DOI: 10.54597/mate.0068
Tóth, K.., Pintér, Zs, Nagy, M. Z. (2022): Information systems in agri-food chains.
In: Srečec, S., Csonka A., Koponicsné Györke, D., Nagy M. Z. (Eds.):
Management of agri-food chains. Gödöllő: MATE Press, 2022. pp. 150–163.
(ISBN 978-963-623-023-4)

CHAPTER 10

Information systems in agri-food chains

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The aim of Chapter 9 is to learn about the most important characteristics of agricultural information systems and to describe the essence and structure of an agricultural management information system on the market.

The purpose of this chapter is for the reader to:

- Correctly interpret the concept of information systems in agriculture, including the food industry,
- Understand the necessity of corporate application of agricultural information systems,
- Get to know the characteristics of information systems in agri-food chains,
- Review the features of an agricultural management information system on the market.

10.1 Conceptual background of information systems

The existence of information is essential in terms of competitive advantage and in making informed decisions. Those companies that do not have up-to-date, accurate, sufficient quantity and quality information are at a disadvantage, which in the long term worsens the market position and endangers the operation of the company. Recognizing this, the importance of information is constantly increasing and information accessed at the right time and in the right form functions as a resource.

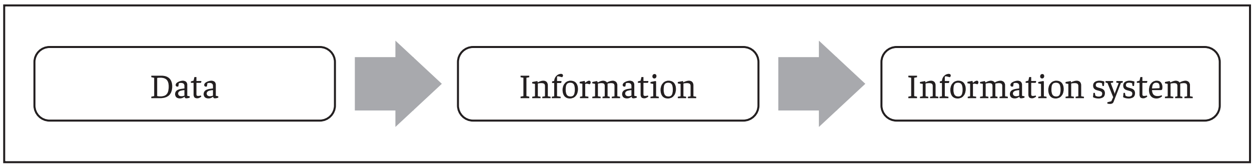

Figure 1. *Procedure of data process*

Information systems are based on data (facts, concepts, instructions) that are suitable for processing and can be interpreted by humans or machines[1]. According to another approach, it can transmit and store the characteristics of already available states, which can thus be used in the future[2]. If we transform these raw facts into a form that can be easily interpreted and used by humans, then we are already talking about information. In addition to information, information is also new knowledge, clarification, and one of the components of the processes that integrate the operation of companies. Its important characteristic is that it has value, is easy to interpret, reduces uncertainty and helps to make decisions.[3, 4, 5]

Up-to-dateness and high utilization of human resource capacity are becoming increasingly important factors in the market, therefore it is essential that companies can reduce and speed up the time invested in the production of information. There are also opinions that the existence of effective information systems is already considered a condition for remaining on the market[6]. Information systems were created to support these processes, which support the performance of organizational tasks with useful information in a way that creates and processes data and information that serve as basic resources[7, 8]. A set of (technically definable) linked elements that collect, process, store and distribute information and thus facilitate the decision-making, coordination and control of companies[4]. Systems are usually built from components of different qualities and these elements are integrated for end users[9]. In most cases, the information can be created not only in a pre-recorded manner, but also with subjectively selected independent queries, so the system can satisfy if a different need than the previous information needs arises.

The classification of information systems is not uniform, they appear differently in distinct sources, of which Table 1 aims to provide a summary without claiming to be complete.

Table 1. *Possible classification of information systems*

Based on fit (Krajcsák, 2012)	**Based on function**		**According to the direction of support (O'Brien & Marakas, 2010)**
	Based on (Dobay, 1997)	**Based on (Kacsukné Bruckner & Kiss, 2007)**	
Functional	Communiational *(TPS)*	Transaction processing *(TPS)*	Operation supportive: – Transaction processing *(TPS)* – Process controll *(PCS)* – Enterprise collaboration *(ECS)*
Corporational	Management *(MIR, MIS)*	Management *(MIS)*	
Interorganizational	Decision supportive *(DSS)*	Decision supportive *(DSS)*	
	Management *(VIR, EIS)*	Executive *(EIS)*	
	Office automation *(OAS)*	Enterprise resource planner *(ERP)*	Management supportive: – Management information systems *(MIS)* – Decision supportive systems *(DSS)* – Executive informational systems *(EIS)*
	Implementation	Supplier relationship management *(SRM)*	
	Groupwork	Supply chain management *(SCM)*	
		Expertive *(ES)*	
		Enterprise performance management *(EPM)*	Operation and management supportive: – Expertive *(ES)* – Knowledge management *(KMS)* – Strategical informational *(SIS)* – Functional business *(FBS)*
		Business intelligence *(BI)*	
		Customer relaionship managing *(CRM)*	

From the table above, it can be established that, based on their relationship with each other, the simplest systems are created separately only to perform a specific function (e.g. support for the performance of accounting tasks). The integration of several functional information systems is already called a corporate integration system. However, it may also happen that the integration systems of two or more organizations need to be combined, which can be referred to as inter-organizational integration.

Information systems can also be grouped according to function. The groupings shown in the table originate from two different sources, which, although very similar, still show differences, which is why we thought of describing both. We consider it important to draw the reader's attention to the fact that there is different content under the same abbreviation.

According to Dobay, communication systems and transaction processing systems (TPS) are suitable for monitoring organizational events, and can handle the collection and storage of data for various tasks[10]. Management information systems (MIR, MIS) support the provision of information to managers by generating reports. Decision support systems (DSS) help with analysis and modeling tasks. Management information systems (VIR, EIS) support management goals with clearly understandable information. The data management of office automation systems (OAS) focuses on documents and data and is suitable for handling them. Implementation systems are involved in the value creation process. Group work systems provide group access to databases.

Based on the classification of information systems (Kacsukné Bruckner & Kiss, 2007), we can already find several categories[11]. The transaction processing system (TPS) is no different from the previous ones, it collects and stores data related to everyday business tasks and monitors transactions. The management information system (MIS) in this classification focuses on the information needs of managers, which is supported by the preparation of reports at regular intervals. A decision support system (DSS) is an improved version of an MIS that focuses on a specific problem. The executive management information system (EIS) focuses on the senior management layer, minimizes information needs to the most important factors, the representations are graphic.

The enterprise resource planning system (ERP) supports production planning with related resources, e.g. finance. It usually includes buyer and supplier relationships as well. The supplier relationship management system (SRM) deals with procurement and related suppliers. The primary goal of the supply chain management system (SCM) is to increase the efficiency of the supply chain, e.g. supporting the cooperation of companies in a buyer-supplier relationship. The expert system (ES) has been narrowed down to special fields of expertise. The company's performance management system (EPM) provides, calculates and controls performance indicators. The business intelligence system (BI) is suitable for preparing online analyses. And the customer relationship management system (CRM) not least serves the purposes of customer service and marketing, e.g. customer management.

The third large grouping distinguishes between the direction of support in information systems. Based on this, we can distinguish operation, management and information systems supporting operation and management.

The purpose of the information systems supporting the operation:
- process business events and transactions,
- supervise the processes and
- ensure access to up-to-date data.

The purpose of management support information systems:
- supporting the provision of information to managers,
- acilitating effective decision-making by highlighting usable data.

Information systems that support operations include transaction processing systems (TPS), process control systems (PCS) and enterprise collaboration systems (ECS). While the purpose of the first is to process data from business transactions and update the available databases, the second is responsible for managing and following the processes throughout, and the third supports the necessary corporate collaboration and communication (e.g. e-mail).

Management information systems include management information systems (MIS), decision support systems (DSS) and executive information systems (EIS). MIS can support decision-making with predetermined reports, e.g. production performance. DSS already provides direct support for decision-making, e.g. predicts profitability. Based on MIS, DSS, and other sources, EIS provides information adapted to management needs, e.g. analysis of business performances.

However, there are support systems for both operations and management, e.g. expert systems (ES), knowledge management systems (KMS), strategic information systems (SIS), and functional business systems (FBS). Expert systems provide advice, e.g. in the case of a loan application. Knowledge management systems help the creation and dissemination of business knowledge within the organization, e.g. access to best business practices. Strategic information systems support the company's competitive advantage, e.g. shipment tracking. In the case of functional business systems, the operation of the basic functions of the organization is supported, e.g. accounting applications.

10.2 Information systems in agriculture and the food industry

The need for information is also present in the agricultural sector, and even nowadays it plays an increasingly important role. The spread of digital/smart technologies and solutions is increasingly decisive in this sector as well. Let's see how agriculture is also becoming a "slave" to technology.

10.2.1 Farm-management systems

It can also be seen in the previous chapter that the individual literature sees, treats and groups the information and its areas of utilization differently. One of the reasons for this is, on the one hand, the diversity of tasks and, on the other hand, the different needs of individual sectors. The framework information system that encompasses agriculture is the farm system, the main characteristics of which are: open (it is closely related to its environment), dynamic (changing over time), stochastic (interactions between the elements of the system – people, animals, plants – and the environment) and artificial (man-influenced). Its main goal is to achieve income (yield) from agricultural activity (in money or in nature).

From a farm system perspective, any agricultural system is a purposeful human-made organization composed of five major subsystems these are[13, 14]:

- The technical subsystem in which resources, technology, knowledge and opportunities are used to produce products.
- The organizational subsystem is nothing more than the organizational framework accepted by the official bodies, in which communication, job descriptions, and the distribution of responsibilities and tasks are included in the farm system.
- The informal subsystem already exists if an economy includes two or more persons. The larger the number of people involved, the more complex the informal structural subsystem becomes.
- The goals and values subsystem is related to the goals and values that make the agricultural system work as a purposeful system.
- The management subsystem is connected to the entire farm system. The manager's objectives determine the long- and short-term plans, the creation of the organizational structure, business decisions, technology selection, resource allocation, opportunities, processes through harmonization with the subsystems.

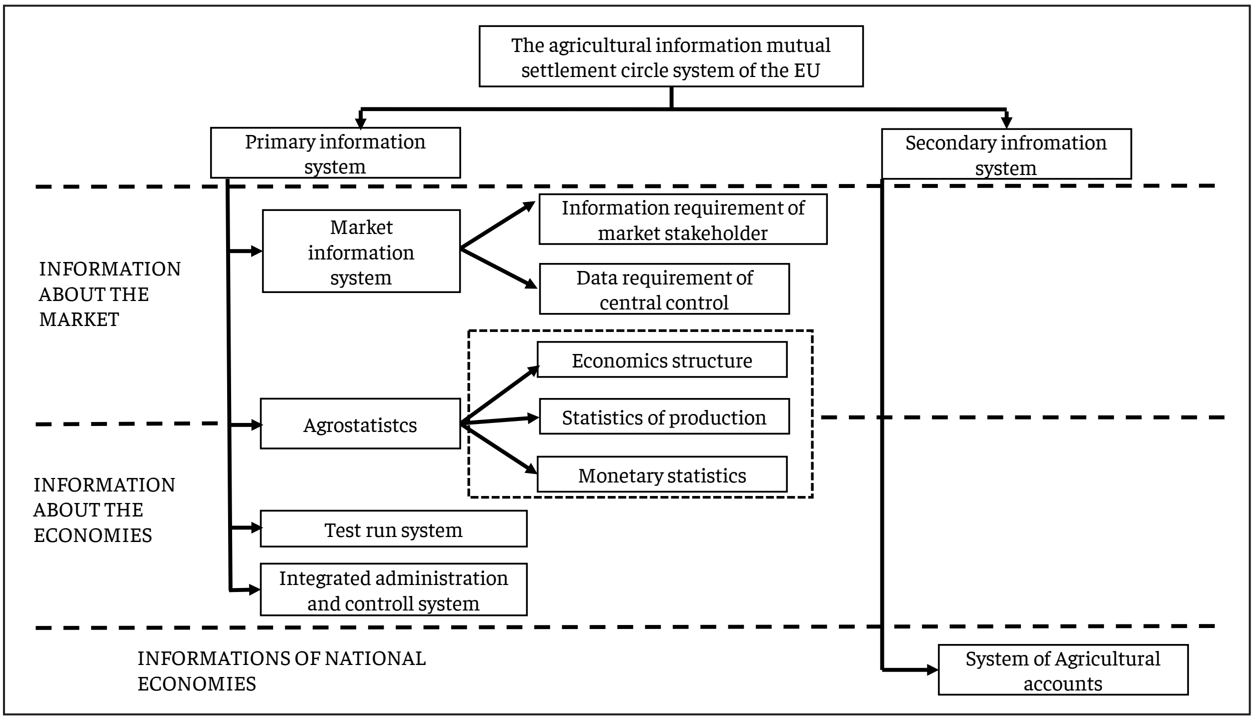

Figure 2. *The Agricultural Information System of the European Union*
Source: Kapronczai[16]

These five subsystems could also be called the building blocks of the farm system. In order to function effectively, management must pay special attention to these integrative processes, which requires properly trained human resources[15].

In the following, let's look at a concrete example of how an information system in agriculture looks and is structured.

The information systems of the EU can basically be classified into two large groups (Figure 2). Primary or prime information systems collect large amounts of direct data. Secondary or subsidiary information systems usually get their information from the databases of the primary systems. The primary data collection - on which the agricultural information system of the European Union is based – can be divided into the following areas: agricultural statistics, FADN (Farm accountancy data network), market information system and the set of information systems for obtaining subsidies.

The promotion of the development of Hungarian agricultural information systems, and as part of this, statistical systems, can be dated around the 2000s due to the EU accession negotiations.

10.2.2 Material and information relations (virtual systems) in the agricultural economy

Based on the previously mentioned systems, the system of relationships of information can be seen, now let's look at what kind of information is needed in the field of agriculture and, perhaps one of the most important things, from whom it can come.

Nowadays, broader and coordinated communication is becoming more and more important in value-enhancing relationships. With the use of technology and other tools, this is forced by the growing competition in the global and domestic markets, the growing needs of different consumers, and the ability to adapt agricultural products to consumer needs[17].

The key factors of the virtual agricultural economy are the groups that manage R&D developments and put information technologies into practice. The point is how we organize them, how we can take advantage of their collective ability. "Agricultural initiatives depend on the skills of professionals and the coordination, integration and management of their tasks."[18] This requires significant relationships, because public institutions and local and regional development agencies must also be partners in economic activities. Figure 3 shows the relationship system of the actors[18].

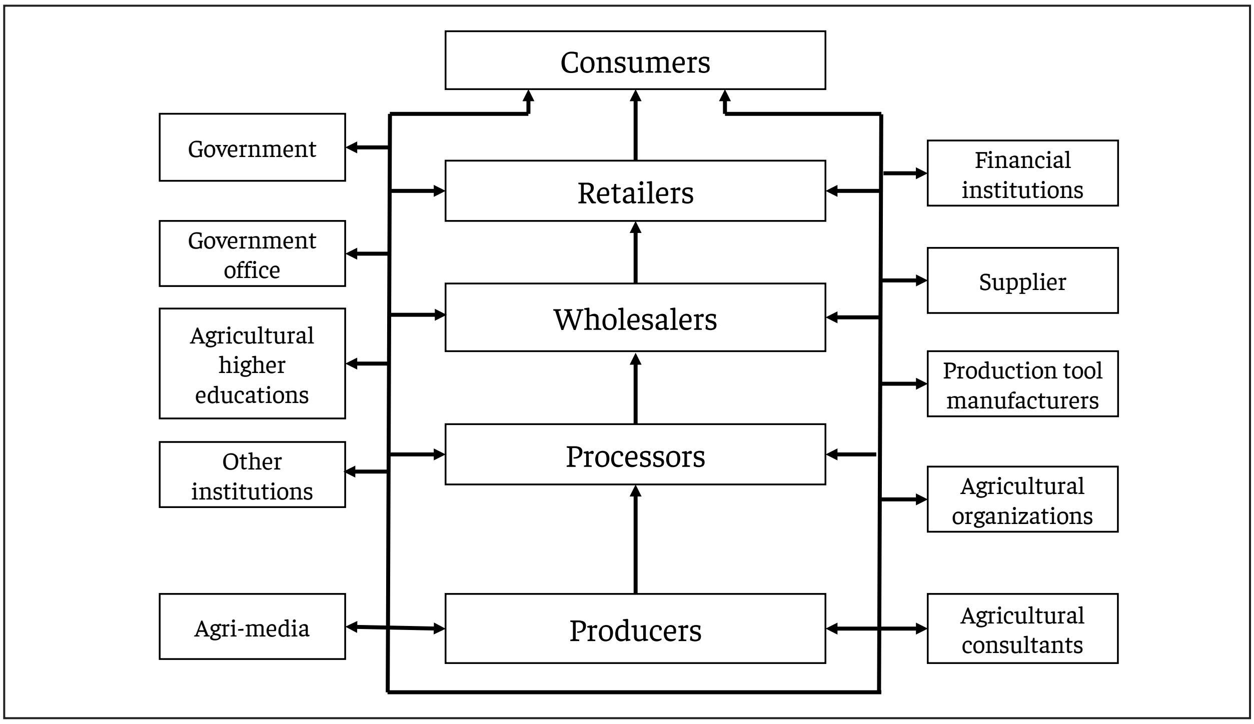

Figure 3. *Material and information relations in the agricultural economy*
Source: Holt and Sonka[17]

10.2.3 Agri-food 4.0

In the next subsection, Agri-Food 4.0 will be presented, that is, how the new digital technology is transforming agri-food supply chains and agriculture.

"Agri-Food 4.0" is an analogy of the term Industry 4.0, which is derived from the concept "Agriculture 4.0". Examining the origins of the industrial revolution, steam engines started the concept of industry, the use of electricity later raised the concept of industry 1.0 to Industry 2.0, and then the use of technologies marked a milestone in the industrial revolution with the concept of Industry 3.0. Industry 4.0 is about incorporating and integrating the latest developments based on digital technologies. This enables businesses to deliver real-time information on behavior and performance. The challenge is to maintain these complicated network structures and connections. These are necessary in order to be able to identify and satisfy the dynamic requirements of parties organized using technologies, especially those interested in the supply chain. In this context, the agricultural field is no exception, although it has some special features depending on the field of expertise.

In fact, all agricultural machinery now includes electronic controls, entering the digital age. In addition, agriculture is supported by electronics, sensors and drones to collect data on many key aspects – such as weather, geographic, spatial location, animal and plant behavior – and the entire life cycle of the farm. However, the application of appropriate methods and methodologies to increase the performance of agricultural supply chains remains a challenge, so the concept of Industry 4.0 has been further developed and adapted to Agriculture 4.0 (which will be explained in more detail below) in order to analyze the behavior and performance of the given area[19]. The appearance of remote-controlled, satellite-controlled machines in the fields or the lack of seasonal agricultural labor will not only use Industry 4.0 technology, but also the application of new varieties and food technologies developed with the help of digitalization and research and development. By integrating production, processing, trade and research and development, new organizational forms appeared in the food industry. The integration of areas with different profitability with helps risk sharing and mitigation as well as creates balanced income. Perhaps these processes help with globalization to ensure that food is provided with environmentally friendly and sustainable agricultural technologies[20].

Adoption of intelligent farming technologies (SFT) in agriculture

Agriculture, one of the important areas of the food economy, is not spared by technological development and innovation. The digitalization of agriculture is considered the fourth (4.0) revolution in agriculture, expressed by the wide range of available digital technologies and data applications. Politicians and experts assume that smart farming technologies (SFT: Smart Farming Technologies) have a significant potential to improve the economic performance of agriculture and contribute to the sustainability of agriculture. This is justified by the fact that they can increase the accuracy of plant and soil input based on site-specific needs, and these aspects can be connected to farm management systems[21].

The agricultural digitization process is driven by the rapid growth in the use of large-scale data. Examples include the further development of existing agricultural technologies (e.g. tractor-based devices that rely on GNSS) as well as applications and software for mobile devices. The purpose of the latter is to connect the data of agricultural production processes (e.g. input quantity and timing) and farm-level work processes and information related to quality management[22].

Fountas et al. currently four general types of technological applications can be distinguished[23]:

- recording and mapping technologies that collect accurate data for subsequent location-specific applications,
- tractor GPS and connected devices that use real-time kinetics for proper application of variable input speed and precise control of tractors,
- applications, farm management and information systems (FMIS) that integrate and connect with mobile devices for easier monitoring and management and
- autonomous machines (e.g. weeding and harvesting robots).

It can be concluded that the technologies that contribute to "smarter" farming are extremely diverse. They benefit cropping practices (reduce the environmental and climate impacts of farming), crop yield (increase soil health) and quality (increase resilience) and farm operations (reduce costs for farmers)[24]. These technologies are called Smart Farming Technology (SFT).

SFT contribute to the sustainability of agriculture as they are able to increase the accuracy of crop and soil use based on site-specific needs and directly link management practices to farm management systems[24, 25, 26], preparing the economies to address labor shortages and climate change[27].

These systems are needed in the long term, because one of the current challenges of production systems is balancing sustainable production with the needs of society or the market. In industrial sectors, certificates are used to reduce the environmental impact of such activities. These are directed to the development of processes in order to become more efficient and to reduce the impact on the environment. Currently, some of these certificates are also used in the European Union, for example ISO 14001 and EMAS (Eco-Management and Audit Scheme)[28, 29, 30].

EMAS is more rigid, more precise, more accessible[28] than ISO, which is why it was chosen by the European Union. The development of sustainability indicators for agriculture is a complex task, which begins with the determination of the parameters to be monitored (soil erosion, soil acidity, production efficiency, among others). The determination of these parameters and the meaning of the indicators can also be influenced by regionality or geographical location, noting that some parameters cannot be uniformly applied in all regions[31].

Sustainability and the agri-food supply chains – challenge, vision

Globalization and free trade policies, as well as consumer demand for safe and high-quality food, have put pressure on the various stakeholders, or key players, in the agri-food supply chain. Impact, contributions, and socio-economic and environmental factors are the most important actors in achieving a successful supply chain flow.

Despite various techniques and conceptual models to make the agri-food supply chain more efficient and profitable, there are still many gaps and new challenges in the supply chain that hinder fruitful, sustainable food production. However, emerging techniques such as traceability and blockchain, food laws and legislation, or the aforementioned conceptual models are expected to contribute to a smoother flow of the agri-food supply chain[32].

The revolution in digital technology has led to a new phase in the field of agri-food technologies. Digital technology has come to the fore and has changed the way people communicate, interact and exchange data in society. Smartphones, smart watches, drones, notebooks, computers, broadband Internet services, etc. are technological innovations that are now known to everyone. Today, the agri-food supply chain is also affected by the digital technological revolution. For example, climate change and its impact on agriculture have been monitored using information and communication technologies (ICT)[33]. ICT is beneficial to global food supply chains as it can provide vital data on innovative techniques for preharvest and postharvest operations[34].

A lot of literature is published on ICT, artificial intelligence, GIS, etc. and their role in the agri-food sector. For example, Wang presented the importance and applicability of e-logistics in supply chain management[35]. The effectiveness of ICT can be best utilized in agricultural trade, extension programs and enforcement of good agricultural practices[36]. Choosing the right planting period, controlling diseases and pests, managing irrigation, managing livestock, choosing the best seeds and plant varieties, and planning storage areas are just a few examples of the role and benefits of ICT in the supply chain. The use of drones in agricultural fields is well known and popular. Sensors are also used to obtain information and meteorological data from isolated or remote rural farming areas. According to Sylvester, sensors can also help preserve highly valued agri-food products[37].

ICT can have direct benefits and help in product identification, food fraud vulnerability, quality and safety measurements, etc. Büyüközkan and Göc ̧er recently proposed an integration framework for the development of a digital supply chain (DSC), with practical applications expected in the near future (Figure 4)[38].

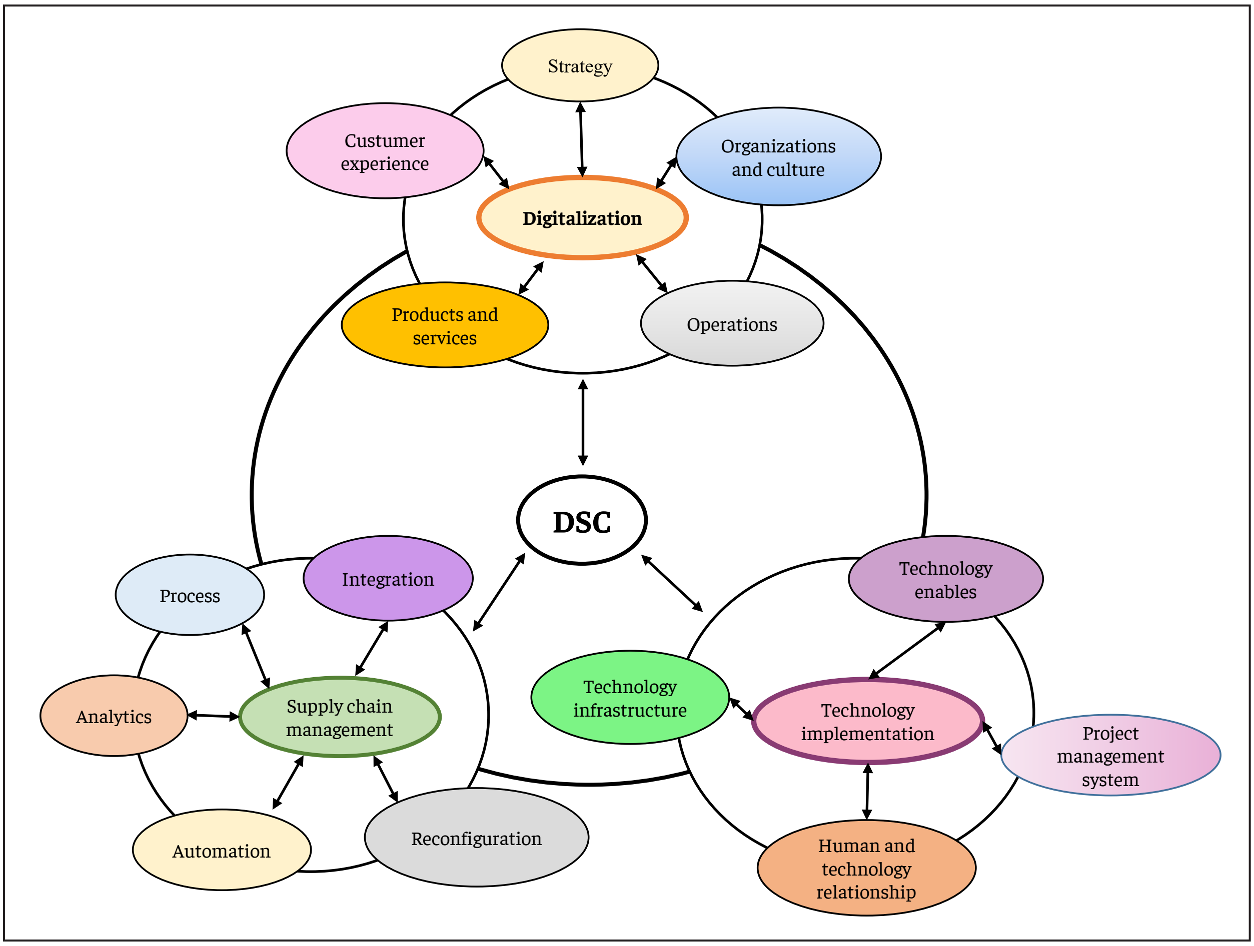

Figure 4. *Integration framework for DSC development*
Source: Büyüközkan & Göç[38]

Some of the popular software developed to identify traceability are Enterprise Quality Management, Food Trak-2 and Qual-Trace. Like other technologies, ICT has its own barriers, such as lack of technical experts and support staff, chances of miscommunication over long distances or in remote regions, lack of access to signals (bandwidth), uncertainty in agri-food in forecasting supply chain trends (demand and supply)[39, 40, 41]. These obstacles must be overcome in the future.

Importance of precision farming

Thanks to the interconnection of agricultural technical and IT developments, the gradual spread of precision farming can be observed. A set of technical, IT, information technology and cultivation technology applications that make production and plant organization more efficient. The main objective of precision farming is to produce high-quality and safe food by using the available resources (forage, water, energy, etc.) as efficiently as possible, all by applying digital solutions. The big question is how to manage in a competitive way, to increase efficiency, while also placing great emphasis on environmental sustainability.

Precision agriculture typically involves the use of state-of-the-art machinery, so the use and maintenance of related machinery and equipment requires appropriate expertise. The introduction of precision procedures requires investment, so small and medium-sized farms can currently only use them to a limited extent. Precision agriculture can offer a solution for mitigating the harmful effects of climate change, feeding the growing population (food quality and crop safety), environmental protection, and sustainability. Precision technologies greatly contribute to sustainable food production, since efficient production also means a reduction in the emission of harmful substances and the ecological footprint of animal husbandry[42].

We have mentioned several times that one of the inherent features of technical developments is properly trained human resources, be it agricultural workers or service IT specialists. Agricultural digitization requires new types of IT professionals. Instead of specialists with traditional, general information technology skills, specialized IT specialists who know the particularities of the given production and management sector are also needed in many areas of economic life, for example: technical IT, economic IT, or IT agricultural engineer[18]. That is why it is extremely important that the curriculum and quality of the available education is able to follow the rapid changes, because without this, they cannot take place smoothly.

10.3 Possibilities of using a particular agricultural information system

The book chapter – without claiming to be complete – tries to present some good solutions for the practical application of information systems. These software can help the food production enterprises that are the basis of the agri-food chain, therefore, after the theoretical overview, a general farm management software will be presented.

The management information system to be described was created for the registration, control and planning of the production processes of agricultural enterprises. After entering the data, the information that can be extracted is suitable for assisting the work of the family farmer, the manager of a farm of several thousand hectares, the integrator interested in a large area, or the specialist consultant handling the administration of several farms. In addition to the needs of farmers involved in field crop production, it also provides a good solution in the viticulture, winemaking, orchard, horticulture and animal husbandry sectors.[43]

During use, it records, among other things, data related to land areas, knowledge about labor and stocks, stores earth operations, but also provides data to the weighbridge with a direct connection. Aggregated statements and reports can be requested from the modular system. The functions available in each module are detailed in the following subsections.

Registration of land-related data

The main pillar of the information system is the so-called in the cultivation periods module, the register of the land on which the enterprise farms. The cultivation period is a cost collection unit created from the base table, with one culture, one owner, limited in space (hectare) and time (date interval). It is also possible to query the entered data in tabular form per record, or visually displayed on a map.

Related to this, in another, the so-called land issue module, the land owners, the topographical numbers of the land areas, including the ownership shares of the owners, as well as the land lease contracts, are registered. Using the basic data, the software can even make land rent payments, and these payment lists can even be loaded into bank programs as a group and transferred to the land owners at the same time. The topographical numbers can be connected to the tables, i.e. to the cultivation periods, even divided, so that the land rent can also appear as an expense for a given cultivation period. It is possible for the system to calculate and automatically charge the land rent as a cost for the given period, but this cost can also be manually charged to the boards.

The big advantage of the system is that it is able to collect and compare costs and returns, even when broken down to table level. On the one hand, the costs can be collected by recording the work operations (this is the basis of the management diary), in addition to the land rent, the drying fee (e.g. at the time of weighing) can also be charged to a given board within the system, but anything can be entered as other costs.

When choosing the display on the map, the given sign can be placed exactly in the space, which can be a great help not only for the practical specialist but also for the colleagues working in the office. The map can be built from several layers: you can draw topographical numbers or even mepar boards under the table itself (growing period). It can be made e.g. hand drawing, which can be edited and deleted, but ready-made polygons can also be uploaded. By adding a fleet tracking system, the control procedure can be simplified, because it is possible to track exactly where the company's power machine has traveled.

In connection with the map display, by supplementing it with another application, it is possible to precisely track and keep track of and document exactly where and how much a given power machine is working. Thanks to the system, the machine operator can also record his daily activities himself, and the system is able to create a performance-based work operation and worksheet from the resulting data.

In the case of land, it is necessary to mention the land-based subsidy, in connection with which mepar tables can be created with the help of the software. Each mepar board has a parcel identifier, which must be indicated in the payment application for area-based subsidies. In the system, the parcels can be recorded according to the way they appear in the payment request, so that they can be connected to the physically managed fields (growing period). In this way, it is possible to know exactly how much subsidy amount can be used for a given cultivated area, and at the same time a management diary can be produced. Since the size of the cultivated area and the area eligible for support are not always the same, the information system in question also serves well to show the difference between the two.

Records of labor, assets and stocks

In order for the software to be able to calculate costs, it is necessary to record the most important inputs, i.e. tools, stocks and labor. Regardless of the value limit, all machines and assets can be registered in the system, but primarily production assets (power machines, work machines) should be listed here. It is also advisable to record the device that generates general costs, such as the agronomist's off-road vehicle, which does not produce, but its refueling, servicing and other costs are recorded. The general principle is that the more detailed data is recorded, the more the software can help by sending a reminder message, e.g. warning when changing oil. In the case of machines, the sum of diesel, spare parts, service, lubricants and other costs (e.g. insurance premiums, depreciation) and the performance can be used to quotient the settlement price, on the basis of which costs can be shown. These can all be recorded in the system.

In the module for registering the labor, in addition to being able to document the basic data, with the help of lists, e.g. the working hours of the employees or even the wage costs can be reviewed. Based on the work operations, the work performance of the employees can be checked and edited, and on those days where no work hours are displayed due to the lack of work operations, the reason for the absence can be specified (e.g. sick leave, unpaid leave). The system can also warn e.g. in the case of an employee employed in seasonal work, on the 120th day, that the employee concerned has reached the maximum of the legal framework in a given form of employment.

The purpose of these programs is not payroll calculation, but they can be used in proportion to the data to determine the cost of living. It achieves this by calculating an actual cost by the end of the year based on the total cost of the labor given to the company – including gross wages, contributions, cafeteria, telephone and travel reimbursement – and an actual cost can be calculated from the total quotient of actual number of hours which can be used next year as account price in the system.

The quantity and value of stocks become visible in the system, and any stock movement is easy to manage: revenue, sales, use in work operations, listing option (stock inventory statement). Under the stock menu item, you can see all movements related to stocks.

- Inward movement results in monetization, e.g. purchase, or yield, when the produced product can be purchased for stock.
- Outward movement can be achieved through sales, operational expenses (seeds for sowing, pesticides for spraying), scrapping, storage losses, transfer of foreign stock, or re-storage.

Record of work operations

With the help of the interface, the work operations can be recorded, which is the heart and soul of the system, since the operational costs can really be displayed during the cultivation periods. Work operations can primarily be recorded on a board (for the growing season), marking the work operation group itself, recording its total performance, assigning man, power machine, work machine, and, if necessary, the material. When the latter is used, the system also monitors and records changes in the stocks. By recording a work operation, a cost is displayed on the board, we provide information for official announcements (mepar board), performance and cost are recorded for machines and labor, and the stock management module also changes, since the material is removed from the warehouse.

In addition to the table operations, it is possible to record service (repair, maintenance) operations, but operations carried out for an economic unit, i.e. factory operations, can be recorded by selecting the appropriate cost-bearing economic unit, or even wage controlling.

Work operations, as economic events, can be submitted from the system as auxiliary operation dispatches, even broken down to operation level, with the performance of the auxiliary operation and the corresponding value. The system calculates the cost on the basis of operational performance, either by dividing it between the power machine and the working machine, based on their performance, or at the internal settlement price, or, when invoicing, at the external settlement price, based on the information received from accounting.

In the case of precisely guided work operations, it becomes extremely easy to extract the management log, nitrate report, or even the spraying log, which also simplifies the work of the agronomist.

Cooperation between accounting and the agricultural information system

The practical advantage of the information system is that – regardless of the official reports provided by accounting – the decision-maker or the agronomist can see the costs of farming as soon as possible. The program is not intended to replace bookkeeping or payroll, but rather to provide the professional decision maker with information.

With such a system, it is possible to find a common language that both accountants and agricultural professionals understand. It may be good news for accountants that the software can manage both ledger 6 and 7 (as an economic unit) and a given invoice can be broken down to any length and an accounting identifier can be assigned to it. Several accounting identifiers can be assigned to an economic unit, so the software can also handle differences between accounting systems.

The agronomist wants to see different data, and the accounting will provide different data at the end, because while the accounting divides all costs, the agronomist only wants to see costs directly affecting a given area in the system. For example, the specialist is not interested in the general cost of the offroad vehicle, while accounting, among other things, has the task of dividing this between the individual areas.

It is very important for these systems that appropriate basic data is entered, as otherwise the actual cost and the cost itself will be incorrect. If, for example, the operating hours are recorded, an operating log can be kept from this, but not all systems will filter out if something was typed by the basic data recorder.

One of the system's interface connections, the weighscale

The scale module is extremely important from the point of view of the users' stocks recorded in the system. The scale ticket interface shows all the data of the scale ticket: sender, place of sender, identifier (from which table) the product is. The system can even handle special cases when, e.g. two different companies are forced to operate a given board, and one company has a warehouse and weighing house, which the other company does not own. If the crop truck comes in from the field, the system weighs it and distributes it proportionally between the two companies per hectare, thus displaying the amount of garbage and water removed proportionally. At the end of the operation, the crop appears at the storage company as its own property or as a foreign stored product. It is also possible to issue a manual balance sheet in the event of a network connection termination. It is possible to record the drying data, and if necessary, the drying data can also be modified afterwards.

It is also possible to modify the prepared scale notes, while preserving the original scale note.

Not closely, but in connection with the balancing, the crop sales contracts should also be mentioned, which can be recorded in the system, and the scale tickets can be linked to them automatically. In the same way, crop purchase contracts can be recorded, and storage and drying accounts can also be prepared. Of course, it is also possible to issue a scale sheet, based on different aspects: partner income, partner expense, i.e. the system shows the income and expenses of a given partner. The same can be done when measuring wages.

From the point of view of data management, it is a big advantage that the software can completely replace the weighing program so that the program receives the data based on the certified weighing. In this way, the decision maker can see the returns in real time, even immediately. For this, it is necessary that the balance is directly connected to the information system, so the balance software can even be omitted. Both inbound and outbound measurement is possible, but the system owner can also use transfer measurement and wage measurement that does not affect own stock. When delivering crops, it is possible to document which field a given crop came from, so the software can calculate the gross and net yield for it.

Statements

The simplest forms of reports in the system are dashboards, that is, up-to-date graphs that can be customized and displayed on the external interface, which transparently contain the most important metrics for the manager, so that the company's operations can be monitored down to the board-level details. Within the report module, different reports can be created by topic, thanks to the filtering option, in countless versions. In addition to these, Excel format downloads within the system work by sorting and filtering the columns of given items on almost every interface, from which statements can also be prepared.

In addition to all this, the benchmarks – in comparison with the data of other farmers – provide a completely anonymous way of comparison for company actors based on aggregated data. As a basic setting, in addition to the data of the own company's company group, the data of the average system user (that is, the grand average) and the data of the 15 and 3 users deemed by the system to be the best can be displayed. In addition, however – by different filtering options according to needs –, one's own performance becomes visible at the regional level, farm size or e.g. based on annual rainfall.

Some modules of the program can also replace official notifications, since it can produce management logs and spraying logs in (xls) format that meet the legal requirements, but it is also possible to create material in xml format that can be loaded into the system of the General Form Filling Program (GFFP) with the help of the software. The data required for official announcements are recorded, e.g. the fields according to the payment request, thus the master data, are in the system, which simplifies the subsequent work processes and the control process. By reducing document management, manpower can be freed up.

Data quality so-called With the help of the "ADM" indicator, users' data entered into the system, their accuracy and professionalism can be compared, thus the activity can be compared with the activities of other users. A higher value close to 100% indicates more accurate user activity.

Data handling

The company operating the information system pays attention to data security in accordance with the current GDPR regulation, thanks to which no data can be stolen from the system without consequences. Individual users may have different authorizations, as they are granted access to them depending on which modules they use. In addition, every company that uses the software has a system manager who knows as much as possible about the software and who is given system administrator rights at the start. Of course, there is also a level above the company system administrators (the so-called supervisor), which – if necessary – can block possible unauthorized activities and turn modules on and off.

The presented system can be provided to the user in two ways: as a rental right for a predetermined period of time, in which case the user pays a rental fee for the software every month, or as an initial investment cost by paying the license fee, after which an annual supporting fee must be paid. It is important that the data entered into the system are the property of the given economic operator even after the termination of the contract!

Experiences related to the implementation of the investigated agricultural information system

A young researcher investigated the circumstances of the introduction of the information system in the case of two agricultural enterprises from the south of the Danube using in-depth interviews. At the time of the investigation, one company had already used the system for years, while the other had started the implementation process in the year of the investigation.

The training period of the employees took place faster at the company that started implementing the system recently, i.e. in 2020, while the process was slower at the company that started implementing the system earlier (in 2008). This can be explained by the fact that in the years that have passed since then, digitization has undergone significant development, nowadays the use of IT systems is extremely widespread and natural in the everyday life of businesses. As expected, the company that has been using the system for a long time listed more areas of use, which can also be explained by the significant difference in the time of use.

According to company managers, the system significantly facilitates decision-making, as the necessary information is quickly and accurately available to them. Network connectivity, reliability, support, costs, and performance are much more important for businesses than manufacturer reputation.

In the case of both companies, the employees were afraid and distrustful of the new system, but this changed in a positive direction during use. The employees using the system at both companies highlighted the query options according to complex needs as the main factors that make their work easier.

From the results of the research, it can be clearly established that when using the software, managerial decision-making was significantly simplified thanks to the accurate, up-to-date data provided by the system and the useful analyzes that can be made with the system. It also came to light that there are many areas and modules that businesses do not use, even though the system would make it possible.

From the written above, it follows that the introduction of a management information system proves to be a successful investment in the long term, despite the fact that difficulties arise at the beginning of the process due to the many new features.

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