

## **THE ROLE OF LOGISTICS IN SUSTAINABLE DEVELOPMENT OF AGRICULTURAL ENTERPRISES**

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**Abstract.** The analysis of logistics costs in agricultural enterprises in process aspect was carried out in the paper. The aim of the research was to identify those process activities, in which the optimization of logistics costs can influence the realization of strategic aims of sustainable development. As a result of the research, some indexes of logistics costs for agricultural enterprises were estimated. Also, the differences among the costs, depending on the area shape and used technologies, were shown in the paper.

**Key words:** logistics, agricultural enterprises, logistics costs, sustainable development

### **INTRODUCTION**

The concept of sustainable agriculture may not be limited to the search for balance only in the natural environment, but it needs to be understood in a wider context and referred to the broad sense of social welfare [Michna 2000, Woś and Zegar 2002]. Thus in the implementation of this idea it would be advisable to search for such farming methods, which would ensure the realization of production, economic, ecological and social goals [Runowski 2004].

It seems that one of the methods to create internal harmony in an agricultural enterprise is to introduce into management the concept of logistics, which generally concentrates on the optimization of material and information flow within the enterprise as well as over the entire supply chain [Christopher 2000, Blaik 2001]. Thanks to logistics, processes of planning, control, realization and monitoring of the time and spatial transformation of products are performed, and through the harmonization of these actions the stream of physical and information flows is initiated. Thus it means that logistics –

coordinating and integrating stages and processes occurring both in an individual enterprise and in the entire supply chain to guarantee that the end-buyer receives an appropriate product in the right time and place – by nature should be treated as a tool with a potential to balance development [Skowrońska 2006]. In the optimization of this process the problem of logistics costs is crucial, especially its comprehensive presentation. However, attempts undertaken in Poland to identify and assess the level and structure of these costs are not systematic and comprehensive studies [Blaik 2001]. The main cause of this situation is the application of traditional accounting methods in enterprises, which do not supply information required in modern logistics in its process and market aspects, e.g. many logistics costs connected with the analysis of profitability of a given product or customer remain hidden in other costs, such as production or marketing.

In view of the above the aim of the study was to determine logistics costs in agricultural enterprises in the process aspect so that on this basis it is possible to identify these process actions, the optimization of which in the logistics aspect may affect the realization of strategic goals of sustainable development.

## MATERIAL AND METHODS

Pilot studies were conducted in the production year of 2004/2005 in seven large agricultural enterprises in the Wielkopolska region. They were multi-unit enterprises – having in their organization structure between two and five units with different expanse shapes. The area of analyzed enterprises ranged from 612 ha UR to 3628 ha UR. These enterprises run typical agricultural production of similar structure.

In the literature on the subject, in view of the complexity of the presented problems, several definitions of logistics costs are presented. Taking into consideration the comprehensive approach to the above mentioned costs and the specific character of the analysed enterprises, in this study the applied definition was the one proposed by Skowronek and Sarjusz-Wolski [2003], who defined logistics costs as the consumption of labour, means and objects of production expressed in terms of money; financial outlays and other negative effects of extraordinary events caused by the flow of goods (raw materials, materials, products, goods) in the enterprises and between enterprises, as well as the maintenance of stocks. Taking into consideration this fact, for the realization of the aim of the study special charts were developed in order to record all actions (events) connected with the production of each product at all stages of the process, i.e. procurement, production and distribution. Figure 1 presents the identification of logistics processes in a graph form. Due to the complexity of these processes in an agricultural enterprise, in the presented figure a certain simplification was used, as logistics processes were presented for an enterprise with one business centre. For multi-facility enterprise additionally passages between objects would have to be included, as it was the case in this study.

Each action was ascribed a specific process index. Thanks to this in further calculations it was possible to aggregate properly logistics activities according to the adopted range of logistics costs. This made it possible to define indexes of logistics costs (in PLN/ha) for each final product, as well as to determine the level of one of the basic indexes of logistics costs for an enterprise, i.e. the share of these costs in total production

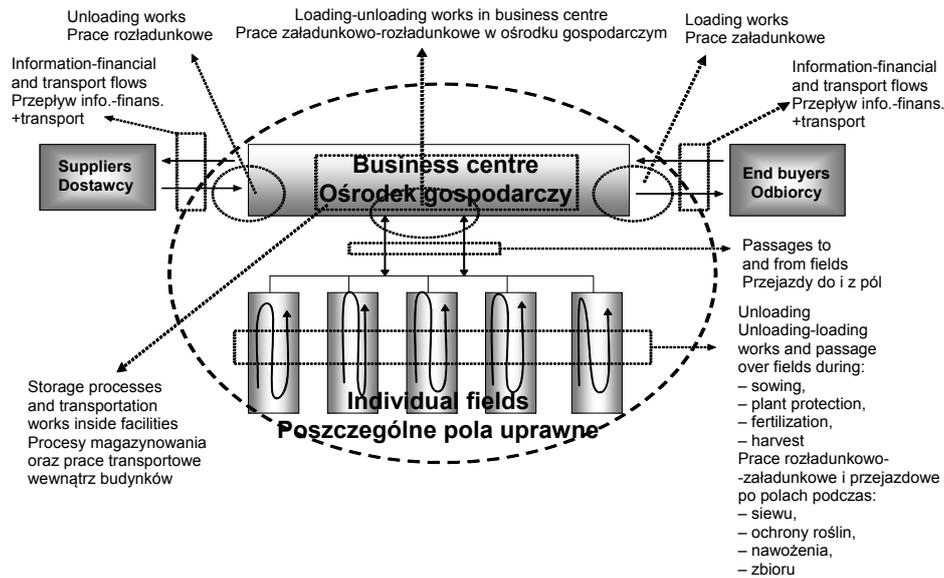


Fig. 1. Logistics processes in an agricultural enterprise

Source: author's study.

Rys. 1. Procesy logistyczne występujące w przedsiębiorstwie rolniczym

Źródło: opracowanie własne.

costs [Twaróg 2003]. Taking into consideration the specific character of large-area agricultural enterprises, logistics costs were calculated as follows:

$$K_l = K_{fpm} + K_z + K_{pi}$$

where:

$$K_{fpm} = K_a + K_{dz} + K_{pr} + K_{mpe} + K_{zut} + K_{infpm}$$

$$K_z = K_{ad} + K_{pr} + K_u + K_k + K_{inz}$$

$$K_{pi} = K_{pr} + K_{me} + K_a + K_{ut}$$

Individual groups of logistics costs ( $K_l$ ) include:

a) costs of physical material flows ( $K_{fpm}$ ):

- costs of depreciation of fixed assets engaged in logistics processes ( $K_a$ ),
- costs of rent (rent for store place, garages, umbrella roofs, service roads) ( $K_{dz}$ ),
- costs of labour of staff engaged in processes of physical material flow ( $K_{pr}$ ),
- costs of material, fuel and energy consumption ( $K_{mpe}$ ),
- costs of external transportation services ( $K_{zut}$ ),
- other costs (taxes and insurance of transport equipment, repairs and maintenance of equipment) ( $K_{infpm}$ );

b) costs of stocks ( $K_z$ ):

- costs of depreciation or rent of storage facilities ( $K_{ad}$ ),
- costs of labour of store-keepers ( $K_{pr}$ ),
- costs of losses ( $K_u$ ), (stock obsolescence, losses during evaporation, pests, diseases),

- costs of capital frozen in stocks,
- other costs (costs of storage insurance, costs of energy) ( $K_{inz}$ ).
- c) costs of information processes ( $K_{pi}$ ):
  - costs of labour of staff engaged in information flow ( $K_{pr}$ ),
  - costs of material and energy consumption ( $K_{me}$ ),
  - costs of depreciation of information equipment ( $K_a$ ),
  - cost of telecommunications services ( $K_{ut}$ ).

## RESULTS

The conducted analysis made it possible to determine indexes of logistics costs (in PLN per 1 ha UR) for individual complexes of logistics activities in large-area agricultural enterprises. It results from the performed calculations that the total level of the index of logistics costs for this type of enterprise ranges 1126.3-1637.4 PLN/ha UR, including 71-86% for the costs of physical material flow – which gives the index value ranging 900.8-1391.5 PLN/ha UR. When analyzing this complex of logistics activities in detail it was found that the highest costs were connected with the consumption of fuel, materials and energy – 43%, and labour costs – almost 25%.

In turn, the index of costs of stocks ranged 191.2-278.4 PLN/ha UR. In this group of costs the highest share of approx. 38% was found for the costs of rent connected with storage facilities. Investigations showed that the information flow in the analysed enterprises generated only 1.1-1.4% total logistics costs, which gave the index of 13.8-21.9 PLN/ha UR. The dominant cost in this group was labour cost of 8.7-13.8 PLN/ha UR.

The level of logistics costs is determined by the relation to other economic values, characterizing the activity of the enterprise, e.g. in relation to the total costs of its operation or in relation to the value of sales of its products and services. Studies conducted in selected large-area agricultural enterprises showed their high share in the total production costs (38-47%) in comparison to enterprises in sectors other than agriculture, for which this index ranges 20-30%. A similar analogy was observed in the level of the index expressing the share of logistics costs in relation to the value of sales of products and services. In the analysed enterprises the mean level of this index ranged 23.5-31.2%, whereas in some types of enterprises, as it was shown by studies conducted in developed countries, this index amounted to as little as 5.8-12.1% [Blaik 2001, Christopher 2000, Skowronek and Sarjusz-Wolski 2003].

Further analysis made it possible to identify these logistics processes, which have an effect on the sustainable development of agricultural enterprises and which optimization may contribute to the realization of strategic goals of this development. Three groups of logistics processes were identified (Table 1):

- A) passages between business centre and field,
- B) passages over fields,
- C) loading-unloading works.

Table 1. Variation in selected logistics costs depending on the level of factors affecting sustainable development of agricultural enterprises

Tabela 1. Zróżnicowanie wybranych kosztów logistyki w zależności od poziomu czynnika wpływającego na zrównoważony rozwój przedsiębiorstw rolniczych

Logistics process Proces logistyczny	Name and level of factor Nazwa i poziom czynnika	
A Passages between business centre and field (in PLN/ ha cultivated area) Przejazdy w relacji ośrodek gospodarczy – pole (w zł/ ha uprawy)	expanse shape rozłóg	
	advantageous korzystny  87.2	disadvantageous niekorzystny  401.1
B Passages over fields (during sowing, spraying, fertilization and harvest) (in PLN/ ha cultivated area) Przejazdy po polach (podczas siewu, oprysków, nawożenia i zbioru) (w zł/ ha uprawy)	technological simplifications uproszczenia technologiczne	
	no simplifications bez uproszczeń  672.4	with simplifications z uproszczeniami  511.1
	set efficiency wydajność agregatów	
C Loading-unloading works (plant production + animal production) manhour/ha arable land PLN/ha arable land Prace załadunkowo-rozładunkowe (produkcja roślinna + produkcja zwierzęca) rbh/ha UR zł/ha UR	low niska  785.5	high wysoka  675
	mechanization level poziom zmechanizowania	
	low niski  11.2	high wysoki  5.8
	201.6	197.2

Source: author's calculations.  
Źródło: obliczenia własne.

As a result of the conducted investigations it was found that the index of costs of passage between the business centre and fields and back in enterprises with an disadvantageous expanse was on average 4.6 times higher (ranging 3.1-6.9) in relation to enterprises with an advantageous expanse. Apart from expanse shape, the number of technological operations performed in individual crops and the distribution of these crops in relation to the business centre, resulting from crop rotation, had an effect on the level of this index. The number of technological operations depends on the type of crop and the applied technology, within which in some analyzed enterprises numerous technological simplifications were applied, such as no-tillage or combining plant protection and fertilization operations.

The application of the above mentioned technological simplifications had a significant role also in case of the number of passages over fields, which is a function of efficiency of applied sets. As it was shown, optimization in this respect undoubtedly contributes to a reduction of the number of passages over fields (the difference in costs between identical crops ranged 24-46%), which considerably reduces the negative effects of soil compaction by wheels of machinery sets. As it results from earlier studies, soil compaction by wheels of sets of machines leads to changes in physical and biochemical properties of soils, reduced yields and increased energy input into the cultivation of compacted soils [Wielicki and Wajszczyk 2000]. Results of topsoil compaction are short-term, whereas effects of subsoil compaction are long-term in character. Alakukku and Elanen [1994] found the effect of subsoil compaction on plant yields in the

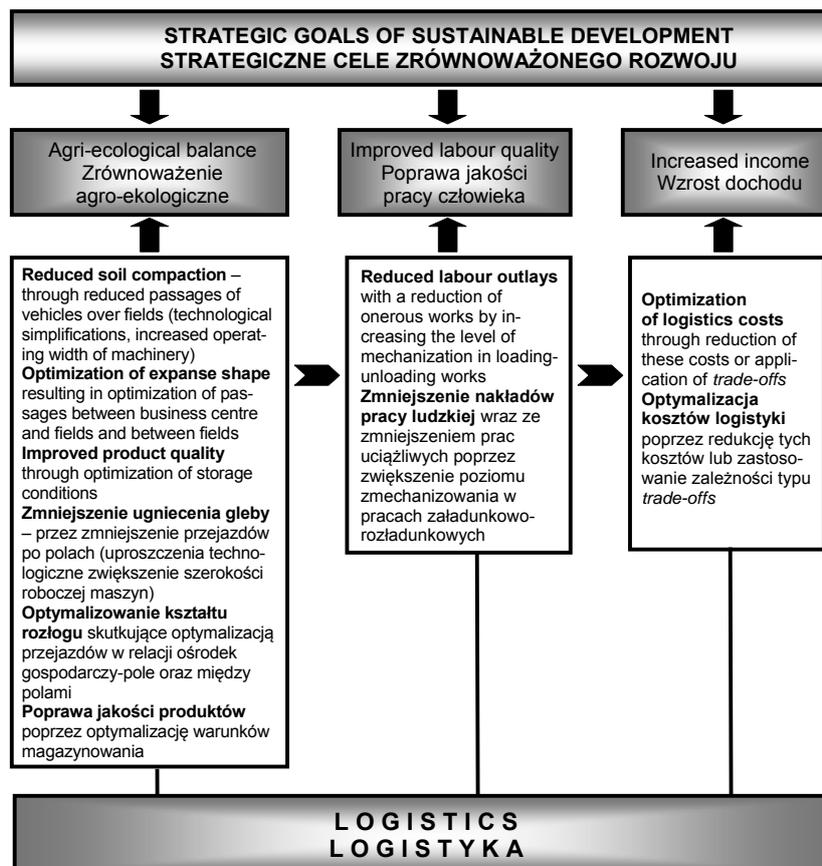


Fig. 2. The role of logistics in the realization of strategic goals of sustainable development of agricultural enterprises

Source: the author's study.

Rys. 2. Rola logistyki w realizacji strategicznych celów zrównoważonego rozwoju przedsiębiorstw rolniczych  
Źródło: opracowanie własne.

sixth, while Etana and Hakansson [1994] – in the eleventh year of study. Hakansson [1994] concluded on the basis of investigations on the range and effect of subsoil compaction that it may be irreversible and lead to permanent yield reduction. Elimination of subsoil compaction by subsoiling is ineffective and connected with high energy consumption, thus Hakansson and other authors indicated the reduction of passage of machinery sets and not the elimination of subsoil compaction as the correct strategy aiming at the preservation of soil tilth.

Taking into account the realization of the second strategic goal of sustainable development of agricultural enterprises, i.e. improvement of labour quality, the key issue is the mechanization of loading-unloading works, including those especially onerous in animal production, such as e.g. racking up feeds and manure removal. These works belong to a group of works with the highest labour consumption in the logistics of agricultural enterprises – absorbing 70-75% total outlays connected with transport [Wajszczuk 1998], which was generally confirmed in this study, especially in enterprises with low levels of mechanization of these works. On the other hand, in enterprises with high levels of mechanization of loading-unloading works, labour outlays were reduced by approx. 50%, at the maintenance of a similar level of costs connected with work of machinery used in these processes. It resulted from the application of modern and at the same time costly technological solutions. Thus, on the one hand labour costs were reduced and on the other hand costs of work of machinery increased. Such an optimization of the logistics process and thus logistics costs is defined in literature on the subject as *trade-off* [Milewska 2005].

Summing up, on the basis of the conducted analysis the role of logistics in the realization of strategic goals of sustainable development in case of agricultural enterprises may be illustrated by the proposed diagram, given below (Fig. 2).

## CONCLUSIONS

1. On the basis of the conducted analysis three types of logistics processes were identified, affecting sustainable development of agricultural enterprises, i.e. passages between the business centre and fields, passages over fields and loading-unloading works. Optimization of the above mentioned logistics processes may promote the realization of strategic goals of sustainable development of agricultural enterprises.

2. The introduction of mechanization in such logistics processes as loading-unloading works leads to reduced labour outlays (by approx. 50%) and its improved quality.

3. Studies on the optimization of logistics costs in agricultural enterprises, in view of the index of the share of these costs in total costs (38-47%), seem advisable and may lead to increased income in these enterprises.

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## ROLA LOGISTYKI W ZRÓWNOWAŻONYM ROZWOJU PRZEDSIĘBIORSTW ROLNICZYCH

**Streszczenie.** W pracy dokonano analizy kosztów logistyki w przedsiębiorstwach rolniczych w ujęciu procesualnym. Celem badań było zidentyfikowanie tych działań procesowych, w których optymalizowanie kosztów logistyki może wpłynąć na realizację strategicznych celów zrównoważonego rozwoju. W wyniku przeprowadzonych badań ustalono wiele wskaźników kosztów logistyki dla przedsiębiorstw rolniczych, a także wykazano różnicowanie w tychże kosztach w zależności od rozłogu i stosowanych technologii.

**Słowa kluczowe:** logistyka, przedsiębiorstwa rolnicze, koszty logistyki, zrównoważony rozwój

*Accepted for print – Zaakceptowano do druku: 9.01.2008*

*For citation – Do cytowania: Wajszczuk K., 2008. The role of logistics in sustainable development of agricultural enterprises. J. Agribus. Rural Dev. 1(7), 141-148.*