

AGRICULTURE AS A FIELD FOR LOGISTICS ACTIVITIES DEVELOPMENT

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Abstract

Agriculture is the sector with strong specificity of production processes. This results from the use of the forces of nature (earth, solar, biological processes) and live organisms. Similarly as in the whole economy, the modernization of agrarian sector influences on growing importance of logistics. Modern agricultural enterprises must transport and store not only huge amounts of inputs (e.g. feed, fertilizers, pesticides, energy, seeds, etc.) but also the final plant and animal products (grain, tubers, forage, live animals, meat, milk, wool, etc.). Apart from that, the relationship between companies and their environment is becoming more and more significant. There is a strong attention to well prepared and created communication channels providing reliable flows of information, goods, money and people. This paper presents the scale of the production and transport of major crops in Poland against the background of non-agrarian products (coal, liquid fuels). Moreover, author presents the classification of the products that are part of internal and external trade and storage process in a classic agricultural enterprise. Some trends in technical solutions and technology used to streamline manufacturing processes with their use in agriculture on the example of milk production cereals were also laid out.

Keywords: Agriculture, logistics, agricultural products

1. INTRODUCTION

Agriculture is an important sector of the national economy, both historically (as the oldest area of conscious human production) and in modern times. In 2014, 2.38 million people, that is 16.3% of the total labour force in Poland, were employed in this sector and its share in the gross value of fixed assets was 4.6%, while in terms of land-use it amounted to 52.1% of the country (agricultural companies farmed on a surface area of 16.3 million ha)(*Own calculations based on: Rocznik Statystyczny Rolnictwa 2015 [Agricultural Statistical Yearbook 2015], GUS, Warsaw and Rolnictwo w 2015 roku [Agriculture in 2015], GUS, Warsaw, 2016 [9, 10]*). Its contribution to generating national income was lower (due to the lower work efficiency than other segments of the national economy and variable forces of nature) and amounted to 2.6%. However, in all highly- and medium-developed countries of the world, despite the declining share of agriculture in GDP generation, the sector is recognised as an important one, particularly due to its necessity in maintaining society's food security and its equilibrating role in times of an economic crisis. Moreover, it is also important as a source of income for residents of rural areas, a market for industrial products and services, and recently also due to its role in maintaining environmental, landscape or genetic (biodiversity) values.

In the case of this sector, just like in the economy as a whole, its modernisation leads to an increase in the importance of logistics [3]. Modern agricultural enterprises transport and store significant amounts of production means (feed, fertilisers, pesticides, fuels, seeds, seedlings, etc.) and final products - plants (grains, tubers, feed) and animals (live animals, meat, milk, wool, etc.). Their relationships with the environment are increasingly important, including communication channels (flows of information, goods, money, people).

The aim of the paper is to present the scale of products transported and stored in agricultural sector in comparison to non-agricultural products (e.g. coal or liquid fuels). This allowed to define the importance of logistics activities for agribusiness.

2. NATURE OF AGRICULTURE AS A FIELD FOR THE APPLICATION OF LOGISTICS SOLUTIONS

The role of logistics in agriculture (and the agribusiness as a whole) is of particular importance due to the nature of this sector, which manifests itself in, among other things [1], [4]:

- 1) a significant temporary imbalance of supply and demand for agricultural products (this applies to plant production, in particular); the fact that many agricultural products are obtained only once a year and during a particular season (strawberries - early summer, cereals - summer, apples - mainly autumn etc.); the fact that demand for vegetables, fruits and animal feed remains relatively constant, it is necessary to store many raw materials, which require warehouses, which in turn result in costs,
- 2) the necessity, in case of agriculture, of creating specific warehouses, as most of the products deteriorate when improperly stored; in the case of many products warehouses cannot be universal in nature (such structures are cheaper), as they must fulfil specific requirements, e.g. temperature, humidity and ventilation, so investments are quite significant,
- 3) conducting numerous transport activities on unpaved roads and fields, even ploughed, which results in considerable fuel consumption and increases transport costs, in addition to posing high technical requirements for agricultural means of transport;
- 4) the negative impact of many atmospheric factors such as rain, hail, thaws, snow, ice, snow drifts, etc., which also increases the cost of transport, as well as the risk of accidents and equipment failures;
- 5) the limited transport and storage possibilities of many agricultural products (e.g. milk, meat, fruit and vegetables), as they often contain 80 - 90% water, are less concentrated and require processing, e.g. into dried products, jams, cheeses, meats and breads;
- 6) the frequent economical and physical difficulties in transporting agricultural products; their economic sensitivity stems from a high water content, while the physical aspect - from the fragility of the products (e.g. in case of improper transport, raspberries or strawberries change into a compact mass, losing their commercial value for individual customers), as well as from the processes of fermentation, rotting, drying, etc. that occur,
- 7) the specific means of transport required by many agricultural products, e.g. milk tanks, vehicles adapted for transporting cattle, pigs, poultry or eggs; such means of transport are specialised and can rarely be used in a more universal manner,
- 8) a farm being a transport company "involuntarily". For example, the production of potatoes on a 1 hectare field requires about 2 tonnes of potatoes, a few hundred kilograms of mineral-based fertilisers, hundreds (and in unfavourable conditions, even thousands) of litres of water for spraying against weeds, pests and diseases. Furthermore, it's necessary to harvest several tonnes of potatoes from the field and they must be standardised according to size, and delivered to the appropriate recipient. This means that transport and storage are the basic work of farmers and processors of agricultural products [2],
- 9) the fact that logistics management is made easier by the existence of a limited number of large entities rather than many small ones; in agriculture there is considerable territorial distribution and fragmentation in terms of farm size, which leads to relatively small batches of goods and generally small-scale (though growing) production, while processing plants want to acquire large portions of a single commodity, namely cereals, fruits, vegetables, animals, etc.; even though there are organised producer groups with one of their tasks being the merging of small batches of goods into large ones. However, in Polish agriculture their scale is insufficient, as farmers prefer to act alone, which entails significant complexity of logistics activities associated with the receipt of agricultural products and deliveries of agricultural production means,
- 10) the fact that the last two decades have led to significant changes in technology, as well as agricultural and related technology in particular within Polish agriculture and agribusiness; we are dealing with machinery and equipment of different generations, not always compatible, which makes it difficult to maintain a stream of technological and logistical processes,

- 11) the differing technological level is concurrent with various levels of producer's knowledge - not all of them appreciate and implement modern technological requirements. They are often very attached to traditional production methods, while modern recipients have specific requirements within the scope of product quality and uniformity,
- 12) agriculture and agribusiness featuring numerous and independent intermediary links in the supply chain leading "from the farmer's field to the consumer's table", which causes significant disruptions in the flow of information and difficulties in "coordinating" their operations, as well as the supply of raw materials and products to the subsequent links in the food supply chain.

3. PLACE OF LOGISTICS PROCESSES IN AGRICULTURE

Agricultural businesses, just like other sectors of the economy, operate by moving means of production and products between three areas:

- 1) on the "input" side, meaning arranging supplies of products necessary for agricultural production (and possibly non-agricultural, manufacturing and services) to an entity,
- 2) within the entity in several ways:
 - a) storing own (self-supply) and external raw materials used in production, and means of production themselves,
 - b) transport from a warehouse to the places of use (to the field, buildings for livestock, workshops, other warehouses),
 - c) transport pertaining to the production process (in production buildings, including buildings for livestock, on agricultural land),
 - d) transport from production areas to warehouses for internal purposes or to conduct a sale,
- 3) at the "output", i.e. by organising transport of agricultural products directly to external customers (trade, processing, consumers).

According to this summary, agricultural production is associated in its entirety with the efficient organisation of logistics processes, although usually these are not described (named) as such within the enterprises. A systematisation of areas of activity and product groups related to logistics processes, with specific examples, is shown in **Table 1**.

Table 1 Systematic description of areas of activity that require logistics processes in the agricultural enterprise

Area of activity and product group	Examples of products
I. Supply	
Construction materials and equipment	Bricks, cement, concrete mixer
Machines and devices	Tractors, combines, ploughs, cultivators, harrows
Spare parts	Ploughshares, tyres, machine components
Small appliances, working clothes	Pitchforks, spades, wheelbarrows, overalls, rubber boots
Energy carriers	Diesel fuel, coal, electricity
Fertilisers and pesticides	Urea, potash salt, ammonium nitrate,
Medication and others	Calem Plus, Dietan, Virkon S
Seeding material	Seeds of cereals, maize, seed potatoes
Breeding stock	Calves, piglets, lambs, chicks
Feed, supplements	Mlekopan, "T-mix" pigfeed, 926-Rarytas

Area of activity and product group	Examples of products
I. Supply (continue)	
Water	Water from pipelines, wells, streams, natural and artificial reservoirs
Other	Professional information (technological, market, financial, regulatory, etc.), magazines, official and trade correspondence
II. Storage and internal trade	
Storage and transport of purchased goods	Products from point I
Own feed	Hay, silage, grains, fodder beets
Own seeds and seedlings	Cereals, grasses, legumes, potatoes
Water supply, sewerage pipelines	Water from a proprietary source, delivered, sewage
Excrement and organic fertilisers	Manure, slurry, liquid manure, compost
Moving employees	Family members, employed persons
Cash	Polish currency, foreign currency
Means of internal communication	CB Radio (occasionally)
III. Sale	
Animals	Cattle, pigs, wethers, poultry
Products of animal origin	Eggs, milk, wool, leather, manure (occasionally)
Plant products	Cereals, rapeseed, legumes, pulses, grasses, potatoes, sugar beets, vegetables, fruit, hay (occasionally)
Processed products of agricultural origin	Butter, cheese, sausages, sauerkraut
Products of non-agricultural origin	Handicrafts, collected herbs, dried mushrooms, berries
External products for resale	New or used machinery, equipment, seeds
Other	Contacts with the market and institutions

Source: own drawing up the author

The presented examples of production processes and products subject to logistics activities, such as procurement, transport, storage and distribution, do not exhaust the entire issue, but they do indicate its wide scope and complexity. This means that the effectiveness of operations of agricultural companies requires efficient logistics management.

4. SCALE OF TRANSPORT AND STORAGE IN AGRICULTURE AS A SECTOR OF THE POLISH ECONOMY

The amount of freight is significant in agriculture, although people from outside the industry are often not aware of this. It is due to the spatial dispersion of agricultural production over 1.4 million farms, covering an area of 16.3 million ha, on the one hand, and the fact that production occurs not only in buildings, but also in fields, meadows, pastures and orchards, on the other. The high tonnage of transport in agriculture is also a consequence of the high water content of agricultural products (For example, green fodder from grasses and legumes can contain 70 - 85% water, bulb and root plants 80 - 90%, while green fodder from maize to be used for silage should contain about 65% water. Fruits contain 80 - 95% water, while seeds and dried fruit 10 - 15%. Even wood comprises 40 - 50% water.).

In **Table 2** we present the scale of production and consumption of selected agricultural products and production means.

Table 2 Scale of production of selected agricultural products and consumption of certain production means in agriculture in 2014

No.	Product name or production means	Unit of measurement	Amount
1.	Cereal harvests	Mt	31.9
	- including basic	Mt	24.4
2.	Harvest of straw from basic cereals	Mt	25.0
3.	Hay harvests	Mt	13.7
4.	Sugar beet harvests	Mt	13.5
5.	Potato harvests	Mt	7.4
6.	Oilseed harvests	Mt	3.3
7.	Pulse harvests	Mt	0.5
8.	Production of animals for slaughter (calculated into meat)	Mt	4.4
9.	Cow milk	bn l	12.6
		Mt	13.0
10.	Chicken eggs	bn pcs.	103
11.	Purchased seed stock:		
	- cereals	kt	74.4
	- potatoes	kt	39.9
12.	Nitrogen fertilizers	Mt	6.0
13.	Calcium and magnesium fertilizers	Mt	2.4
14.	Multi-component fertilisers	Mt	1.7
15.	Phosphorous fertilisers	Mt	0.3
16.	Pesticides	kt	64.8
17.	Purchased concentrate feeds	Mt	9.0
18.	Water consumption for irrigation	bn m ³	82.1
		bn t	82.1

Source: [9].

Please note One litre of milk weighs an average of 1.03 kg, hence production amounting to 12.6 billion litres is around 13 million tonnes.

The volume of transported goods and, in effect, stored goods, is very large in agriculture. In **Table 3**, for comparison, we present the scale of the largest non-agricultural production.

The scope of transport of agricultural products is similar in size or larger than for industrial products, but it is of a decidedly different nature. For example, cereals total about 57 million tonnes of grain and straw (slightly less than e.g. bituminous coal, and twice as much as copper ores and concentrates), but it is highly dispersed. Cereals are produced by all of the more than 1.4 million farms in Poland, while the mining and extraction sector had 4661 registered companies in 2014. Cereals, rapeseed, legumes flow through a (sometimes) long supply chain, which translates into numerous intermediate links in the chain and significant transportation, handling and storage needs, usually greater than in the case of industrial products. Moreover, a significant part of the transport takes place on fields or dirt roads, unpaved and rapidly deteriorating under unfavourable weather (especially rain). Many transport means exhibit limited efficiency, are not in good condition, old, already

depreciated, highly cost-intensive (frequent failures, high fuel consumption). On small farms, 30-, 40-year-old, or even self-built, tractors are sometimes still in use. Furthermore, warehouse facilities in agriculture, although quantitatively large, are in a significant part traditional, not mechanised, and frequently significantly worn down, in need of urgent repairs.

Table 3 Scale of production of selected non-agricultural products in 2015

No.	Product name or production means	Unit of measurement	Amount
1.	Bituminous coal	Mt	72.7
2.	Lignite	Mt	63.1
3.	Gravel, pebbles and similar raw materials for the purposes of construction, use as road and railway aggregate	Mt	37.7
4.	Calcium oxide and similar for construction purposes	Mt	36.5
5.	Copper ores and concentrates	Mt	35.0
6.	Silica and quartz sands	Mt	10.7
7.	Dolomites	Mt	3.2
8.	Chalk	Mt	3.0
9.	Gas	hm ³	5623.7
10.	Petroleum	kt	927.7

Source: [8]

5. DIRECTIONS OF CHANGES IN AGRICULTURAL LOGISTICS

Agricultural logistics is an area of fairly rapid changes in terms of both the means of production and links within supply chains. There are several reasons for this.

- 1) After many years of stagnation, the surface area structure of farms is beginning to change. As a result of the privatisation of state farms (PGR) large-scale private enterprises emerged (particularly in western and northern Poland), which employ modern management techniques and apply advanced technologies for large scale production. The number of such larger farms in central and eastern Poland is increasing as well. Such companies, with large uniform batches of goods, prefer to sell to a food processing company rather than use the services of intermediaries.
- 2) Recipients give farmers increasingly precise guidelines for raw material quality, so the importance of direct contacts is increasingly important. They also prefer dependable and proven suppliers, ones able to offer the greatest amount of standardised goods, both for trade (e.g. fruits, vegetables) and for processing (e.g. potatoes, animals for slaughter).
- 3) The production means industry, including transportation, storage devices and structures, gives customers more and more technologically advanced solutions, although these are usually more expensive and require better management to be fully utilised. On the one hand, this leads users to increase the scale of their operations, while on the other it encourages better planning of relationships with suppliers and recipients of products.

The changing situation has some consequences for the relationships between links in the supply chain. This can be briefly presented on the example of selected agricultural products. In the case of cereals, oilseed rape and legume seeds, storage in own warehouses (barns) is still the dominant means of warehousing, but collection of products directly from the field is increasingly widespread, with transport straight from the combine to external warehouses (trade intermediaries or processing companies), and agricultural enterprises are more often using bins or similar, usually to store feed grain.

Roughage had been stored in barns or in open areas (as heaps, stacks) in the past, but now it is more frequently left on the field or placed in the yard (haylage, hay, straw, all under foil), without building costly barns (many of which are being used as sheds for machines) or silos for silage.

Supply chains in the dairy sector, which is experiencing rapid concentration, have become simplified in recent years. While milk was produced on a small scale by almost all farms (estimated to number nearly 2 million) before the economic transformation, in 2014 about 10.5 million tonnes of milk were supplied in bulk quantities by about 130 thousand farms [5] [9], [10]. Small-scale operations have virtually withdrawn (having been eliminated due to the small scale of production and high purchase costs) from milk production, while large farms are rapidly increasing the number and productivity of cows, milk production, as well as upgrading farm buildings, in particular purchasing fast milk cooling tanks (after milking), which is a condition for its receipt by dairy processing plants. Small (rural) milk collection points have practically disappeared. For decades after the war they received milk from individual farmers (even just a couple litres per day), while in the current system milk is taken directly from the farmers to dairy processing plants, without intermediaries. This serves to improve its quality and lower purchase costs.

In the production of beef, pork, mutton or poultry mainly warehouses for storage of fodder are needed, with small premises being sufficient for storing medications or tools. Live animals, in contrast to milk, do not require regular and frequent transport, so they stay in production buildings, not warehouses, until their sale.

6. CONCLUSIONS

- 1) A clear tendency to shorten supply chains can be observed in agriculture and its economic environment. This stems from concentration processes in the agricultural sector and the emergence of companies with large-scale production, on the one hand, and the fact that recipients prefer contacts with manufacturers offering a standardised product in large quantities, which makes it possible to skip intermediate links, on the other. This makes it possible to reduce the cost of purchasing and standardising products, while maintaining quality requirements. This process eliminates small producers, who, by abandoning farming, permit strong companies to further consolidate. A particular form, which would allow them to survive on the market and develop, is the creation of producer groups. This kind of cooperation has so far been employed mainly by fruit growers, although it could also be useful to other farmers with a smaller scale of production.
- 2) The growing scale of production and stronger relationships between companies that form subsequent links in the food supply chain encourage a particular type of outsourcing, which involves moving the transportation and storage operations from agricultural enterprises to external service or trade companies and end users. A farmer released from storage operations and some transport tasks not only foregoes a part of the associated costs, but can also concentrate on agricultural production and expand its scale.
- 3) In agricultural enterprises themselves, within the scope of technological processes associated with transport, combining transport and consumption of several means of production is becoming more frequent. An example of such activities is moving materials from farm buildings to the field, such as products for sowing (seeds), fertilising (mineral-based soil fertilisers) and plant protection products (pesticides, to protect seeds in the soil, for example).
- 4) In recent years there has been a breakthrough in the storage of some forms of roughage. Thanks to the introduction of balers and bale foiling machines it has become possible to forego the construction of drive-through silos for haylage production (although they are still needed in silage production). It can be therefore concluded that a switch is taking place - where possible - from expensive closed warehouses to open storage, with new security techniques, such as covering in foil.

- 5) Agriculture is a sector, in which logistics processes have been carried out from its inception. In the 20th century, both quantitative and qualitative changes have been occurring, which could be defined as the initial phase of industrialisation. Today, we are witnessing advanced changes associated with the replacement of transport, warehousing and communication means to more modern and efficient versions, as well as changes in the division of tasks between agricultural enterprises and their economic environment towards outsourcing to external transport and storage operations, with the functions being taken over by service entities or final customers. This market is not yet overly developed, but it seems quite promising for logistics companies.

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