Logistics in agricultural production

Logistika v zemědělské výrobě

D. Vaněček, D. Kaláb

University of South Bohemia, České Budějovice, Czech Republic

Abstract: In spite that the great importance of logistics in industry, business and other branches is generally acknowledged, this problem is not systematically investigated in agriculture. As a presumption of a detailed analysis, the knowledge of the volume and structure of the material flow is necessary. The authors have proposed their own methodological procedure which issues from technological indicators, published by the Ministry of Agriculture CR for individual plants and categories of animals and which makes possible a further classification of these data for enterprises with different level of farming. These published standards of the Ministry serve as basic stones and by means of their combination, the volume of material flow and its structure during one year periods is possible to calculate. The advantage of the proposed method is a fast finding out of necessary data and possibility of taking into account some specific conditions of the investigated enterprises.

Keywords: material flow, material handling, logistics in agriculture

Abstrakt: Přestože význam logistiky v průmyslu, obchodu a dalších oborech je všeobecně uznáván, v zemědělství není tato problematika systematicky zkoumána. Předpokladem podrobných analýz je znalost objemu a struktury materiálového toku. Autoři proto navrhli vlastní metodiku, která vychází z technologických ukazatelů, publikovaných Ministerstvem zemědělství ČR pro jednotlivé plodiny a kategorie zvířat a která tato data ještě dále diferencuje pro podniky s různou intenzitou hospodaření. Tyto publikované normativní hodnoty Ministerstva slouží jako základní kameny, jejichž kombinací lze zjistit objem materiálového toku a jeho strukturu v podniku během jednoho roku. Výhodou metodiky je rychlé zjištění potřebných dat a možnost zohlednění některých specifických podmínek ve zkoumaných podnicích.

Klíčová slova: materiálový tok, manipulace s materiálem, logistika v zemědělství

INTRODUCTION

At present time, the importance of logistics is increasing in many economic branches, especially in industry and business. Logistics is considered to be a science, dealing with the integrated management of all the material and the corresponding information flow from suppliers through transformation of input materials up to the end consumer. Though there is no unified definition of logistics, most of the authors agree with this explanation. The importance and the volume of material and information flow increases especially in the contemporary global environment, when subjects from different countries and continents integrate into production and business. To manage the material and information flow successfully, it is necessary to have a good overview concerning its volume and structure. With these problems, applied on agricultural enterprises, did the authors deal in this article.

LITERARY SURVEY

On the growing importance of logistics and especially on its integrated function in the enterprise, there refer all authors, whose publications were devoted to this theme. In the last years, it is for example Pernica (1998), Pernica, Mosolf (2000), Gros (1996), Kortschak (1994) and others. Publications are dealing with logistics in industry or business, exceptionally in services, but neither is concerned, even if only partially, with logistics in agriculture. We focused our attention on these problems during the last time and some results were published in the "Collected papers of the VŠB TU Ostrava" (Vaněček, Kaláb, 2001). As a basis of the necessary data collection for our method proceeding, the publication of the Ministry of Agriculture CR (Kavka et al., 2000) has served.

MATERIAL AND METHODS

According to the volume and structure of material flow, the structure of organisation in the enterprise should be created, for example by means of units for material supply, material storing, control and production units, units for storing of finished products and their distribution to the consumers, units for receiving orders and their administrative settling etc.

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Calculation of the material flow in agricultural enterprises can be made in different ways, the main of which are the following:
– on the basis of the accounting data,
– by means of a qualified estimation of the enterprise management,
– on the basis of standards.

Each of these methods has its own advantages and disadvantages with regard to the exactness or rapidity of calculation. In the past, the method of qualified estimation was used more in agriculture and the authors included into the material flow non-agricultural activities too, mostly construction activity in the enterprise or transport for other firms. So they received calculations, that the volume of material handling related to 1 hectare of agricultural land was 80 tons, but from this, the share of agricultural materials was only 30 t/ha. This oversized volume has been caused by the large acreage of agricultural farms (mostly of state farms) and by the reality, that most of materials were handled two times or more, first to the temporary store and secondly to the definite place of consumption.

Calculation of the material flow volume on the basis of accounting evidence is based on exact data concerning purchase of individual inputs; certain problems appear in calculation of the intermediate product (fodder for cattle or farm manure for application on the fields) or in determining the time of their application.

Calculating the material flow volume on the basis of standards has its advantages and disadvantages too. As regards advantages, there are first of all:
– fast way of calculation,
– unified methodology which can be applied in all investigated enterprises.

The authors have proposed a simple way of calculation of the volume and structure of material flow, which links up on the recently published technological standards (Kavka et al. 2000). These standards make the cost calculation possible with regard to different plants and categories of farm animals and according to three levels of farming intensity (technology with low, standard and high inputs) and because standards are broken into individual operations, it is possible to change inputs and outputs according to the real situation in the investigated farm. With a simple arrangement of standard tables, it is possible to calculate the volume of inputs and outputs per 1 ha of the farm plant or per one farm animal during the year. And that is the method we have used.

RESULTS

The example of deriving the volume and structure of the material flows from the standards of Kavka (2000) is in Table 1.

Share: Σ outputs : Σ inputs according to three alternatives:

intensive inputs 11 000 : 14 547 = 0.76
medium inputs 9 500 : 14 121 = 0.67
low inputs 7 500 : 13 692 = 0.55

Inputs exceed outputs, but only due to the share of organic fertilizers, otherwise outputs prevail. This situation appears in agriculture as a consequence of the bi-

Table 1. Inputs and outputs for malt barley (kg)

	Intensive inputs				Medium inputs		Low inputs	
	frequency	basic material per hectare	supply	carry away	supply	carry away	supply	carry away
Share of lime application	0.25	2 000	500		500		500	
Organic fertilizers	0.3	40 000	12 000		12 000		12 000	
PK fertilizers	1.0	525	525		420		315	
Mg fertilizers	0.2	210	42		51		27	
N fertilizers	1.0	100	100		100		100	
Seed for sowing	1.0	180	180		180		180	
Chemical protection – dicotyledont weeds	1.0	300	300		300		300	
Chemical protection – monocotyledont weeds	0.5	300	150		60			
Fungi diseases	1.5	300	450		300		150	
Protection – pests	1.0	300	300		210		120	
Harvested corn	1.0	5 500		5 500		5 000		4 000
Harvested straw		5 500		5 500		4 500		3 500
Total			14 547	11 000	14 121	9 500	13 692	7 500

Note: "Frequency" means, whether the operation was realized on 1 ha or only on its part
Data for technologies with medium and low inputs are simplified here and they include only results, which were achieved as a product of the frequency of the given operation on one hectare and the volume of basic material in kg
Supply concerning plant production concerns water for spraying

ological process, when photosynthesis makes the harvest greater than are the inputs into the production. The share of inputs and outputs can be considered from other aspects, too. One of them is "water" as an input, which from the view of handling represents no problem, water for plant protection can be taken from the pond, water for animal production in stalls is available from the pipeline (if we do not calculate with its price). After deduction of water, the share of outputs and inputs changes as follows:

intensive inputs	11 000 : 13 347 = 0.82
medium inputs	9 500 : 13 251 = 0.72
low inputs	7 500 : 13 122 = 0.57

There is only a small change. A much greater change can appear in animal production, where water consumption per one animal and year is substantially higher.

The next possibility is to take into account only the market product and not secondary products (straw in cereal production, born calf at milking cows etc.). Such an approach is possible in industry, where waste is calculated, but in agriculture with the closed circulation of nutrition this could be possible perhaps in highly specialized enterprises only.

Share: Σ outputs : Σ inputs without water and secondary product – straw

intensive inputs	5 500 : 7 847 = 0.70
medium inputs	5 000 : 8 751 = 0.57
low inputs	4 000 : 9 622 = 0.42

It is evident that the differences between individual alternatives are not too remarkable and so next we will consider only the first alternative with all kinds of materials, including water, straw etc.

If the rate of outputs to inputs is in plant production usually 1.0 or lower, in animal production the situation is mostly the opposite. Fattening of young animals lasts weeks, months, so inputs considerably exceed outputs, which equal the slaughter weight. The same situation is in milk production, when the cow consumes a great quantity of fodder per day but produces 10–20 liter milk a day only. But if we take into account the production of farm manure, the difference between outputs and inputs decreases.

We can conclude that the volume of material flow in agricultural enterprise is influenced first of all by the production intensity and that this volume can be calculated on the basis of standards, given for individual plants and categories of animals.

Table 2. Plant production (data per 1 hectare)

	Wheat		Rape		Peas		Potatoes	
	input	output	input	output	input	output	input	output
Lime (share)	500		500		500		500	
Industrial fertilizers	595				550		600	
Organic fertilizers	8 000		500		10 000		16 000	
Water– plant protection	2 650		12 000		1 705		2 170	
Seed for sowing	210		4 074		280		3 000	
Harvested output		7 000	4	4 000		4 100		21 000
Straw		7 800						
Total	11 955	14 800	17 078	4 000	13 035	4 100	22 270	21 000

Table 3. Animal production (data per 100 animals per year)

	Category of farm animals							
	milking cows		cattle-mast		sows		hens	
	input	output	input	output	input	output	input	output
Supply	42 250		13 700		14 660		170	
Litter	300 000		300 000					
Concentrated fodder	169 600		128 000		95 000		12	
Farm fodder	1 350 000		750 000					
Water	2 555 000		1 400 000		547 500		25	
Milk		750 000						
Calves production		5 400						
Piglets production						3 960		
Farm manure		1 200 000		450 000		750 000		5
Meat – eggs production				50 200				6
Culling and loss-rate		21450		1 140		8 200		170
Total	4 416 850	1 976 850	2591700	501 340	657 160	762 160	207	181

In Tables 2–3, there are standard inputs and outputs for some other plants and categories of animals as examples.

Application of proposed standards (example)

For presentation of the methodological procedure, agricultural enterprise CIZ-Agro near the town Dačice has been chosen. The enterprise exploits 2 555 ha of agricultural land, in production structure, there are mainly cereals, raps, sows and pigs for fattening.

Such a rough calculation needs some corrections, because some operations with material handling can be carried out by an external organization, for example in plant protection. The production and consumption of farm fodder must be balanced (it is not realistic to produce much more than what is the consumption or to have much more cattle without own production of silage, hay or fresh fodder) – Table 4.

When we applied this correction on the enterprise CIZ-Agro, the total material flow decreased to 48.5 t/ha. We can eliminate water consumption from this volume, which does not demand any difficult handling (12.55 t/ha) and for logistics purposes, there remains the material volume of 35.95 t/ha. The sequence of the most important materials is seen in Table 5.

From the view of management, it is important to decrease the necessary number of handling activities. As one handling activity, we consider one loading and one unloading of the same material.

In this agricultural enterprise, handling of farm manure has been carried out 2x (from the stable to the dung heap and later from the dung heap to the field). Corn has been manipulated 3x (from the field to the drier, from the drier to the store, from the store gradually to the mill). Straw has been manipulated twice (from fields to stacks, from the stack to stables etc). So more important than the volume of material flow (t), the volume of material handling (t) is necessary to ascertain, which will be usually higher.

The higher number of handling operations should not be a disadvantage (for example at corn it is realized 3 times). It depends on the fact, whether it is carried out manually or mechanically. It is necessary to pay attention to the volume of manual material handling and to try to decrease it by the means of better machines or better procedures (Figure 1).

CONCLUSIONS

The recommended procedure for material flow investigation from the view of logistics:

1. To establish the real (or planned) structure of production with regard to the acreage of individual farm plants and categories of farm animals.
2. Multiplying the heads of animals in different categories and acreage of farm plants by the standard material flows we receive:
   a) The total volume of material flow in the enterprise per year in tons.

Table 4. Total volume of material flow during the year

Plant production		Animal production	
Material	t/year	Material	t/year
Lime	1 260	Handling of the supplied animals	306
Organic fertilizers	31 560	Concentrated fodder	3 659
Industrial fertilizers	1 619	Water	32 061
Seed for sowing	337	Handling of the output animals	940
Plant protection (water)	1 606	Culling and loss – rate	148
Corn of cereals	7 884	Sewage	13 401
Straw	5 566	Handling of animals replacing culling and loss – rate	52
Hay (meadows)	1 506	Handling of piglets	25
Maize (silage)	7 350	Farm manure production	6 336
Green, fresh fodder	9 453	Straw production	2 940
		Farm fodder (silage, hay, fresh)	12 499
		Milk	2 652
		Calves production	31
Total	68 141	Total	75 050

Table 5. Sequence of the most important materials in CIZ-Agro (t/ha)

Kind of material	Material flow (t)	Kind of material	Material flow (t)
Organic fertilizers (farm manure, sewage)	19 738	Concentrated fodder	3 659
Farm fodder (silage, haylage, hay, fresh)	12 499	Milk	2 652
Corn	7 884	Industrial fertilisers	1 619
Straw	5 566	Lime	1 361

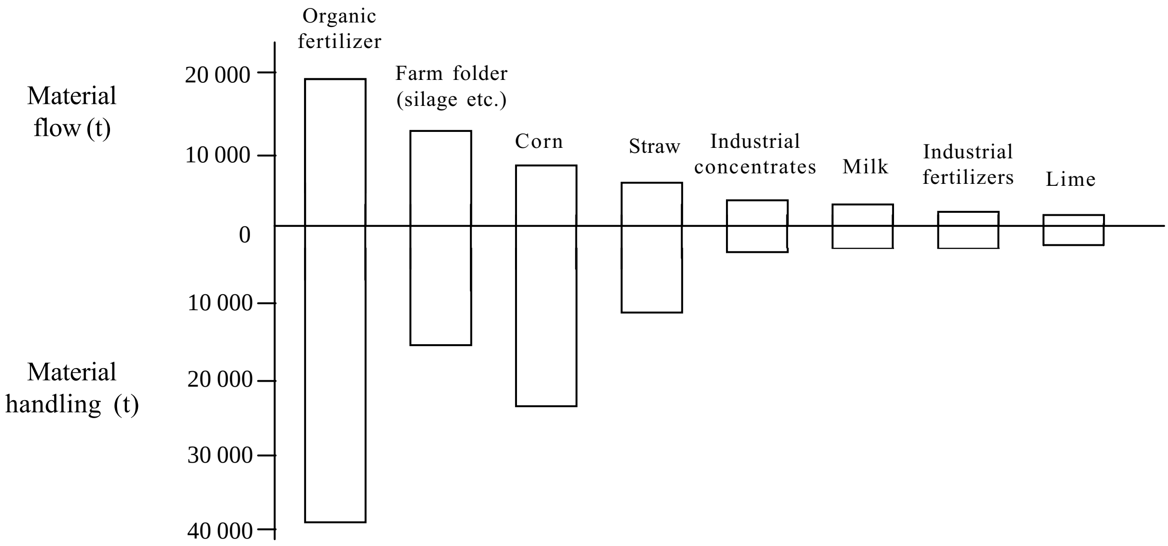

Figure 1. Material volume (t) in CIZ-Agro

b) The total volume of individual kinds of materials in the enterprise during the year in tons (corn, industrial fertilizers, milk, pork, calves, etc).
c) It is necessary to consult the received data with the management and to make some corrections according to the experience of the enterprise management.
d) Different kinds of materials will be arranged in a decreasing sequence to present the most important points which demand our attention (new machines, stores, transport means).

3. Calculation of the volume of material handling in the enterprise (which will be higher than the volume of material flow, because of two or three handling operations with some materials). We recommend to consider as one handling operation one loading and one unloading of the same material, with no regard to the way of realization. But this realization must be carried out by own farm workers only, not by the means of any service organization. The volume of handling operations can be influenced by the management much more than the volume of the material flow. First of all, it is necessary to find out materials which demand the largest volume of these jobs and to judge especially carefully the volume of manual handling operations. In this direction, the rationalization activities must be focused.
4. The volume of handling operations in non-agricultural production. Calculation of this volume will depend on the specific activities and planned production per year.
5. Calculation of necessary machines for transport and material handling. This calculation should link to the previous data and should show the critical points which will be necessary to improve by the means of changing the technology, new machines or outsourcing (using service organization).
6. Evaluation of the appropriateness of stores and temporary stores (capacity, layout, technology, mechanization and losses on the stored material).
7. Calculation of indicators. For deciding among some alternatives, it is advantageous to express the given results in simple indicators. As most important, we consider:
   a) the volume of material flow per 1 ha of agricultural land and the structure of the material flow in the main kinds of materials (%);
   b) the volume of material handling per 1 ha of agricultural land and the structure of the material handling (%), with special regard to manually handled materials.

Calculation of the volume of material handling in non-agricultural production into these indicators we do not see as convenient, this should be evaluated independently.

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Contact address:

Prof. Ing. Drahoš Vaněček, CSc., Ing. Dalibor Kaláb, Jihočeská univerzita v Českých Budějovicích, Studentská 13, 370 05 České Budějovice, Česká republika, tel: +420 38 777 2484 (2487), e-mail: dvanecek@zf.jcu.cz, kalab@zf.jcu.cz