

CHAPTER 2

Agri-Food Supply Chains Design and Management

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This chapter presents the basic concepts of the agri-food supply chain, taking into account the specifics of this chain. The chapter includes questions such as: What is an agri-food supply chain? What is agri-food supply chain management and why is it important? It provides information on how an agri-food supply chain can be structured and what the specifics of each type of chain are. It also identifies who are the actors (stakeholders, members) of the agri-food supply chain, their roles and main activities in each agri-food supply chain.

2.1 Introduction to Agri-Food Supply Chains

In the Croatian language, the term Supply Chain (SC) is of relatively recent origin and today in the literature various synonyms are used for this term such as: supply chain, supply chain, supply chain, etc., depending on the author, the problem research and the observed sector. There are extensive analyzes and numerous definitions of the supply chain in the scientific literature. Waters^[1] states that the supply chain consists of a series of activities and organizations through which materials pass on their way from the initial supplier to the end customer. The author defines materials as all things that a company runs to create its product, so it distinguishes between tangible materials (raw materials or semi-finished products) and intangible materials (for example, information). Furthermore, Waters defines both upstream and downstream activities in the supply chain (Figure 1).

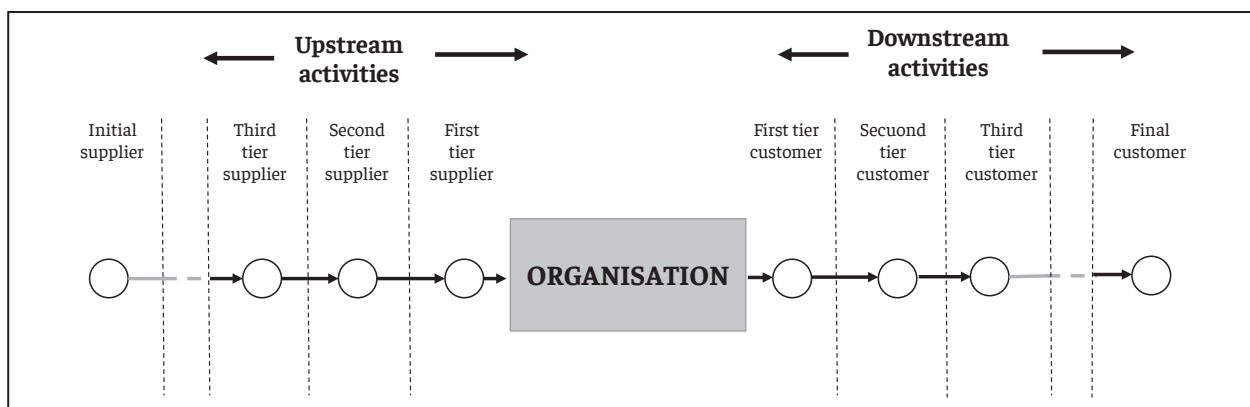


Figure 1. Supply chain activities. Source: Waters^[1]

Thus, upstream activities represent all those activities by which materials are launched towards the company, ie all activities performed by companies that are in the supply chain before the observed company. These are mainly suppliers (first order suppliers, second order suppliers and so on). While downstream activities in the supply chain include all activities by which materials move from the observed company, ie, all activities performed by companies that are in the supply chain after the observed company, it is mostly customers who can also be divided into first tier customers, second tier customers and so on to the end consumer.

Agri-Food Supply Chain – AFSC starts from the primary producer (organization or individual engaged in agriculture), and the food product obtained at this stage moves through various processing methods, distribution, storage and other processes before reaching the end consumer. Agri-food supply chains, as well as supply chains of other types of products are networks of interconnected economic entities working together to convert goods and distribute these goods from raw materials to the final product and meet customer/consumer requirements^[2, 3].

AFSC geographically covers all areas of food chains with its specifics: local, regional, national and international. They are constantly evolving from simple, which were initially categorized as commercial, competitive or simply customer-supplier relationships to the present day increasingly complex relationships between a growing number of actors in the food chain. Today, AFSC strives for long-term, quality cooperation with an emphasis on food quality with greater traceability and agility in order to achieve increasing consumer satisfaction while achieving a competitive advantage and sustainability of the food supply chain.

AFSCs operate in a complex, dynamic environment at a time where product quality is vital. Bourlakis and Weightman^[4] describe six key factors that play a significant role in the evolution and development of modern food supply chains. These are: quality, production technology, logistics, information technology, legislative (regulatory) framework and consumers.

2.1.1 Defining Agri-Food Supply Chain

One of the first AFSC models was offered by the first experts to explore the role and potential of Food Supply Chains – FSC in the rural development process^[5], while the management of agri-food supply chains (Agri-Food Supply Chain Management – AFSCM) was first defined by a group of Dutch scientists^[6, 7]. Subsequently, a number of scholars and practitioners changed or adapted the definition of the AFSC with regard to: the academic background of the author, the research topic, the sector being researched/analyzed (eg food industry, retail, family farms, etc.), the number and the type of stakeholders involved (eg short / long or direct / indirect chains) or specific processes of a particular chain (eg organic production), types of products (eg fresh or processed), etc.^[8, 9, 10].

Accordingly, different terminology for AFSC is used, especially in the English-speaking world. Some of the premieres are: Food Chain FC; Food supply chain management (FSCM); Food Industry FI; Agri food chain AFC; Agricultural Supply Chain (ASC); Agri-Food SupplyChain Management AFSCM; Agri-food supply chain networks (AFSCN); Fresh produce supply chain management (FPSCM); Perishable food supply chain quality (PFSCQ) and others.

It can be concluded that there is no generally accepted definition of an agri-food supply chain or han supply chain. Some examples of definitions are:

“Agricultural supply chain (ASC) is a supply chain of products of agricultural origin”^[11].

“The food supply chain (FSC) involves the direct exchange of food from farmers to consumers or various stages of activities, such as processing raw agricultural products, as well as checking consumer safety standards and packaging or transport activities that add value to food before it is sold.”^[12].

“The agri-food supply chain (AFSC) is a set of” farm to fork “activities, including agriculture (ie tillage and crop production), processing / production, testing, packaging, storage, transport, distribution and marketing”^[8].

“The food supply chain (FSC) is a sequence of operations that takes care of the perishable nature of products, large fluctuations in demand and prices, increased consumer concerns about food safety and dependence on climate conditions”^[13].

“FSC is defined as the processes from production to consumption of fresh products (fruits, flowers and vegetables).”^[14]

“FSC is defined as a large variety of products and companies that operate in different markets and sell different food products.”^[15]

2.1.2 Specific characteristics of the Agri-Food Supply Chain

AFSCs differ significantly from other supply chains due to the specifics of agricultural production, its dependence on natural conditions, seasonal nature of production, specific product characteristics (eg short shelf life and perishability of products) and related logistics. According to van der Vorst^[6], some of the characteristics of AFSC are:

- 1) the unique nature of products because in most cases they relate to goods with a short life cycle,
- 2) high product differentiation,
- 3) seasonality in harvest and production,
- 4) variability of quality and quantity of used agricultural inputs and yields,
- 5) special requirements relating to transport, storage conditions, quality and recycling of materials,
- 6) must comply with national/international legislation, regulations and directives on food safety and public health, as well as environmental issues (eg carbon and water footprints),
- 7) the need for specialized properties, such as traceability and visibility,
- 8) the need for high efficiency and productivity of expensive technical equipment, despite the long production time,
- 9) increased business complexity,
- 10) existence of significant capacity constraints.

Supply chains of agri-food products are characterized by^[16]:

- 1) business relationships that typically confront profit sharing within the supply chain (so-called profit-rebate relationship);
- 2) treat farmers as substitutable (and usable) inbound suppliers, who often operate in a limited market or under short-term contracts and therefore take on greater risk;
- 3) the profit from the sale of finished food products is unevenly distributed along the supply chain because processors and traders usually earn a significantly higher share of earnings compared to producers of raw materials.

The agri-food supply chain has two main objectives^[17]:

- 1) to meet consumer requirements and
- 2) to become and remain economically viable by means of effective chain management.

In addition, the supply chain of agri-food products can be discussed in two ways:

- 1) commodity chains aimed at processors through which production from agricultural holdings moves downstream as raw material to processors or to commodity exchanges,
- 2) value-oriented consumer chains that are the last link in food supply chains. Agri-food products usually reach end consumers through retail or directly, ie through short supply chains. Unlike the supply chain, the consumer-driven chain is more regulated and often barred from entering a particular market in the form of legal or voluntary standards that ensure traceability, quality control and food safety.

Comparing the management of food supply chains and the management of non-food supply chains, there are a number of attributes according to which they differ significantly and which will be discussed in more detail in the following chapters of the book: Relationship and Management; Integration and cooperation in the agri-food supply chain; Supply chain agility; Logistics management; Traceability; Food quality assurance and safety; Packaging; Food marketing and labeling; Food waste management and food loss; Food legislation, etc.

2.1.3 Types of Agri-Food Supply Chains

In general, we distinguish two main types of agri-food supply chains^[7]:

1. Figure 1. Supply chain activities. “Agri-food chains for fresh agricultural products” (such as fresh vegetables, fruits, flowers). In general, these chains may include growers, stock exchanges, wholesalers, importers and exporters, retailers and specialty stores, and their suppliers of inputs and services. Basically, through all these phases of grown or manufactured products, the internal characteristics of the product remain intact. The main processes are handling, conditional storage, packaging, transport and trade in these goods.
2. “Agri-food chains for processed food products” (such as meat products, canned food products, dairy products, juices, confectionery products, etc.). In these chains, agricultural products are used as raw materials for the production of consumer products with higher added value. In most cases, different processing procedures (eg canning, drying, freezing, etc.) extend the shelf life of food products. Processed food can also be defined as value-added food. Such food can undergo different levels of processing. Eg the first level is chopping, cleaning and packaging of fresh fruits and vegetables and their placement, for example, under a certain brand. In the second level, food goes through simpler processing procedures, such as converting fruits, vegetables, cereals, etc. into simpler food products such as flour or frozen fruits and vegetables, etc. The third level involves using more complex technological processes of processing agri-food products into ready-to-eat food. These can be various biscuits, cakes, juices, canned food, coffee, pasteurized dairy products, etc.

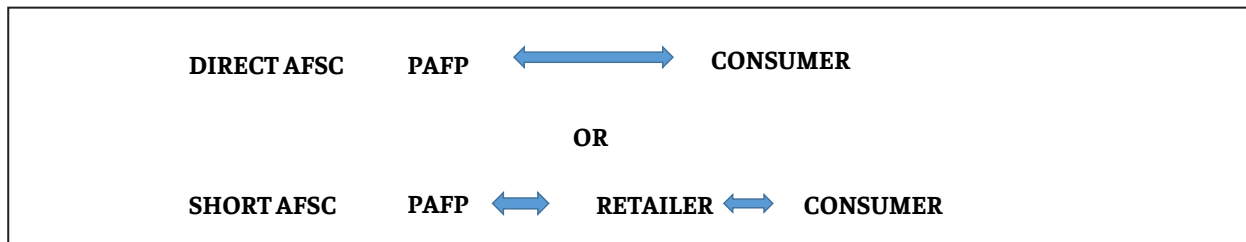
In addition to the fact that all food is very sensitive to a variety of conditions, additional requirements are met by those companies engaged in the production and distribution of perishable food products. In doing business with this type of product, it is necessary to ensure the shortest possible time of their passage through the supply chain^[18]. In this case, it is a “cold chain” or temperature-controlled food supply chain that aims to preserve food throughout the supply chain. Specific phases of the cold chain are refrigeration and freezing systems, storage, transport and retail showcases. Appropriate (low) temperatures need to be ensured through all phases in order to ensure microbiological, physiological, biochemical and physical safety and the expected shelf life of food. These are mainly fresh meat and fish, certain fruits and vegetables, and frozen and/or semi-frozen food products.

The next division of the AFSC would be according to the type and number of actors/stakeholders in the supply chain. While Ványi^[19] considers that the supply chain consists of at least two members, Mentzer et al.^[20] define the supply chain as “a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flow of products, services, finance, and / or information from source suppliers to end users”. According to this definition, it is assumed that at least three members (manufacturer, customer and supplier) are required for the supply chain. However, there are also supply chains in which there is only one producer and end consumer, ie only two levels of the supply chain. Such supply chains are known as “Short Supply Chain-SSC” and are characteristic of primary agri-food chains^[21].

Due to the aforementioned specifics of the AFSC and a number of different actors, the AFSC is much more difficult to define and present and depends on the level of complexity. Mentzer et al.^[20], in general, identify three levels of supply chain complexity (SC): “direct supply chain”, “extended supply chain” and “ultimate (final) supply chain”. However, when we talk about supplying consumers with agri-food products, we must point out the fact that most of these products, especially in developing or underdeveloped countries, are sold to consumers through various forms of short supply chains. Also, given today’s trends and consumer demands for healthy, home-grown and locally produced food in developed countries, there are various movements promoting local food and the search for alternative forms of food production, distribution and consumption, reconnecting producers and consumers, strengthening local agricultural systems and agricultural markets and building new links between rural and urban areas^[21]. Short food supply chains provide a reliable replacement for conventional supply chains, as food reflects the characteristics of ‘local’, ‘natural’, ‘healthy’ and ‘reliable’. Words such as “quality”, “sustainable” and “traditional” characterize Alternative Food Networks (AFN), denoting small and specialized production^[22]. AFNs have certain basic features which include: social cooperation and partnership between producers and consumers, the ability to reconnect

production and consumption with sustainable models, the ability to foster local markets with a regional identity and re-aggregate value in the trade of quality and differentiated products, for example, organic^[21]. In addition, conventional ways of selling food, especially agricultural products, are not the most favorable ways of selling for small farmers. In the conventional food chain, processors (industry), traders and various intermediaries benefit the most, while primary producers/farmers sell their products at very low prices. In particular, the structure of the food sector is bipolar, on the one hand, several large companies dominate the market such as multinational companies (eg Nestlé, Danone, Mars, JBS, etc.), and on the other hand, there is a significant group of SMEs operating mainly in regional markets.

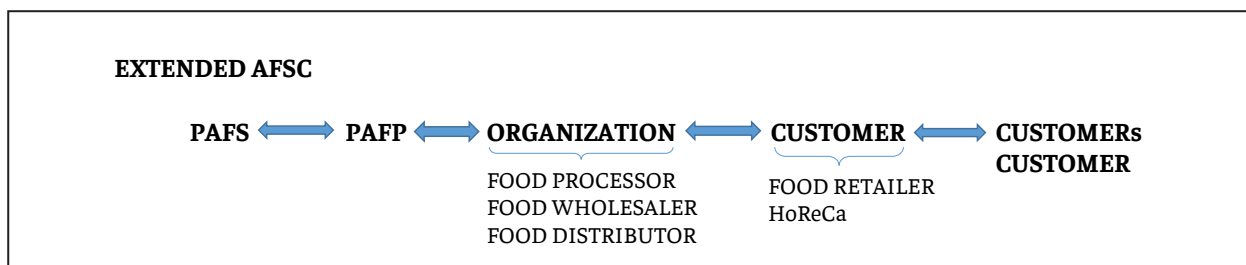
Adapted from Mentzer et al.^[20] Figure 2 shows the “direct AFSC” and its stakeholders which is also considered a short AFSC^{[23]1}.



*Figure 2. Direct and short AFSC
Source: Gajdić et al.^[23]*

All, and especially longer agri-food supply chains, should be seen as “value chain systems” in which raw materials (from an agro-industrial source) are converted into final consumption as they move through the chain and increase value. Each phase of the agri-food supply chain, conditioned by the specifics of products and processes, significantly affects the logistics of the chain and information and communication technology used in a particular chain or part of the agri-food supply chain.

Adapted from Mentzer et al.^[20] Figures 3 and 4 show the “extended AFSC” and the “ultimate or ultimate AFSC” made up of different stakeholders^[23].



*Figure 3. Extended AFSC
Source: Gajdić et al.^[23]*

Figure 3 shows the extended AFSC, but not the entire chain. Depending on the number of stakeholders involved and the type of product, it may look different. The expanded AFSC includes the Primary agri-food supplier (PAFS) as the Primary agri-food producer (PAFP) and other actors involved in the downstream flows of products, services, finance and / or information. A food processor, food wholesaler or food distributor can be found at the site of the organization or central company, and a food retailer or HoReCa, which delivers fresh or processed agri-food products to end consumers, can be found in the role of customer^[23].

The ultimate AFSC (Figure 4) covers all organizations involved in all upstream and downstream flows of products, services, finance and information from PAFS to the end user or end consumer. The ultimate AFSC can be very complex, especially if it is an international or global AFSC. Such a chain may include various market helpers, service providers or intermediaries (certification bodies, financial institutions, market research companies, etc.) Given the potential for a myriad of alternative AFSC configurations, it is important

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to note that any of the actors shown may be part of different AFSCs, or part of the upstream and downstream streams that make up the SC^[23].

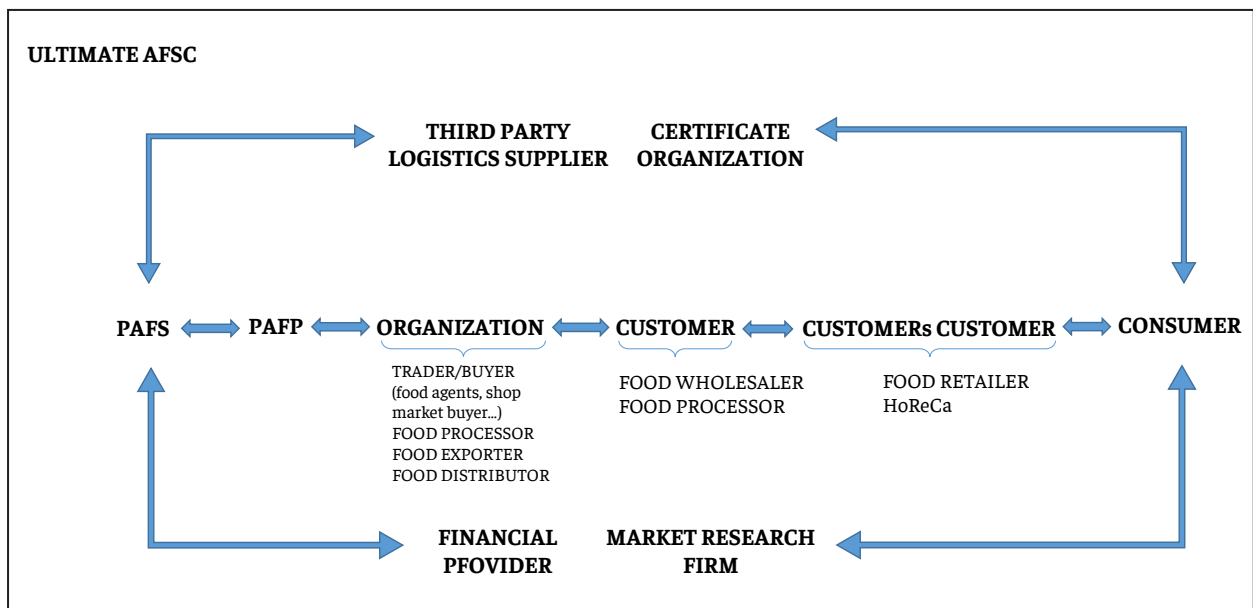


Figure 4. Ultimate or ultimate AFSC
Source: Gajdić et al.^[23]

The more members in agri-food supply chains, the longer the supply chain and the more difficult it is to coordinate due to specific customer needs, lack of transparency and insufficient information exchange among individual members of the supply chain^[24, 25].

Different numbers of partners involved in different business processes along the AFSC while creating a greater variety of complex relationships can significantly affect the performance of the AFSC. One of the critical factors in AFSC is how to ensure quality and fair cooperation among stakeholders while taking care of economic, environmental, social, organizational, marketing and security factors and responsibility towards companies, consumers and society^[26]. For this to be achievable, the most effective way to manage the AFSC needs to be found.

2.2 Agri-food supply chain actors and their activities

A typical AFSC consists of several basic phases: source of raw materials/agricultural producers; processing and production of food products; packaging, storage and handling; wholesale distribution; redistribution to retail consumers. The first phase refers to the production of inputs for agricultural production, which includes the breeding of animals, crops, etc. From this phase, the products are distributed to the market or sent to the third phase, which relates to the processing process. In this phase, the transformation of input products into finished products takes place, which are then packaged and stored so that they can be later distributed on the market, which would be the third phase. Distribution on the market represents the fourth phase of the food supply chain, while the last phase involves retail distribution and consumption by end customers. Some of these phases (eg packaging, storage, handling) can occur more than once depending on the complexity and length of the supply chain.

If any of these phases are compromised, various problems will arise and the entire supply chain will be in danger. This is where the big problems and challenges that food supply chain managers have to deal with arise. Eg: lack or inefficiency of food traceability, maintaining food safety and quality at all stages, inadequate communication between stakeholders, increasing supply chain costs, inventory management, sustainability of food chains, etc. Figure 5 shows the general agri-food supply chain and common actors in food supply chain. Those are:

1. Primary suppliers of agri-food products that supply raw materials to agricultural producers, ie inputs, eg, seeds and planting material, fertilizers, etc.
2. Primary producers of agri-food products that produce and deliver food in raw form, eg fruits, vegetables, cereals, meat, fish, etc. They can be small businesses, ie family farms and medium or large such as companies.
3. Processors (eg food industry) who use fresh agricultural products from agricultural producers as raw material to create other food products / food according to consumer requirements. These can be meat and meat products, canned, dried or frozen fruits and vegetables, various flours and other products from cereals, dairy products, etc.
4. Distributors, ie companies that act as a link between producers, processors and markets. They are very important stakeholders, especially when it comes to global food supply chains.
5. Wholesalers and retailers who make food products available to final customers/consumers in an appropriate place in certain quantities and of appropriate quality. They create their range according to the requirements and needs of certain groups of customers/consumers.
6. HoReCa (hotels/restaurants/cafes) are an important link between producers/processors and consumers. They procure food from primary agricultural producers or processors and create a new food product, very often “made to order by consumers”, ready for consumption.
7. End consumers who are the last and could say the most important stakeholders in the food supply chain. The economic sustainability of the food supply chain also depends on their consumption. The consumer has an extremely important role in the supply chain as the whole process takes place with the purpose of meeting his needs and requirements, all in order to generate profit throughout the AFSC.

Importers and exporters of agri-food products can also be included in the supply chain if it is an international supply chain.

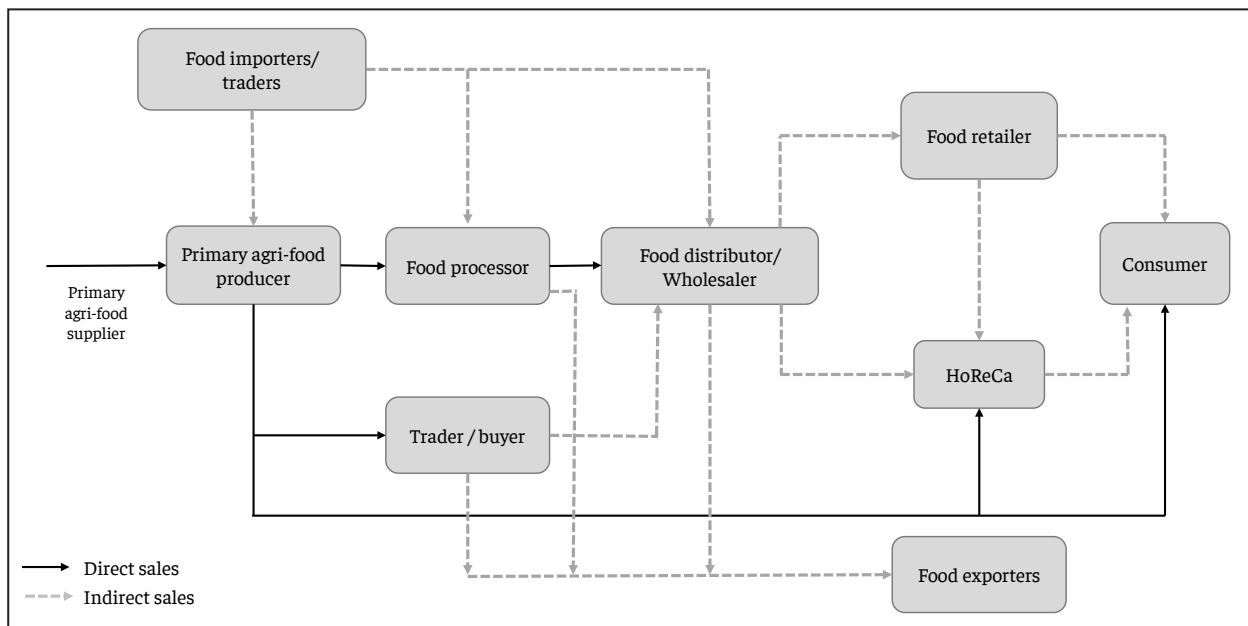


Figure 5. Actors of the agri-food supply chain
 Source: Gajdić et al.^{[27]2}

Members of the supply chain can be divided into primary members and other members who support the business of primary members of the supply chain^[28]. Primary members include all those organizations whose activities participate in the production of a specific product. Other members include companies that help raise resources, contribute their knowledge, or provide assets for primary members of the supply

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chain. These can be transport companies, banks, companies that procure production equipment, companies that deal with advertising, etc. One company can be considered a primary member, but also a supporting member. Such a situation occurs when the company carries out primary activities in one process or supply chain and support activities in another. This means that each company can belong to one or very company and several different AFSCs, ie it usually has more than one supplier and customer. For example, a vegetable producer obtains inputs such as seed and planting material or fertilizer from several different suppliers. It delivers produced vegetables directly to consumers or to one or more processors, who distribute processed vegetables (eg in frozen or canned form) through one or more retail outlets or through HoReCa.

Regardless of the number of members of the agri-food supply chain, it is necessary to ensure an appropriate level of information and product flow at each stage of the supply chain in order to ensure that the quality of food products is maintained.

2.3 Agri-Food Supply Chain Management

The term “Supply Chain Management” is relatively new and it first appeared in the logistics literature of the 80s of the last century as an approach to inventory management with an emphasis on the supply of raw materials. Over the years, the concept of SCM has changed, although it has always been predominantly focused on industrial production and services, and has received surprisingly little attention in agriculture^[29]. However, since its introduction into the retail and processing industries, the concept of supply chain management has spread to other industries, including the agri-food sector^[7].

According to Chandrasekaran and Raghuram^[30], Agri-Food Supply Chain Management – AFSCM involves a range of processes such as supply management, production management and demand management to ultimately satisfy customers through a competitive distribution channel.

Constant and sudden changes in agri-food systems affect the ability of agri-industrial enterprises to compete in the food market. Both small and large businesses face challenges such as reducing operating and other costs, time delays in the flow of goods and information, inevitable innovations, chain sustainability, changes in legislation, and increasingly sensitive consumer demands. With the advancement of local and innovative food products, the product life cycle is shrinking and the role and needs of consumers are constantly increasing. Also, the need to adapt to the constant and rapid changes that are happening in the market and in the entire community is increasing. These changes require managers, owners of small family farms and other stakeholders of any segment of the food supply chain to know and be able to increase their competencies, skills and knowledge, which will inevitably affect the success of the entire supply chain. Large and small companies must continuously work on innovations and improvements, follow trends while adapting to consumer needs. Knowledge and experience in managing food supply chains can help them significantly in this process.

When managing the supply chain, it is very important to achieve cooperation between all members of the supply chain in order to achieve maximum efficiency. If the communication between the organizations in the supply chain is at an enviable level, the preconditions are created for achieving the appropriate level of satisfaction of end consumers, which will ultimately result in an increase in the income of business entities. Supply chain performance will be higher if the profitability of the supply chain is higher as well^[31].

2.3.1 Defining Agri-Food Supply Chain Management

Agri-food supply chain management (AFSCM) includes activities or operations from production, distribution and consumption to effective and efficient management of food quality and safety issues^[32]. The management of the agri-food supply chain is very complex, and cooperation in the AFSC is largely conditioned by its specific characteristics. Food quality, food safety and freshness over a limited shelf life make AFSCs more complex and difficult to manage, and therefore differ significantly from non-food product chains^[32]. The agility of the chain is important for AFSC, in order to be able to respond quickly to changes and challenges in the food sector, such as rapid urbanization, natural disasters, changing nature of food demand,

food quality, food security, traceability, communicable diseases (e.g. COVID 19), accelerated changes in agricultural technology (eg precision agriculture), weaknesses of the rural population in the region in meeting the requirements set by food processing and retail companies, the impacts of climate change on agriculture, etc.^[23, 33, 34].

On the one hand, influenced by trends involving globalization, urbanization and agro-industrialization, food supply chains or networks and agribusiness are now moving rapidly towards globally connected systems with a large number of complex relationships. On the other hand, in response to the negative environmental, social and economic effects of the conventional way of selling and based on the logic of quality, which is considered different from the logic of efficiency, short food supply chains are being increasingly developed. They focus on highlighting the quality of food and the ethical, environmental, social and economic conditions of its production^[35].

Supply chains can be managed as a single entity through a dominant member or, alternatively, through a partnership system that requires well-developed cooperation and coordination^[7]. The goal of each supply chain is to achieve the best possible performance of each individual member of the supply chain and at the level of the entire food supply chain. However, this is not easy because all partners must agree on the selection of key performance indicators and target values.

Lambert and Cooper^[36] distinguish three key decisions in SCM:

1. Structure of the supply chain network – who are the key members of the supply chain with which the processes are connected?
2. Supply Chain Business Processes – What processes need to be linked to each of these key supply chain stakeholders?
3. Supply Chain Management Components – What level of integration and management should be applied for each process link?

According to Tsolakis et al.^[8] Some of the main strategic, tactical and operational decisions in designing the AFSC would be:

1. Strategic decisions
 - Choice of agricultural technologies
 - Investment portfolio development
 - Encouraging partnerships in the supply chain
 - Supply chain network configuration
 - Establishment of a performance measurement system
 - Ensuring sustainability
 - Adopting quality management policies
2. Tactical and operational decisions
 - Harvest planning
 - Logistics operations planning
 - Support food safety through transparency and traceability

2.3.2 The significant attributes of the Agri-Food Supply Chain Management

As already mentioned, significant efforts are needed to make the right decisions regarding the flow of information, products and resources in supply chain management. Each food supply chain can improve its efficiency and flexibility. In order to improve the performance of the supply chain, effective chain management is needed, ie AFSCM, which focuses on the harmonization of all processes and quality cooperation of all actors in the supply chain.

The AFSCM involves a complex and integrated decision-making process of different AFSC actors. This is particularly pronounced when it comes to the production and distribution of fresh, seasonal and perishable products in the face of high supply and demand instability. In general, AFSC design and planning encompasses all field-to-table processes and stakeholders, starting from the primary farmer and ending with the end consumer. These include issues related to crop planning, harvesting, food processing operations,

marketing channels, logistics activities, vertical integration and horizontal cooperation, risk and environmental management, food safety, ensuring sustainability^[8]. The advantages of supply chain management are numerous^[17]:

- better control of product quality and safety,
- reduction of product losses,
- better demand management,
- reduction of transaction costs,
- technology sharing and access to capital,
- collaborative knowledge sharing among chain partners.

Stakeholders involved in AFSC face a number of challenges and must systematically make and address a range of decisions important for the successful functioning of all activities at each level of the supply chain, especially in large, complex or international food supply chains.

Some of the most important issues or areas encountered in the planning and management of agri-food supply chains are^[7, 8]:

1. Specific characteristics of products and processes

The special characteristics of products and processes in AFSC have implications for actors in these supply chains with regard to the selection of agricultural technologies and processing/production facilities, recording and use of product and process data, communication of data between processes at supply chain level, etc. Fresh food products (eg fruits, vegetables, meat, etc.) whose composition and quality change very quickly over time, will significantly affect the management of processes in the supply chain. For example, the perishability of a product which requires specific storage and transport conditions; differences in the quality of biological products, eg between batches, and even at the level of an individual product (for example sugar, fat content, etc.); or variations in the quality of agricultural products among producers. At the retail level, for example, products closest to the expiration date may need to be sold first, often at reduced prices, etc. Processed food products (for example meat and dairy products, canned or dried fruits and vegetables, etc.) whose process production, composition, produced quantities and quality may depend on the raw material input, ie primary agri-food products (for example origin and history of products; unpredictable yields in primary production, inputs used in production processes, with their effect on processed properties, etc.) they also have implications for supply chain process management.

Within the supply chain of agri-food products there are always several different processes that must be well coordinated and interdependent, ie have an impact on the success and satisfaction of all stakeholders involved in the supply chain and an important effect on the quality of products delivered to final consumers. This means that the final product should have the characteristics that must be achieved when the production processes and the use of resources are in accordance with predetermined specifications. For example, if we buy a product that is labeled organic, it should really be produced and marketed in accordance with the rules for organic food production and distribution. In addition, consecutive continuous production (eg milk) and separate production (eg packaging) often have to be reconciled in the AFSC. Moreover, different actors in the food chain, as well as different consumers and consumer groups have different views on the properties of food products, which poses an additional challenge to harmonize the processes in the chain.

2. Complexity and structure of supply chains

As noted earlier, more than one actor and supply chain process operating in parallel or sequentially over time can be identified in the AFSC. As a result, different companies may have different roles in different supply chain structures and at the same time work with several different supply chain partners, who may be in competition with them in another supply chain. Formal management mechanisms, including vertical coordination and formal contracts, play an important role in structuring / creating food supply chains. On the other hand, particularly short supply chains are often coordinated and guided by informal governance mechanisms that include informal agreements, trust, commitment and reputation. This all has a significant impact on decision-making that will ensure efficient supply chain management regardless of its structure or length and the number of chain members.

3. Information system technology

Since actors in agri-food supply chains are generally part of more than one supply chain, these companies should possess such flexible information systems and communication technology and be able to work with different governance mechanisms for different supply chain partners at different times. At the same time, these systems and technologies should be applied and configured for each supply chain process using a mass adaptation approach and allow for the frequent exchange of vast amounts of information among chain actors. Modern technology and information systems can significantly improve and facilitate the management of supply chains and ensure traceability and transparency throughout the chain (eg Blockchain Technology).

4. Transparency and traceability

A key factor in relation to transparency is production according to pre-defined production standards, specified in quality and safety standards in food supply chains. Timely exchange of information to allow transparency of data, detailed registration of processes, resources and product characteristics, such as product history, quality variations, etc., is crucial for all agri-food supply chains. This is important to enable production management, traceability, recall management and compliance with legislation and other food-related regulations and standards. In addition, divergent and convergent processes and products that significantly affect and sometimes make it difficult to achieve traceability in these chains often alternate in food supply chains. Eg. in the production of dairy products, raw materials (e.g. milk) come from different producers (farms) and are mixed before different finished products (e.g. yogurts, cheeses, dairy spreads, etc.) are obtained for different markets.

5. Satisfying different consumer requirements (mass adaptation)

Consumers have changed in recent decades. They have become more critical and each has its own unique set of specific requirements and desires regarding the production and distribution of food products, imposing a trend of mass adaptation. For the final consumer who uses food for immediate consumption, it is extremely important that the food is safe for human consumption and properly labeled. From the consumer's perspective, we distinguish two basic groups of factors important when making a decision to buy food: external or extrinsic (eg. certificate, known manufacturer, packaging, etc.) and subjective or intrinsic (health, freshness, taste, appearance), where subjective characteristics of quality are more dominant^[37]. Quality management of agri-food supply chains achieves improved product and process characteristics, better quality variations throughout the supply chain, product branding, which ultimately significantly affects the decision to purchase food from end consumers.

6. Legislation and government

Each government has adopted formal and informal governance mechanisms that support transparency in food supply chains. Food laws and regulations define various requirements for all entities in the food business. This primarily refers to: meeting the requirements of hygiene (application of good hygiene practice); the obligation to introduce a system of self-control based on the principles of the HACCP system; ensuring traceability at all stages of food production, processing and distribution; meeting the requirements in relation to food labeling or informing consumers in accordance with the prescribed requirements; withdrawal or recall of food from the market if there is reason to believe that the food is unsafe; meeting food quality requirements, etc.

7. Food quality and safety standards

As different actors have a role to play in ensuring the quality and safety of the final product, their activities need to be closely coordinated. Differentiation of food quality begins already in the breeding phase, depends on the conditions of growth of plants or animals in the breeding phase, and the quality is also affected by the method of transport, storage and processing of products. Gathering and sharing different quality information in food supply chains is essential to creating the best possible product quality for the end consumer. Due to the deterioration of quality (perishability) and changes in quality, each individual stakeholder in the

supply chain may impair its competitiveness and performance, and thus affect the competitiveness and performance of the entire food supply chain.

In the food sector, governments focus primarily on protecting public health and safety by creating laws and regulations (e.g., the HACCP system). In addition, nationally and globally, retailers and the food industry have defined a number of voluntary food safety standards in processing and distribution, such as GLOBALGAP, British Retail Consortium (BRC), International Featured Standard - Food (IFS Food), etc. which stakeholders in the food chain must apply if they are to be competitive and part of the global food market.

8. Resolving incidents

All stakeholders in the supply chain must comply with different consumer requirements as well as legal requirements. When incidents occur, companies must, and want to, have the ability to quickly recall products from the market or connect a downstream supply chain to limit the incident and reduce costs. This can be achieved through better management and control of traceability in food supply chains.

9. Accountability and sustainability

Activities and processes of sustainable supply chain management include prevention and reduction of environmental impact, waste reduction, use of environmentally friendly materials wherever possible, recycling and reuse, cooperation with suppliers and other chain partners on sustainability, energy conservation, increasing transparency and traceability in the food supply chain, etc. In the last decade, many companies in the food sector have been encouraged to implement socially responsible business strategies that pay special attention to the ethical aspects of raw material procurement, product production and labor use.

Bibliography

- [1] Waters, D (2003) Logistics: An introduction to supply chain management, Palgrave Macmillan, Basingstoke, ISBN 0-333-96369-5
- [2] Christopher, M. (2005) Logistics and Supply Chain Management: Creating Value Adding Networks, Issue 3, Prentice Hall, Harlow, ISBN: 978-0-273-73112-2
- [3] Bozarth, Cecil B., Handfield Robert B. (2019) Introduction to Operations and Supply Chain Management, 5th Edition, New York, NY : Pearson, Identifiers: LCCN 2017050841| ISBN 9780134740607
- [4] Bourlakis, A., Weightman, P. W. H. (2004) Food Supply Chain Management. Blackwell: Oxford/UK, ISBN 1-4051-0168-7
- [5] Marsden, T., Banks J., Bristow, G. (2000) Food Supply Chain Approaches: Exploring their Role in Rural Development, Sociologia Ruralis, 40(4), pp. 424–438., <https://doi.org/10.1111/1467-9523.00158>
- [6] Van der Vorst, J. G. A. J. (2000) Effective food supply chains: generating, modelling and evaluating supply chain scenarios, PhD-thesis Wageningen University, available at: <https://edepot.wur.nl/121244>
- [7] Van der Vorst, J. G. A. J., da Silva, Carlos A., Trienekens, Jacques H., (2007) Agro-industrial supply chain management: concepts and applications, Agricultural management, marketing and finance occasional paper, Food and Agriculture Organization of the United Nations, Rome, ISBN 978-92-5-105831-2
- [8] Tsolakis, N. K., Keramydas, C. A., Toka, A. K., Aidonis, D. A., Iakovou, E. T. (2014) Agrifood supply chain management: A comprehensive hierarchical decision-making framework and a critical taxonomy, Biosystems Engineering, 120, pp. 47–64. <https://doi.org/10.1016/j.biosystemseng.2013.10.014>
- [9] Dania, W. A. P., Xing, K., Amer, Y. (2018) Collaboration behavioural factors for sustainable agri-food supply chains: A systematic review, Journal of Cleaner Production, 186(June), 851–864., <https://doi.org/10.1016/j.jclepro.2018.03.148>
- [10] Canfora, I. (2016) Is the Short Food Supply Chain an Efficient Solution for Sustainability in Food Market? Agriculture and Agricultural Science Procedia, 8, 402–407., <https://doi.org/10.1016/j.aaspro.2016.02.036>
- [11] Kusumastuti, R. D., van Donk, D. P., Teunter, R. (2016) Crop-related harvesting and processing planning: a review, International Journal of Production Economics, 174(1), 76–92. <https://doi.org/10.1016/j.ijpe.2016.01.010>
- [12] European Commission (2015) You are part of the food chain. Key facts and figures on the food supply chain in the European Union. http://ec.europa.eu/agriculture/markets-andprices/market-briefs/pdf/04_en.pdf
- [13] Yared Lemma, D. K., Gatew, G. (2014) Loss in Perishable Food Supply Chain: An Optimization Approach Literature Review, International Journal of Scientific and Engineering Research, 5(5), 302–311.
- [14] Shukla, M., Jharkharia, S. (2013) Agri-fresh produce supply chain management: a state-of-the-art literature review, International Journal of Operations and Production Management, 33(2), 114–158. <https://doi.org/10.1108/01443571311295608>
- [15] Bukeviciute, L., Dierx, A., Ilzkovitz, F., Roty, G. (2009) Price transmission along the food supply chain in the European Union, In 112th seminar of the European Association of Agricultural Economists, pp. 3–6. <http://dx.doi.org/10.22004/ag.econ.57987>
- [16] Fischer, C., Hartmann, M. (2010) Introduction and Overview: Analysing Interorganizational Relationships in Agri-food Chains. In Fischer, C., Hartmann, M. (Eds), Agri-food Chain Relationships, CAB International, Oxford, pp. 11–21. ISBN 978-1-84593-642-6
- [17] Dani, S. (2015) Food Supply Chain Management and Logistic From farm to fork, London, Philadelphia & New Delhi: Kogan Page, ISBN 978 0 74947364 8

- [18] Zhong, R., Xu, X., Wang, L. (2017) Food supply chain management: systems, implementations, and future research. *Industrial Management & Data Systems*, 117(9), str. 2085–2114. <https://doi.org/10.1108/TMDS-09-2016-0391>
- [19] Ványi, N. (2013) Members of a supply chain and their relationships. *Applied Studies in Agribusiness and Commerce*, 6(5), 131–134. <https://doi.org/10.19041/APSTRACT/2012/5/21>
- [20] Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., Zacharia, Z. G. (2001) Defining supply chain management. *Journal of Business Logistics*, 22(2), 1–25. <https://doi.org/10.1002/j.2158-1592.2001.tb00001.x>
- [21] Gajdić, D. (2019) Definition and characteristics of short agri-food supply chains for products, *Ekonomika misao i praksa*, 28(1), 381–408.
- [22] Maye, D., Kirwan, J. (2010) Alternative food networks, *Sociopedia.isa*, 1–12. <https://doi.org/10.1177/205684601051>
- [23] Gajdić, D., Mesić, Ž., Petljak, K. (2021) Preliminary Research about Producers' Perceptions of Relationship Quality with Retailers in the Supply Chain of Organic Food Products in Croatia // *Sustainability*, 24(13), 1–41. <https://doi.org/10.3390/su132413673>
- [24] Ahumada, O., Villalobos, J. R. (2009) Application of planning models in the agri-food supply chain: A review, *European Journal of Operational Research*, 195(1), 1–20. <https://doi.org/10.1016/j.ejor.2008.02.014>
- [25] Trienekens, J. H., Wognum, P. M., Beulens, A. J. M., van der Vorst, J. G. A. J. (2012) Transparency in complex dynamic food supply chains, *Advanced Engineering Informatics*, 26(1), 55–65. <https://doi.org/10.1016/j.aei.2011.07.007>
- [26] Fritz, M., Schiefer, G. (2008) Food chain management for sustainable food system development: a European research agenda, *Agribusiness*, 24(4), 440–452. <https://doi.org/10.1002/agr.20172>
- [27] Gajdić, D., Kotzab, H., Petljak, K. (2023), Collaboration, trust and performance in agri-food supply chains: a bibliometric analysis, *British Food Journal*, 125(2), 752–778. <https://doi.org/10.1108/BFJ-07-2021-0723>
- [28] Lambert, M. D., Cooper, M. C., Pagh, J. D. (1998) Supply Chain Management Implementation Issues and Research Opportunities. *International Journal of Logistics Management*, 9(2), 1–20. <https://doi.org/10.1108/09574099810805807>
- [29] Routroy, S. and Behera, A. (2017) Agriculture supply chain: A systematic review of literature and implications for future research, *Journal of Agribusiness in Developing and Emerging Economies*, 7(3), 275–302. <https://doi.org/10.1108/JADEE-06-2016-0039>
- [30] Chandrasekaran, N., Raghuram, G. (2014) *Agribusiness Supply Chain Management*, Taylor & Francis Group, Boca Raton, ISBN 9781138627260
- [31] Chopra, S., Meindl, P. (2004) *Supply chain management: strategy, planning and operations*. Second edition. Pearson Education, New Jersey ISBN-10: 0-13-274395-7
- [32] Sufiyan M., Haleem A., Khan S., Khan M. I. (2019) Analysing Attributes of Food Supply Chain Management: A Comparative Study, Shanker K., Shankar R., Sindhvani R. (eds) *Advances in Industrial and Production Engineering*, Springer, pp. 515–523. https://doi.org/10.1007/978-981-13-6412-9_50
- [33] Susanty, A., Bakhtiar, A., Jie, F., Muthi, M. (2017) The empirical model of trust, loyalty, and business performance of the dairy milk supply chain, *British Food Journal*, 119(12), 1–26. <https://doi.org/10.1108/BFJ-10-2016-0462>
- [34] Mathu, K., Phetla, S. (2018) Supply chain collaboration and integration enhance the response of fast-moving consumer goods manufacturers and retailers to customer's requirements", *South African Journal of Business Management*, 49(1), 1–8. a192. <https://doi.org/10.4102/sajbm.v49i1.192>
- [35] Holloway, L., Kneafsey, M., Venn, L., Cox, R., Dowler, E., Tuomainen, H. (2007) Possible Food Economies: a Methodological Framework for Exploring Food Production–Consumption Relationships, *Sociologia Ruralis*, 47(1), 1–19. <https://doi.org/10.1111/j.1467-9523.2007.00427.x>
- [36] Lambert, D. M., Cooper, M. C. (2000) Issues in supply chain management. *Industrial Marketing Management*, 29(1), 65–83. [https://doi.org/10.1016/S0019-8501\(99\)00113-3](https://doi.org/10.1016/S0019-8501(99)00113-3)
- [37] Gajdić, D., Petljak, K., Kralj, N. (2019) Percepcije potrošača o sigurnosti hrane u sjeverozapadnoj Hrvatskoj, *Proceedings, 54th Croatian & 14th International Symposium on Agriculture | February 17–22, 2019, Vodice, Croatia*