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**BOGDAN KLEPACKI, ALEKSANDRA PERKOWSKA**

Warsaw University of Life Sciences – SGGW, Poland

## **ORGANIZATION OF FOOD SUPPLY CHAINS IN DISPERSED PRODUCTION ON THE EXAMPLE OF THE VEGETABLE SECTOR IN POLAND**

Key words: logistics, agriculture, vegetable industry, vegetable preserves

**ABSTRACT.** The study aimed to recognize the supply chains used in the marketing of vegetables and their products, as well as the trends of changes occurring in it. An analysis of vegetable production in the World and Poland was made. The study presents a diagram of the supply chain in agribusiness prepared by the authors. Using the graphical method, a presentation of the flow of raw materials and vegetable products was made, starting from producers of production means for agriculture to the final consumer. The directions of changes in the production of vegetables and their products are presented. The literature of the subject, official statistical data, and studies prepared by the Ministry of Agriculture and Rural Development as well as the Institute of Agricultural Economics and Food Economy - National Research Institute were used in the research. It was found that the vegetable logistics chain includes thousands of farmers, fruit and vegetable processing units, wholesale and retail trade. Such a chain must be very flexible, adapting to the challenges of domestic and foreign markets. The condition for success in implementing supply chains of the vegetable sector is the efficiency of their management, solidarity and trust of participants.

### **INTRODUCTION**

Producing and processing vegetables is a very important sector of agriculture as is food processing and trade at enterprise, regional, national, and global levels. Vegetables are a very important component of the diet of the population in all, especially in poorer countries.

Apart from their participation in food production and creating GDP, the production of vegetables is key as a source of income for producers and creates jobs, both in agriculture as well as processing plants and trade. Fresh and processed vegetables are consumed in large quantities in households, by mass caterers and are the basic (next to fruit) raw material in the fruit and vegetable industry. Low-quality vegetables and vegetable waste are used as feed for farm animals.

The importance of production and the promising prospects for using vegetables in the country for export, as well as the favorable level of profitability of the production of vegetables and processed products compared to other activities, triggers farmer interest in the development of their cultivation. A large number of producers and processors are

arousing the growing interest of farmers, processing companies, traders and exporters in the efficiency of the flow of vegetables and their products – they are interested in the good functioning of logistics chains.

The study aimed to identify supply chains used in the agri-food sector in agribusiness, especially in the marketing of vegetables and their products, as well as determine the trends of changes occurring in it. To achieve the purpose of the study, official statistics data was used, as well as the studies of the Ministry of Agriculture and Rural Development, the Institute of Agricultural and Food Economics – National Research Institute (IAFE-NRI) research, and the literature on the subject.

### SCALE OF GLOBAL, EUROPEAN AND NATIONAL VEGETABLE PRODUCTION

In 2018, vegetables such as tomatoes (16.7%), onions (8.9%), cucumbers (6.9%), cabbage (6.3%), eggplant (5%), carrots (3.7%), peppers (3.4%), lettuce, pumpkin and garlic (about 2.5% each) can be considered as the most important [FAOSTAT 2020]. In global terms, most vegetables are produced by China, whose share in world production in 2018 was about 50.4%, and India (11.8%). For some vegetables, China's share is dominant, as this country produced a total of 90.6% of the world's production of spinach, 80.4% of beans, 78.3% of garlic and 74.8% of cucumbers. In addition to China and India, the importance of other countries in vegetable production is relatively small. The USA is third in terms of the largest vegetable production in the world (2.91% market share), followed by Turkey (2.2%). The largest European producers, Italy and Spain, produce approximately 1.1% of global production. 3.5% of vegetables were produced in the entire European Union, while in Poland 0.5% (21st place in the world) [FAOSTAT 2020].

In 2018, the European Union harvested 64.5 million tonnes of vegetables (about 5 million fewer than a year earlier), including in Poland, 5.7 million tonnes (down 0.3 million tonnes). The largest tonnage production was tomatoes, which in 2017 amounted to 18.3 million tonnes, followed by onions (6.8), carrots (5.6), white cabbage (3.8), watermelons (3.2) and peppers (2.6 million tonnes) [IERiGŻ-PIB 2018]. The main vegetable producers in Europe are Spain (15.0 million tonnes in 2017), Italy (13.8 million tonnes) and Poland (5.7 million tonnes), followed by France, Germany, Greece, and Portugal.

Poland is a major producer of carrots (1.8% of world production in 2018), cabbage (1.4%), cauliflower and broccoli (1.1%), cucumbers (0.7%), onions (0.6%) and tomatoes (0.5% on a global scale) [FAOSTAT 2020]. In 2015, ground vegetable production accounted for 61%, and vegetable production undercover the remaining 39% [MRiRW 2017]. The market for vegetable production is dominated by the production of flavored vegetables (parsley, celery, leeks), legumes (peas, beans), asparagus and rhubarb. Tomatoes dominate in vegetable production from undercover (62.1% of value).

The value of vegetable production in 2017 in Poland amounted to PLN 115,611.7 million, which represents 8.7% of global production (increase by 1.3 percentage point (p.p.) compared to 2010) and 9.6% of commodity production (more by 2.1 p.p.) (calculated based on [GUS 2018, p. 132-135]). In plant production this share was 18.0% globally

(an increase by 4 p.p.) and commodity 24.6% (7.5 p.p.), respectively. Also 1,377.4 thousand tonnes of vegetable products were produced<sup>1</sup>. Vegetables are an important element of export. In the 2017/2018 season, Poland sold 465.5 thousand tonnes of vegetables and 724.9 thousand tonnes of processed vegetables abroad [IERiGŻ-PIB 2018]. The revenue from vegetable exports in 2017 amounted to PLN 4.4 billion and were 45.2% higher than in 2012 (calculated based on [GUS 2018, p. 297]). It follows that the production of vegetables is important for agriculture and the national economy.

Vegetable production takes place in a relatively large number of not very large (in terms of area and scale of production) farms. This production is dispersed, and therefore requires efficient systems of links between producers and recipients of vegetables and the effective organization of transport and storage. In 2010, around 110,000 agricultural holdings produced ground vegetables, including 28.2 thousand farms covering an area of over 1 ha (85% of total crop area) [MRiRW 2017]. Vegetables undercover (over 500 m<sup>2</sup>) were cultivated in 6.1 thousand farms in 2002, and in 2010 in 10 thousand farms. The number of greenhouse facilities over 7,000 m<sup>2</sup> increased from 1,475 to 1,869, and the average area from 10,088 m<sup>2</sup> to 15,201 m<sup>2</sup>.

Vegetable cultivation in Poland is diversified in spatial arrangement due to the dominant number of farms located near larger urban agglomerations and fruit and vegetable processing plants. It can be argued that vegetables are grown in areas where there are many farms with a much smaller area, with an available workforce, although now under more and more mechanization of fieldwork area vegetable farms will increase.

## THE TYPICAL SUPPLY CHAIN IN AGRIBUSINESS

The logistics supply chain includes successive stages from producer to consumer [Costa, Jongen 2006]. It may be of different lengths and depths, start from primary producers/inputs of an original (e.g. natural gas, crude oil, other minerals), or particular cell [Hobbs, Young 2000]. Regardless of the length of chains, all its operations and processes must be coordinated organizationally, technologically and financially [Bowersox et al. 2002].

In the standard supply chain, there are processes related to supply, inventory, production, demand or order management as well as customer relations [Stewart 1995]. So, we are dealing with the acquisition of raw materials, their supply, production and distribution of finished products to the customer [Grunert et al. 2005]. The logistics chain is therefore a type of network extending between the supply and sales market, manufacturers, suppliers, trade, logistics units and final recipients [Ballou 2004]. This network covers the flow of goods (this is the most discernible process), information, but also financial resources.

Universal principles and main organizational forms in logistics chains apply to food flows. The organizational chart that can be treated as common for most agribusiness supply chains is presented in Figure 1.

<sup>1</sup> Statistics only include production in plants employing at least 10 people.

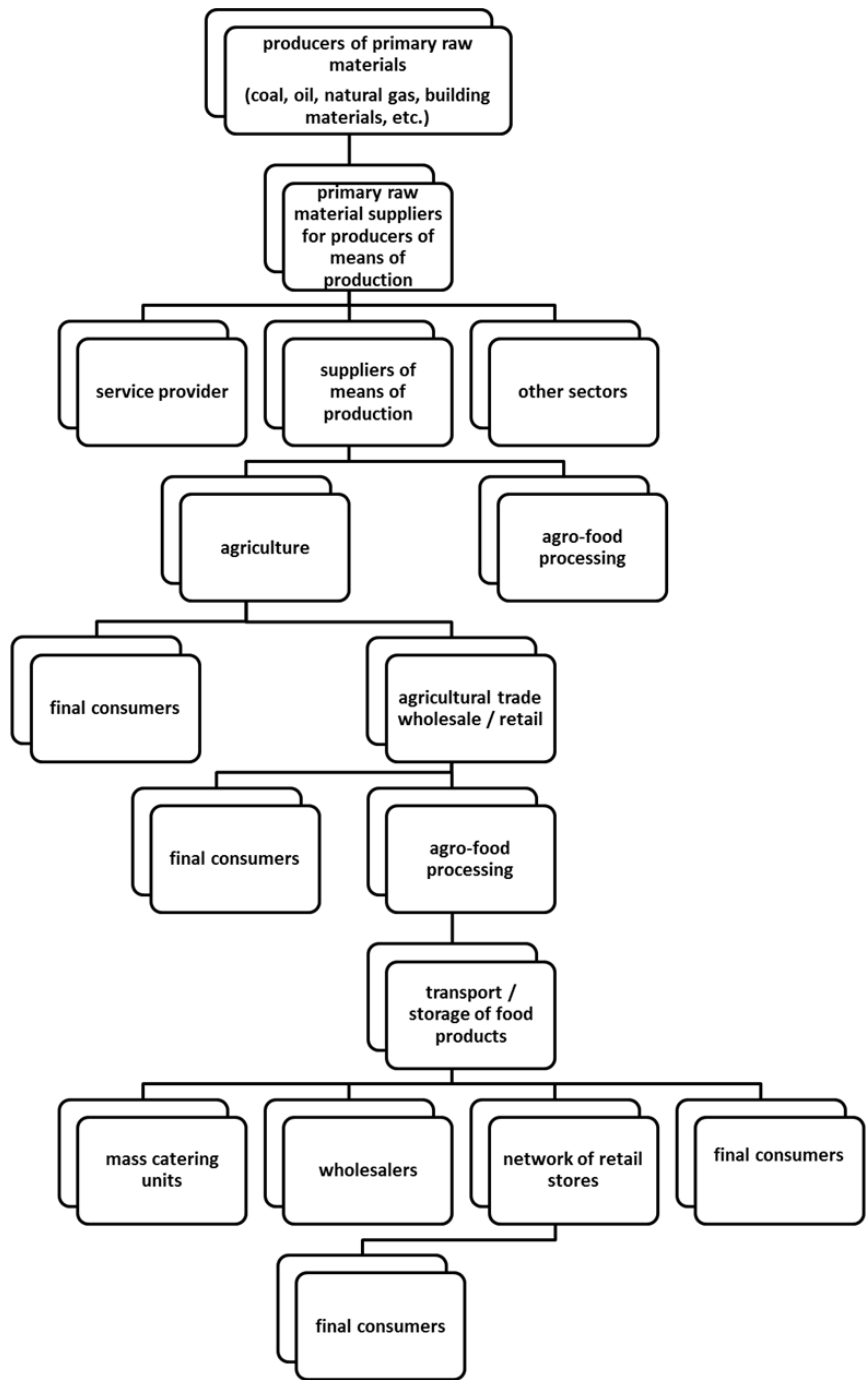


Figure 1. A universal scheme of food supply chains  
Source: [Klepacki, Perkowska 2018]

## VEGETABLE FLOWS AND THEIR PRODUCTS

As part of the food economy or agribusiness, there are logistic chains of individual agricultural raw materials. There are many of them, however as the most important (although often the most complex), one can indicate those with the greatest significance. These are such logistics chains as vegetable – cereal, oilseeds and their products, fruit and vegetables, and animal – dairy, beef, pork, poultry and sheep.

Food products can be obtained from vegetables as a direct raw material (raw, without processing) or indirectly. The first group includes products consumed after washing, grinding or undergoing cooking processes. Vegetables, as a preserved product, also play an important role, e.g. dried, pickled, pickled and frozen vegetables. Feature vegetables, affecting the organization of the flow of goods and storage, are very sensitive products for transport, both physically, because most vegetables are rather quickly subject to the processes of deterioration (wilting, deterioration of taste and visual), and even deterioration (rotting, drying out). Also, vegetables with high economic sensitivity to transport, generally contain a lot of water (apart from seeds – peas, broad beans, etc.) and are not concentrated. They also require expensive means of transport and storage (cold stores). Taking all this into account, as well as the economic importance of vegetables, we conclude that their movement and processing must take place in the efficient links of many networks of connections [Klepacki 2000]. The main processes of the supply chain of vegetables and their products and links are presented in Figure 2.

The vegetable supply chain must start from the manufacturers and suppliers of the means of production for agriculture<sup>2</sup>, which is agricultural machinery, equipment and tools, building materials, energy carriers, fertilizers, plant protection products, medicines, seed and seedlings. The basics of logistics chains need to be sought in mines, machinery factories, chemical factories and other farms.

Vegetable flows for processing take place on many channels. The simplest relationship is producer–consumer, i.e. direct sales to households or mass catering facilities, e.g. canteens. Slightly longer chains includes trade links, one or more (e.g. wholesale trade, then retail trade). More and more common in the early stages of the supply chain are without trade, in relation manufacturer of vegetables – processor, the farm/agricultural and – vegetable processing plants, etc. However, this type of supply mainly concerns producers of large batches of vegetables or sales organized by producer groups [Mubarik, Abedullah 2002]. Many farmers produce smaller quantities of vegetables and use the services of intermediaries, such as commercial companies and private entities [Avermaete et. al 2005].

<sup>2</sup> In discussing the supply chains of agricultural products and their products, manufacturers and suppliers of raw materials and inputs for agriculture are usually overlooked. This is a wrong approach, because modern agriculture consumes large amounts of high-quality raw materials, and the timeliness of their delivery is as important as it is in industrial or commercial enterprises.

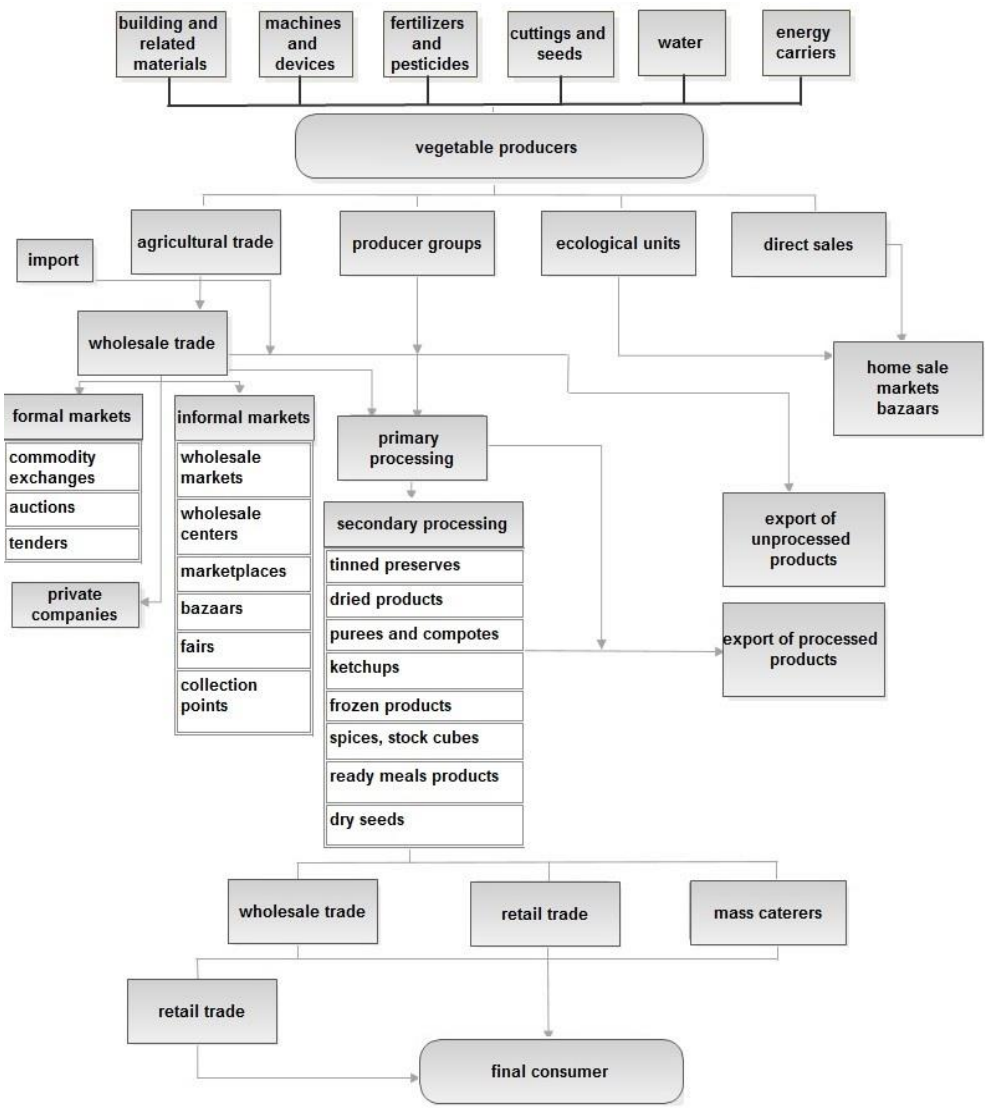


Figure 2. Diagram of the food supply chain of vegetables and their preserves  
Source: own study

## TRENDS OF CHANGES IN THE FUNCTIONING OF THE SUPPLY CHAIN OF VEGETABLES AND THEIR PRODUCTS

Socio-economic transformation, European Union accession, as well as changes in domestic and international markets still affect the Polish vegetable sector in terms of technology, production, organization and structure [Ozimek, Żakowska-Biemans 2011. Keane, Prasad 1999]. The following can be considered as the most important trends:

1. Similarly to other agricultural activities, the number of farms producing vegetables in Poland is decreasing, both in the ground and undercover, however, the scale of its production is increasing [MRiRW 2017].
2. The importance and strength of links between processing industry units and vegetable producers are growing, which is expressed, among others, by imposing requirements on farmers regarding production technology, product quality and standardization, and the number of intermediary links in the vegetable chain is decreasing [Golan et al. 2004].
3. Expectations regarding the precision of implementation of technological requirements in vegetable production, especially in the use of chemicals, are increasing [Sporleder, Goldsmith 2003]. At the same time, similar processes took place in processing, where significant technological progress took place and requirements in the scope of the technological and hygienic regime in food processing increased, including food safety [Bent et al. 2005].
4. Recently, there has been a growing awareness of the use of food safety measures among all participants in the supply chain, from producers to consumers. The importance of quality monitoring systems for sent products is growing, such as the European Rapid Alert System for Food and Feed (RASFF) [Boxstael et al. 2013].
5. As part of specialization, various services are increasingly developed, outsourcing to satisfy the needs of farmers, e.g. in the marketing of seeds or wholesale supply of input [Jarka 2013].
6. There are consolidation processes and the number of vegetable trade units is decreasing, the role of the wholesale market is increasing, while local marketplace trade is marginalized, where fresh vegetables are bought mainly for direct consumption [Sharma et al. 2016].
7. Fruit and vegetable processing plants are being consolidated and internationalized. At the same time, a significant elimination of small processing units took place.
8. The significant development of transport and storage infrastructure has taken place and is still taking place on a national scale [McCullough et al. 2008]. On the one hand, this allows to improve the management and quality of supply chain operations, on the other hand, it creates opportunities to reduce logistics costs in individual terms.



## SUMMARY AND CONCLUSIONS

1. The production of vegetables and their products, next to cereals, milk, meat and fruit, is one of the most important activities in Polish agribusiness, and the efficiency of their logistics chain is an important factor determining the economic situation of many economic entities in agriculture, industry, trade and services.
2. The logistics chain for the supply of vegetables and their products is very extensive, including thousands of vegetable producers, agri-food processing units, agricultural, wholesale and retail trade. It must be flexible, efficiently adapted to the challenges arising from changes in technology, organization and occurring in the agribusiness environment as well as among clients/consumers.
3. Individual links in the supply chain of vegetables and their products are joined by a community of economic interests, both short-term (season, year) as well as long-term strategy. In the conditions of distributed vegetable production, the success of all its participants is determined by the efficiency of chain management, but also by solidarity and the mutual trust of producers, traders, processors, consumers, as well as recognition that each participant in the chain gains a similar extent in participating in it.

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## ORGANIZACJA ŻYWNOŚCIOWYCH ŁAŃCUCHÓW DOSTAW PRZY PRODUKCJI ROZPROSZONEJ NA PRZYKŁADZIE SEKTORA WARZYW W POLSCE

Słowa kluczowe: logistyka, rolnictwo, przemysł warzywny, przetwory warzywne

### ABSTRAKT

Jako cel opracowania przyjęto rozpoznanie łańcuchów dostaw stosowanych w obrocie warzywami i ich przetworami, a także zmian w nim zachodzących. Dokonano analizy produkcji warzyw na świecie oraz w Polsce. Zaprezentowano standardowy schemat łańcucha dostaw w agrobiznesie. Wykorzystano metodę graficzną i dokonano prezentacji przepływu surowców oraz przetworów warzywnych, rozpoczynając od producentów środków produkcji dla rolnictwa aż po finalnego konsumenta. Przedstawiono kierunki zmian w produkcji warzyw i ich przetworów. Wykorzystano w badaniach literaturę przedmiotu, dane statystyki publicznej oraz opracowania Ministerstwa Rolnictwa i Rozwoju Wsi, a także Instytutu Ekonomiki Rolnictwa i Gospodarki Żywnościowej – Państwowego Instytutu Badawczego. Stwierdzono, że warzywny łańcuch logistyczny obejmuje tysiące rolników, jednostki przetwórstwa owocowo-warzywnego, handlu hurtowego i detalicznego. Tego typu łańcuch logistyczny musi być bardzo elastyczny, dostosowany do wyzwań rynku krajowego i zagranicznego. W warunkach rozproszonej produkcji warzyw o sukcesie realizacji łańcucha dostaw decyduje sprawność zarządzania łańcuchem, solidarność i wzajemne zaufanie producentów, handlowców, przetwórców, a także konsumentów.

### AUTHORS

BOGDAN KLEPACKI PROF. DR HAB.

ORCID: 0000-0003-3483-7530

Warsaw University of Life Sciences – SGGW

Institute of Economics and Finance

Department of Logistics

166. Nowoursynowska St., 02-787 Warsaw, Poland

ALEKSANDRA PERKOWSKA, MSC

ORCID: 0000-0002-7059-0689

Warsaw University of Life Sciences – SGGW

Institute of Economics and Finance

Department of Logistics

166. Nowoursynowska St., 02-787 Warsaw, Poland