. The questionnaire analysis was created by a statistical program matching the needs (Stata 15.0 and Microsoft Office Excel). During the analysis, first of all we introduce the frequencies in the whole sample. We analysed the background variables only those, which

showed significant relationships with 95% confidence level. It included the next background variables: gender, age, qualification, type of residence, household monthly income. The analysis contained mainly percentages. In the case of percentage distribution, we carried out significance analyses with Chi-squared tests.

RESULTS

Have people already known and purchased agroforestry products?

Eighty percent of the respondents know the items coming from forestry system production. Two-third of people have already bought them at least once (*Figure 2*).

64% of women bought forestry products So in total only 36% of women have not bought any forestry products so far. Regarding men the rate of proportion, who have bought the products is 72% from the wole. This is an outstanding result (*Figure 3*).

Figure 2

The distribution of purchasing people of those who have already known the products of forestry system in rate of proportion (N=219)

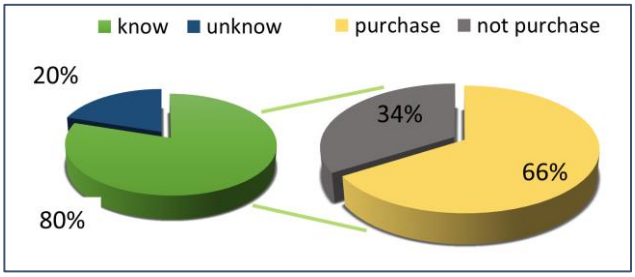
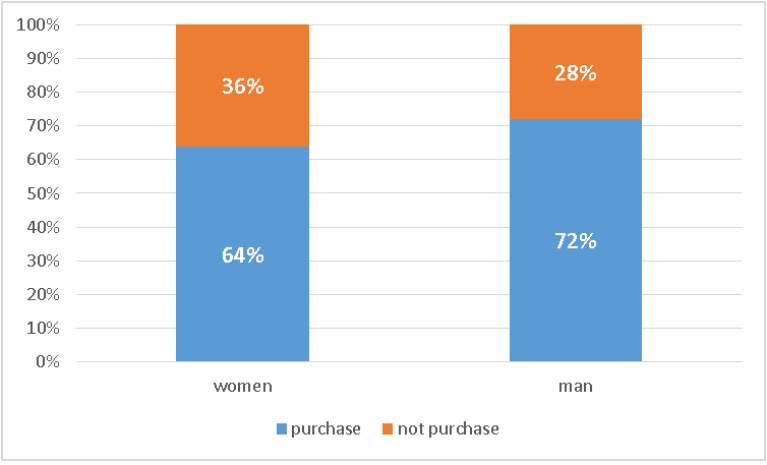


Figure 3

Number of people purchasing in rate of proportion (N=219)

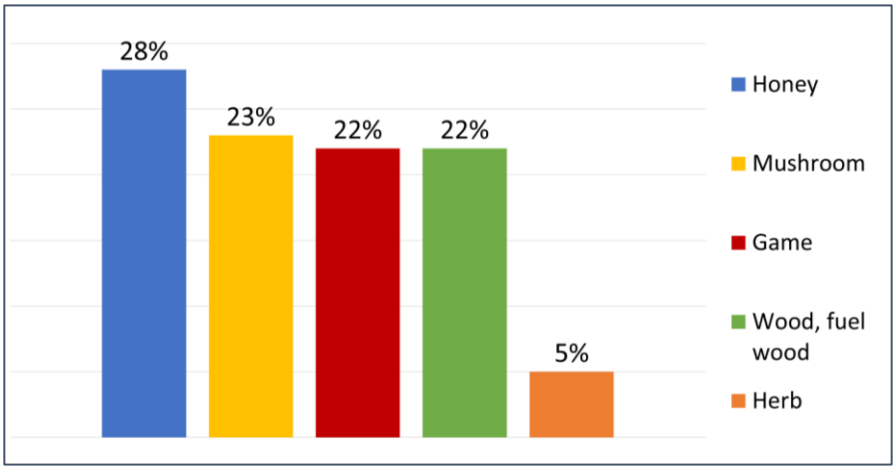


The main fields of consumption which can be interesting for consumers

We can see that we didn't get a significant difference between the four main type of products which is in the consumers' favors (*Figure 4*). Although honey is the first of the preferabbles, mushroom, game, wood and fuel wood categories are close enough in the gradation. This majority of honey, mushroom and game supports other research is as well (*Hegedüs*, 2007). The only exception is the herbs and medical plants category which represent only 5% of the whole demand.

Figure 4

Products of purchasing in rate of proportion (N=66)



The outstanding result of men purchasing forestry products (that we could observe in the previous graph) and also characteristic in the result of background variable analysis in this graph, let us conclude that the main consumers consists of hunters. Every second respondents of men claimed that the venison is the main product they consume in the fields of forestry products, which could corroborate that fact.

Regarding women shoppers, their basket value looks like this: 36% honey, 26% wood or fuel wood, 16% mushroom and the remaining 22% consist of herb and game (*Figure 4*).

54% of the respondents live in villages or cities which population is under 100.000 inhabitants.

Eighty percent of the customers make a living from their monthly salaries and they can even reserve money and live under good financial circumstances without making complaints. Sixty-two percent of women belong to this group. Forty-six percent live in villages and also forty-two percent live in smaller cities from this group. Consequently, we can say women live in the countryside would rather buy the products. Capital city dweller's amounts to 12% of purchasing.

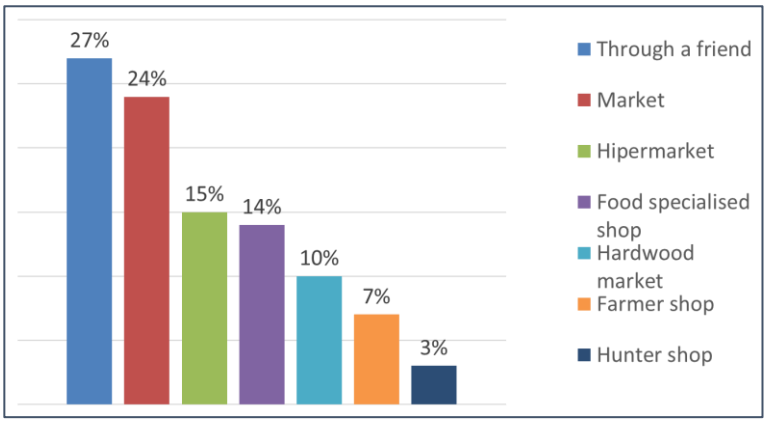
The main places of consumption which can be interesting for consumers

We can underline the first two categories because their value accounts more than half of the all customer's choice (*Figure 5*). Those customers, who have purchased already forestry

products prefers to use zero leveled distribution channels, where they can buy these products directly from the producers. (*Malhotra*, 2008) Consumers would rather trust in their acquaintances than to buy the products at a retailer's shop or in a bigger hypermarket. They assign higher quality to a product which was produced by an acquaintance.

Figure 5

Places of purchasing in rate of proportion (N=66)

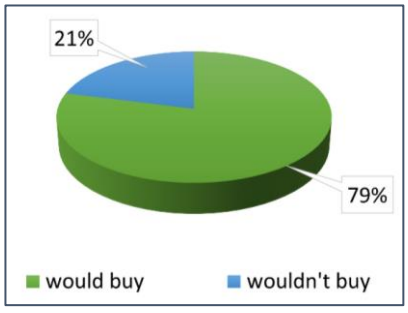


Will respondents purchase products in the future which were produced in agroforestry systems?

If the consumers have already bought products which came from forestry production, then it has a large likelihood that they will buy the same products comes from agroforestry system production (*Figure 6*).

Figure 6

Purchasing in the future (N=164)



So much the more this way of agriculture between tree alleys contributes to responsible consumption and production and maintaining the biodiversity and protecting inhabitats. (*Keserű et al.* 2018) Sustainability has to be our common interest if we want use the natural

resources of the earth in the next decades as well. (*Borelli et al.*, 2018) That's why the proper communication of the relevance of this topic should denote that this is the key for giving purchase motivation to our customers.

Nearly four-fifth of the respondents claimed, that they would buy products which were produced in agroforestry systems.

We can see a strong correlation between the residence type and the desire to purchase: 74 % of the respondents who wouldn't like to buy these kinds of products live in cities which population are under 100.000 dwellers.

We made an analysis with the help of khi-squared test, whether there is a correlation between gender and desire to purchase. We came to the conclusion that the p value is very low (p=0,0062).

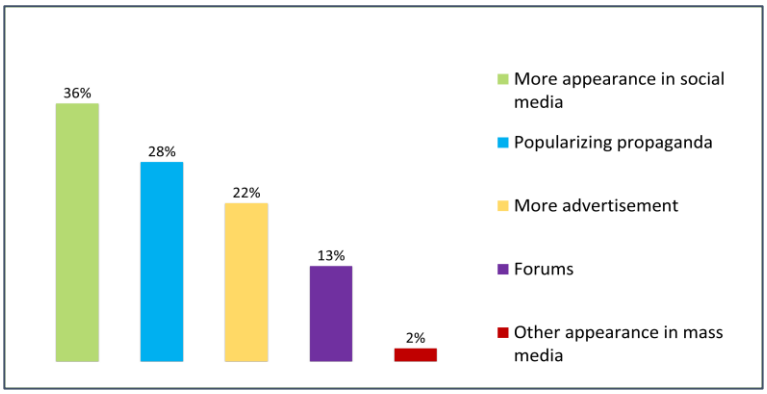
The correlation between gender and the desire to purchase is statistically significant on 95% significancy level. It has a significant effect of the customer's choice. This means that women rather buy the agroforestry products.

Marketing tools for popularizing agroforestry products

85% of the respondents chose one from the three marketing communication forms (*Figure 7*). One third of the respondents think that the most expedient tool to popularize the products is any kind of appearance in the social media. Half of the respondents claimed that some kind of propaganda or any advertisement would reach our research's desired purpose.

Figure 7

Popularizing the products coming from agroforestry production (N=164)



CONCLUSIONS AND SUGGESTIONS

There will be demand for the agroforestry products, which were also supported with international examples. Our target market presumably those women who lives in smaller cities, and their basket mainly consist of honey, to a lesser extent wood and mushroom. In case of men game will be the dominant reason of purchasing. If we can make sales more organized, the public could be more effectively involved in environmental-conscious thinking.

The Weaknesses of selling agroforestry products can be origined from the lack of public visibilty and the earlier weak marketing activity in the field of promotion. Adequate marketing communication methods would affect consumers in purchasing. According to the respondents more appearance in mass media, propaganda and advertisement could enchance the potential future's sales. Further researches needed to comprehensively answer the emerging questions of the topic.

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CONSUMER PERCEPTION OF INSECT AS FOOD IN HUNGARY

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ABSTRACT

Evidences of eating insects can be found in religious literature (Christian, Jewish and Islamic faiths) (FAO, 2013), however most Western societies struggle with neophobic reactions and negative attitudes. The aim of this study was to examine Hungarian consumers' feelings, beliefs, attitudes and motivations for (not) choosing insects as food and insect-based foods through a questionnaire (N=126). Respondents are aware of the benefits of insect flour, they would eat animal product of insect-fed animals, but uncertain in tasting insect food. Knowing the benefits more would encourage them to consume more insect food. Roadshow / tasting and gastro shows could play an important role in the promotion of insect food. More emphasis should be placed on the benefits, positive physiological effects of insect-based foods. In order to bring awareness, information dealing with the benefits should be published (on and offline).

INTRODUCTION

In recent years there has been an increasing interest in replacing the more and more expensive GMO soybean meal and fishmeal with insect flour. Insect flour has a high content of protein and fat, favorable content of unsaturated fatty acids (*Szendrő et al.*, 2018a,b; *Belluco et al.*, 2013; *Verkerk et al.*, 2007), which plays an important physiological role. In addition, its production cost is low and has a small environmental footprint (*Van Huis et al.*, 2013). Moreover, the feed conversion rate (FCR) in insects are lower (1.7 and 2.2 in crickets and mealworm, respectively; *Collavo et al.*, 2005; *Oonincx and de Boer*, 2012) than that of most farmed livestock (2.3 for broiler, 4.0 for pork, and 8.8 for beef; *Wilkinson*, 2011).

Rozin (1988) revealed that cultural influences on attitudes and beliefs as well as the meaning and social appeal of food have a significant impact on consumption. The acceptance of food is also influenced by its nutritional value, quality, beneficial health effects, expected taste and geographic origin (*Barrena and Sánchez*, 2013). Some countries (especially in Asia, Africa and Latin-America) have a tradition of eating insect as a food commodity. However, food-decision making of the Western societies differs considerably. Nowadays insect food is available in some European countries as well; Netherlands and Belgium were at the forefront in Europe to include edible insects in food laws. Since then, Austria, Denmark, Germany, Finland, France, Norway, United Kingdom have or open to internal legislations regulating the trade of insect-based food (*Mancinia et al.*, 2019). The study of *Piha et al.* (2018) also suggested that Northern Europe is a more prepared market for insect food than Central Europe. However, *Van Huis et al.* (2013) found insect food suitable for human and animal nutrition all over the world, still, Western societies struggle with neophobic reactions and negative attitudes. The European consumers' acceptance of insects as food has been studied since 2012 (*Caparros et al.*, 2014; *Schösler, de Boer, and Boersema*, 2012; *Vanhonacker et al.*, 2013; *Verbeke*, 2015; *Yen*, 2009). The readiness to adopt insects as food in Hungary was studied by *Gere et al.* (2017). Hungarians seem to consider eating insects as exotic,

and food neophobia negatively affects insect consumption. *Siemianowska et al.* (2013), *Hartmann et al.* (2015), *Gere et al.* (2017) suggest reducing neophobic reactions and negative attitudes by incorporating insects into familiar food items. Also, the willingness to eat insect-based food products could be increased by giving more information to the consumers.

Some believe that using insects for food is a promising way to overcome numerous global food challenges (*Abbasi et al.*, 2016; *Tomberlin et al.*, 2015; *van Huis et al.*, 2013). Indeed, "edible insects could be on European tables in a near future and be part of a world response to the request of new protein sources" (*Mancinia et al.*, 2019 p16).

The aim of this study was to examine Hungarian consumers' feelings, beliefs, attitudes and motivations for (not) choosing insects as food and insect-based foods through a questionnaire.

MATERIAL AND METHODS

The nationwide consumer study was conducted in 2019. Among non-probability sampling techniques, snowball sampling of data collection was used meaning that the structured survey was given to an initial group of respondents (those who used the Internet) selected randomly. Respondents were encouraged to locate other members of the target population whom they know; i.e. friends, relatives, colleagues, etc.

The survey consisted of 15 structured questions asking Hungarian respondents regarding their perception of insect, consumption of insect or food that contains insects, willingness to taste, factors increasing the consumption of insect food, promotion possibilities of insect food, and background information. Frequency distributions were performed in the evaluation of the questionnaire. Means and standard deviations were calculated.

RESULTS AND DISCUSSION

According to the findings of the questionnaire, respondents are aware of the benefits of insect. On a 1-7 scale all features were regarded well above the average (*Table 1*). However, their answers were not persistent, which is proved by the high standard deviations.

Table 1

Perception of insect on a 1-7 scale (N=126)

Insect…	Mean	SD
…is an excellent source of protein.	6.1	1.56
…requires less water and feed than other animal sources of protein.	5.7	1.69
…has a high nutritional value.	5.6	1.70
…produces less greenhouse gas than any other animal protein source.	5.5	1.76
…is safe to consume.	5.1	1.91
…has positive physiological effects on human.	4.7	1.89
…is produced under controlled conditions in large quantities, also in Europe.	4.6	1.95
…is expensive.	3.9	1.97

Respondents stated that they were interested in gastronomic novelties and like exotic food. They would even eat animal product of insect-fed animals (*Table 2*).

Table 2

Perception of statements by respondents on a 1-7 scale (N=126)

Statements	Mean	SD
I am interested in gastronomic novelties.	5.0	1.91
I am interested in what the animal has been fed, whose meat or product I eat.	5.0	1.68
I would consume a product of animal originated from an animal fed with insect meal.	4.2	2.23
I like exotic food (food from different countries, different cultures).	4.1	2.09
I don't trust new foods.	3.1	1.71

Table 3 shows respondents' suggestions for promoting insect products consumption? The 3.6 mean for trying for instance a cake that contains insects decreased to 3.2 when pictures of insect food were presented. Still, these are the highest scores – the two very high end: one where the insect can be really seen and the other end where it is processed.

Table 3

Perception of statements regarding insect food on a 1-7 scale (N=126)

Statements	Mean	SD
I think the insect foods are exotic (unfamiliar/interesting).	4.8	2.15
I think insect foods can be made for civilized people.	4.6	2.19
I find insect foods to be disgusting.	3.7	2.42
I wouldn't reject insect food if I was a guest.	3.7	2.34
I'd eat foods that contain processed insecticide (e.g. cake).	3.6	2.42
I'd taste insect food.	3.4	2.35
I'd taste a whole insect (for example, crickets or locusts).	3.2	2.39
I would make food that contains insect flour even at home	3.0	2.26
I find the insect dishes tasty.	2.8	2.13
I would only taste insect food abroad (e.g. in the Far East).	2.2	1.63

Eighty-four percent of respondents said they have never tried eating insects (*Figure 1*). Most of the respondents consumed insects in Hungary (9%) and abroad (5%).

In the next question, where more anwers could be chosen, respondents were asked to indicate factors that would encourage them to consume more insect food. One of the most common choice was that if they have known the benefits more (*Table 4*).

Figure 1

Consumption of insect or food that contains insects

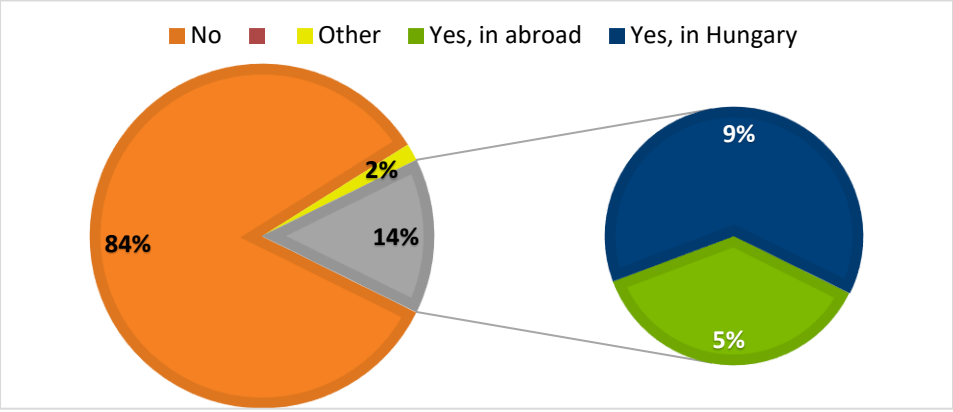

Table 4

Factors increasing the consumption of insect food

Statements	%
If I would like it.	45%
If their positive physiological effects were better known.	43%
If I got used to it.	32%
If I knew how to cook (e.g. recipes).	27%
If insect flour was used to produce the meat I consumed.	21%
If it was cheaper than meat.	18%
If it was used as a supplement to familiar products (e.g. chicken burger).	16%

Of course it was easier to react on how to encourage others - how to promote insect flour? Half of the respondents recommended tasting and gastro shows, but emphasising its environment-friendly production and other benefits were also regarded high (*Table 5*). More access would definitely stimulate consumption and if insect food would be available in resturants.

CONCLUSIONS

First of all, edible insects should be included in food laws in Hungary and other countries. Internal legislations regulating the trade of insect-based food are needed everywhere. Also, more emphasis should be placed on the benefits, positive physiological effects of insect-based foods. In order to bring awareness, articles dealing with the benefits should be published (on and offline). Then – in case of Hungary – insect food could be introduced on the market with the help of supermakets and gastro angels.

Table 5

Promotion of insect food, % (N=126)

Suggestions	**%**
Roadshow / tasting	52%
Gastro shows	50%
Emphasize that its production is more environment-friendly.	43%
Publish online articles about the benefits of insect consumption.	36%
More access	33%
Available in restaurants.	33%
Insect as an alternative to meat.	25%
Publication and distribution of recipe books.	22%
Advertising in social media (eg Facebook, Instagram).	20%
Resources should be provided for domestic insect production.	19%
Publishing recipes in gastro newspapers.	18%
TV commercial	14%
The state could embrace popularization.	14%
Introduce into kindergarten / school catering.	6%

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