MATERIAL FLOW AND STORING OF AGRICULTURAL PRODUCTS IN THE CZECH REPUBLIC

MATERIÁLOVÝ TOK A SKLADOVÁNÍ ZEMĚDĚLSKÝCH VÝROBKŮ V ČESKÉ REPUBLICE

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ABSTRACT

The authors of this paper dealt with the situation in agricultural enterprises in the Czech Republic, first of all from the view of main material flows and suitability and exploitation of storing areas. All investigated enterprises [86] were evaluated according to their acreage and divided into two groups: 1] less than 1500 and more than 1500 ha of agricultural land. As a supplement of this investigation data concerning the transport distances in km and data from the nation-wide census concerning the number and equipment of special storage houses in the Czech Republic are added.

Key words: transport distances / storing / agriculture / material flow / material volume / plant production / animal production

ABSTRAKT

Autoři tohoto článku se zabývali situací v zemědělských podnicích v České republice, především z hlediska hlavních materiálových toků a vhodnosti a využívání skladů. Všech 86 zkoumaných podniků bylo rozděleno podle výměry půdy do dvou skupin: 1) do 1 500 hektarů; 2) nad 1 500 hektarů zemědělské půdy. Jako dodatek k tomuto průzkumu byly získány údaje, týkající se dopravních vzdáleností v kilometrech. Nakonec jsou hodnoceny údaje z Českého statistického úřadu, týkající se počtu a vybavení specializovaných skladů.

Klíčová slova: dopravní vzdálenosti / skladování / zemědělství / materiálový tok / objem materiálu / rostlinná výroba / živočišná výroba

INTRODUCTION

Besides production, agricultural enterprises must focus on profitably selling their products. To obtain the best price, it is often necessary to store the products till the prices are most favorable for the seller.

Agricultural production in market oriented society differs substantially from former period of planned economy. Agricultural enterprises must try not only to plant, manufacture, but first of all they must succeed in selling their products. With selling the issue of storing agricultural products is related, because a part of harvested production must be stored before sold on the market. Also during the production time storing has a great importance. The intermediary product must be stored too, for example hay, silage, haylage etc. for stock feeding and stored must be also some inputs [fertilizers, seed] before their use.

Storing in agriculture has rather different requirements in comparison with another branches of national economy. In industry, trade etc. the aim is the lowest level of inventory, otherwise costs for storing will increase. The ideal way of managing inventory is by means of method Just-in-time, which practically take away inventory and storing. Similar effect has the method of Kanban etc.

In agriculture the production is based on year's cycle and storing must be taken into consideration. It is necessary to have sufficient inventory of fodder, seed, seedlings and another items till the next harvest or it is necessary to purchase these materials at the right time, for the lowest prices.

Figure1 depicts the basic model of inventories, whereas the dash line represents the average level of inventory. Figure 2 depicts the effect of smaller but more frequent lot sizes in industry which decreases the level of inventories [the dash line]. But this model can not be applied in agriculture.

Beside this, agriculture demands not only universal storeplaces, which prevail in industrial branches, with storing products or their parts in boxes or palettes. In agriculture the number of stored materials is substantially lower, but each of them demands usually different kind of storages with different ways of receiving and distribution materials [storages for hay, straw, silage, potatoes, farm manure, sewage, etc.]. It is necessary to deal with storing in agriculture because it influences both quality of products [intermediate products] and costs of the final products.

STORING IN AGRICULTURE

The necessity of storing agriculture products is influenced by these factors:

- Agriculture products have usually great volume and are produced in high quantities. Their storing demands construction of relatively cost demanding stores, which are built only when it is inevitably necessary (in animal production stores for hay, silage, farm manure, sewage etc.).
- There is a possibility to increase the value added of products, for example, to purify or dry cereals or to keep products in a good state for next time, for example, to store potatoes during winter and to deliver them to market in spring, because consumers don't have their own storage.
- For speculative reasons, when product is kept in storage up to the time when higher price is expected (this concerns mostly wheat).
- The necessity to store products, because market is temporary saturated and refuses to accept our products or offers only low prices for them.

Main products stored in agriculture

In agriculture enterprises in middle and higher elevations with prevailing universal plant and animal production, most of inputs and outputs can be divided into following groups:

a) Purchased input materials:

industrial fertilizers, concentrated fodder, seed, seedlings etc.

b) Intermediate products

Intermediate are produced in one branch of agriculture and consumed in other (plant - or animal production). Both can function as inputs and outputs.

- fresh and conserved fodder (silage, haylage, hay, etc.). Outputs of plant production, used as inputs in animal production,
- straw, output of plant production, used as input (litter) in animal production,
- farm manure, sewage from animal production, used as organic fertilizer in plant production.

c) Main market outputs:

Table 1. Number of production centers and average transport distances

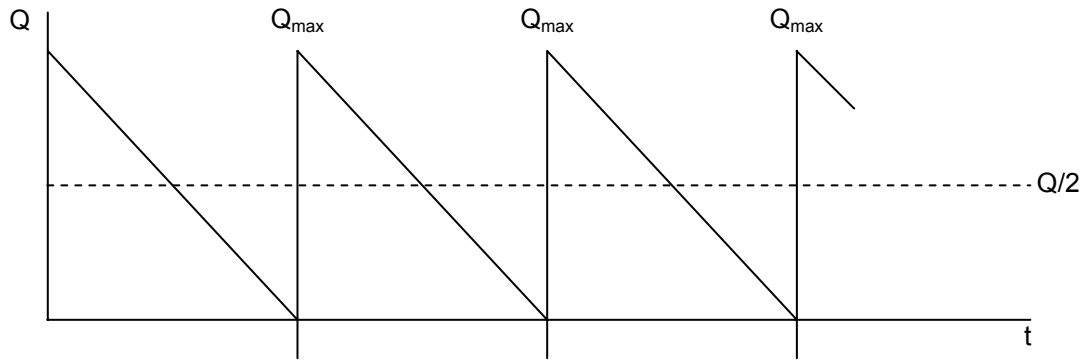
Indicator	Area up to 1500 ha		Area over 1500 ha	
	Number of firms	Results	Number of firms	Results
Maximum direct distance over the utilized land [km]	36	11,15 km	43	20,64 km
Number of production centers in one enterprise	38	2,53	46	5,96
Average transport distance within the enterprise	36	5,42 km	47	6,67 km
Average transport distance out off the enterprise	25	19,38 km	33	34,81 km

Source: authors

Table 2. Material flows according to their volume

Sequence	Number of enterprises	Average rating	Material
1	79	2,42	Silage, haylage – from fields to silage pits, towers
2	78	2,86	Farm manure from stables to fields
3	80	3,46	Grain from fields to own stores
4	76	4,08	Farm dung from sewage, dungwater tanks to fields
5	75	4,16	Straw from fields to stables or stores [barns]
6	34	5,11	Fresh fodder from fields to stores
7	74	5,50	Hay [from fields to stores]
8	48	6,73	Potatoes to stores in own enterprise
9	70	7,24	Animals [transfers in the enterprise]
10	55	7,64	Industrial fertilizers and lime from own stores to fields
11	61	7,98	Water for spraying herbicide and insecticide operations transported by own machines
12	31	9.16	Fill or soil removal, building materials within the enterprise
13	15	9,27	Industrial products [additional production]
14	30	9,63	Fuel

Source: authors



Q .....quantity
Q_{max} .....maximal inventory level after the new delivery
Q/2 .....average inventory level
t .....time

Fig. 1. Basic Inventory model

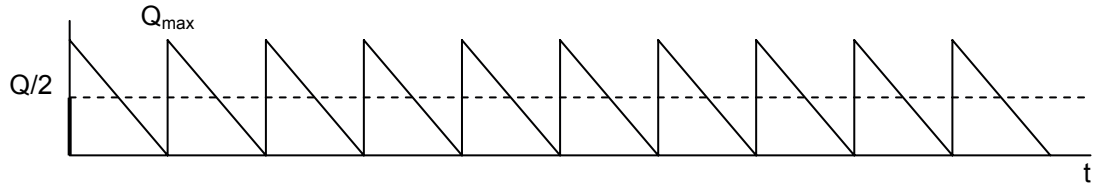


Fig. 2. Inventory model with short cycle time (decreasing level of inventories)

grain, potatoes, rape, flax, milk, eggs, domestic animals for meat etc.

Kinds of storages and their use in agriculture

Agriculture stores should served mostly for one product (material) only, or for products (materials) with similar physical and biological character, for example:

- grain (wheat, rye, barley, oats),
- hay, straw,
- silage, haylage,
- farm manure,
- sewage, etc.

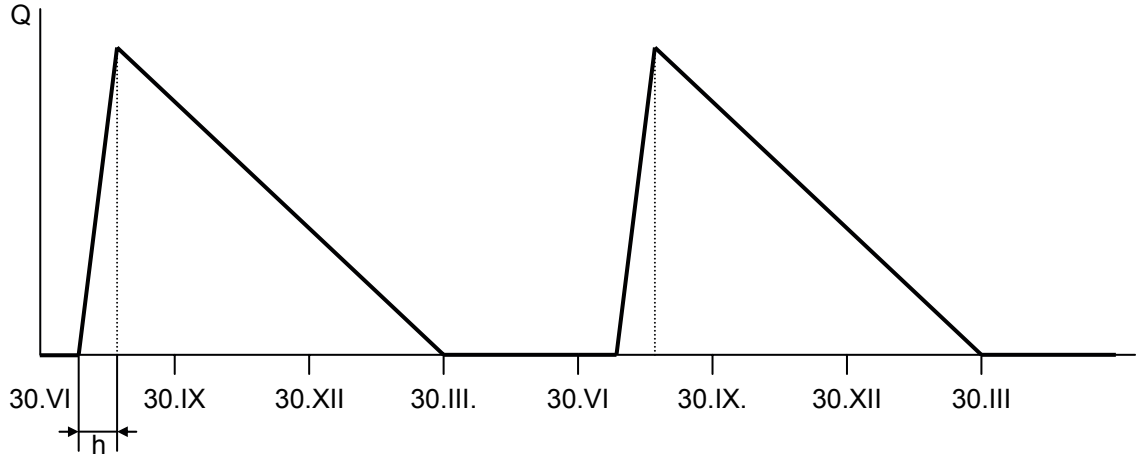
This makes possible to construct storages convenient for storing specific products [materials]. In most cases, there are stored bulk materials as grain, potatoes, conserved fodder, farm manure or liquid materials such as milk or sewage. So mechanization can be simple and with high performance.

Storages for grain, potatoes, straw

These storages receive material once per year and are loaded to their maximal capacity. Later, there is only a gradual emptying. Some time before new harvest, the stores are entirely empty, which influences their efficiency.

Stores for preserved fodder

Production of hay, silage, haylage, can be realized usually twice a year. Silage and haylage must be stored into already empty storage capacities in short time of some days and then hermetically sealed. During the new harvest, when storages are empty and cleaned up, new delivery of material follows. During the whole year or



h ..... time period of harvest

gradual harvest and sales (in tons)

(Source: authors)

Fig. 3

Table 4. Utilization of storage space during the year in % of enterprises

Nr.	Material	Time of storage in months			
		less than 1	1-3	3-6	more than 6
		%	%	%	%
1	Grain	2,5	2,5	20,3	74,7
2	Straw	0,0	1,6	4,8	93,7
3	Potatoes	10,5	10,5	28,9	50,0
4	Farm manure	4,1	17,8	26,0	52,1
5	Farm sewage	4,1	17,8	26,0	52,1
6	Industrial fertilizer	15,6	25,0	34,4	25,0
7	Seed, seedlings	7,6	31,8	27,3	33,3
8	Hay	0,0	0,0	8,1	91,9
9	Silage	1,4	0,0	4,1	94,5
10	Haylage	1,3	0,0	8,0	90,7
11	Workshop's storages	1,4	4,3	1,4	92,8
12	Storages of building materials	3,3	13,3	0,0	83,3

Source: authors

only in winter, these materials are used as fodder evenly. In spring fresh fodder can be used.

Stores for milk

(Cooling tanks with daily collection by milk processing plant).

In cooling tank milk from the morning and afternoon milking is gathered and than transported together.

Farm manure

Farm manure is stored close to stables on the concrete plattform, usually for half a year and then it is transported on fields and plought into soil.

The use of agricultural storages is considerably different from industrial or business storehouses and warehouses. Maximal capacity should correspond to the planned production without regard to indicators of average

Table 5. Storing capacities in the Czech agriculture

Specialization of stores for materials		30.6.2000		From total after 1990		
		Total number of storages	Capacity in tons	Total number of storages	Capacity in tons	Capacity of one store in tons
Grain		14 262	5 182 757	2 402	591 584	246
Haylage towers		899	429 818	43	10 559	246
Silage pits		7 793	12 579 875	595	613 057	1 030
Haybarns		25 236	3 224 012	1 453	158 740	109
Universal		10 507	1 410 804	815	100 666	124
Potatoes:	air conditioned	1 835	320 541	142	23 381	165
	for palettes	577	398 696	11	29 520	2 684
	mixed	1 325	91 550	105	5 158	49
Fruits:	ventilated	549	33 733	93	7 360	79
	cooled	125	37 272	55	9 525	173
	controlled atmosph.	35	23 182	26	12 920	497
Vegetable:	ventilated	285	58 340	77	14 825	193
	cooled	89	18 483	45	8 541	190
	controlled atmosph.	11	3 066	6	1 520	253

Source: Czech Ministry of Agriculture

inventory level or reorder level. But a great importance have the storage costs, which producers usually don‘t consider or ignore when storehouses are constructed.

But in spite of this, it is necessary to know the cost for next decisions, for example, when storing wheat or potatoes:

- how much will be the storing cost for wheat or potatoes, if goods are sold next spring instead of immediately after harvest? What price can give us better profit?

Calculation of the cost is necessary for evaluating different varieties of storing. Cheap storages usually decrease the quality of stored products. Higher cost of high quality storage should be considered for valuable products [vegetable, fruits].

MATERIAL AND METHOD

Necessary data concerning stores and stored materials were received from questionnaires of 86 agricultural enterprises. Most of them are situated in the South-Bohemia region [46,5%), Highland region and Central Bohemia region, some of them are from other regions of the Czech Republic. The legal status was 49,4 % agricultural or trade cooperatives, 22,4% Limited companies /Ltd), and 18,8 % are Incorporated companies (Inc.). companies.

Non incorporated farms [owned by physical persons] were represented by 9,4 % only. They utilize usually smaller acreages where application of logistics in operation is not so pronounced. Almost all enterprises are situated in the altitude from 400 – 600 meters above the sea level, which is the area of favorable conditions for agriculture.

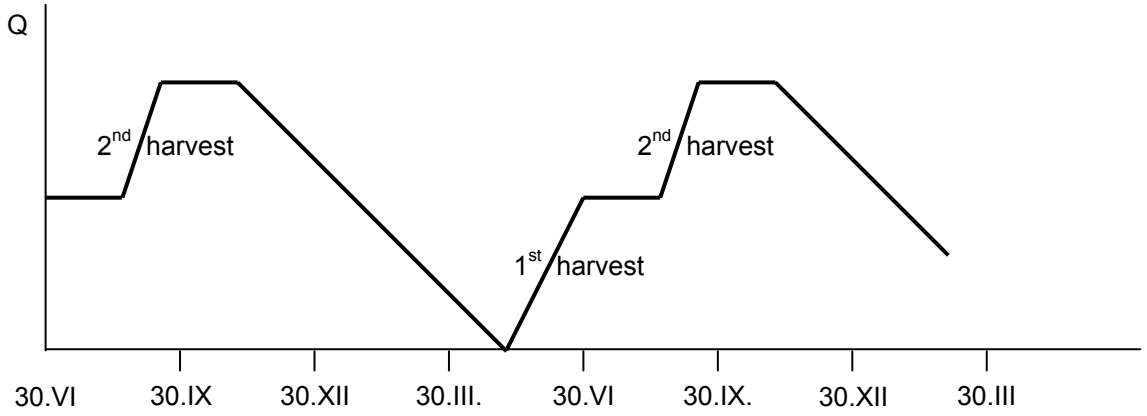
RESULTS

1. Average transport distances and number of production centers

Because agricultural production needs agricultural land and enterprises utilize often some thousands of hectars, transport distances play an important role both for organization and level of costs.

Within transport distances are influenced first of all by the extention of the enterprise land, by its shape and number of production centers. The utilized land is not possible to characterize only by its area, because between fields there are areas of woods, rivers, ponds, infrastructure. So we choose as indicator the longest direct distance over the utilized land in km. The longer is this distance, the higher is the transport cost. Decreasing transport distances are influenced by a number of production centers in the enterprise. These centers are mostly independent entities with allocated land, stables and big part of transport is realized within the frame of these centers.

Table 1 shows the longest direct distance in enterprises with the area up to 1500 and over 1500 ha agricultural land. This distance in enterprises over 1500 ha is almost double, but because bigger enterprises have almost two times more production centers, so average distance in internal transport increased only by 1 km. In external transport this difference is more pronounced.



(Source: authors)

Fig. 4

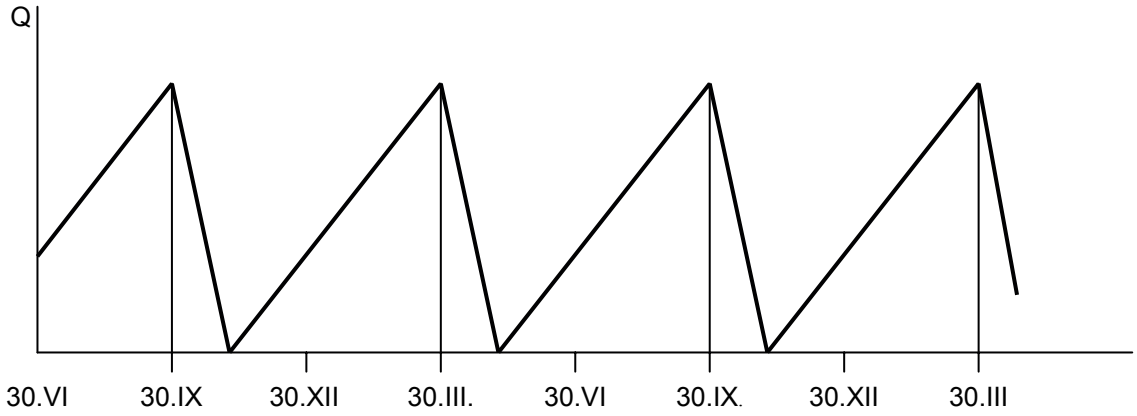


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Fig. 5

2. Sequence of material flow according to their volume

Management of enterprises was asked to rate according to their experience different material flows within enterprise with regard to their volume, so that the biggest flow would be rate as number 1, the second biggest 2 etc. Results are in following table 2.

The most important materials are in the sequence number 1-5. They were taken into consideration by the majority of enterprises and so they are most widespread. The sequence of following materials depends more on specialization of an enterprise.

3. Storing capacities

Managers in examined enterprises were asked to evaluate for most important materials whether their actual storing capacities were sufficient or not. Results were compared among enterprises with the area up to 1500 and over 1500 hectars of agricultural land.

Within agriculture, each kind of material has different individual requirements for storage. This is a disadvantage because different storages can't be substituted for each other. Certain possibility exists only for storing straw

and hay or for silage and haylage. But this is used only in smaller enterprises which have not storages equipped with special technology for loading and unloading.

If we compare storing materials in enterprises with different area, then:

- Difference between capacities in smaller and bigger enterprises are first of all among storages of straw, farm manure, seed and seedlings.
- Regardless to the extent of area, sufficient capacities seems to be for hay, haylage, workshops and building materials. Insufficient capacities are for grain, farm manure [big enterprises] and straw.

Sufficient capacities of storage exists for workshops and building materials. That is probably connected with supression or canceling former affiliated production. The same is valid for storages of potatoes, where their abundance was influenced by decreasing the amount of planting in comparison to the previous time period.

Insufficient capacities are for storing grain. This fact forces enterprises to sell grain during the harvest time, however this time the price is low and it causes considerable financial losses .

In storing straw enterprises should focus on new technologies, mainly on harvesting straw into big bales, which can be stored under open sky on fields, with small losses on quality, instead formerly considerably widespread technology of storing straw in bulk [piles] and harvested by loader wagons.

4. Utilization of stores

Utilization of stores in agricultural enterprises shows that they are used mostly more than 6 months during the year. Only by storing of industrial fertilizers and seed and seedlings they are used proportionally during two time periods in the year. Seed is needed twice per year, in the spring and autumn.

The highest representation in the category with 6 and more months are large volume materials, such as straw, hay, silage, haylage. Besides grain and straw other materials can be delivered twice a year, according the technology of plant's conservation, so these storages can be utilized during the whole year.

Lower utilization of potato storage reflects the effort of enterprises to sell potatoes as soon as possible after the harvest and only enterprises with convenient storage space can afford longer storing without great loss of quality.

Storages of farm manure and sewage reflect also reality that these materials are exported to fields two times a year and sometimes more often. Their shorter utilization is also related to summer pasture , when cattle is outside, so that storing of farm manure and dung must be taken into consideration in winter period only.

In the storing time there were no substantial differences between smaller and greater enterprises. This is the result of using similar technologies of storing and similar storing materials. Only small enterprises store potatoes shorter than 6 month. Larger enterprises tend to prolong storing for a longer time and to sell potatoes at spring for better prices.

5. Storing capacities in the Czech Republic agriculture

The last precise census from the year 2000 enumerates both number of stores and their capacities for main products and intermediate products. These data are supplementary because existing capacities may not be utilized completely. In spite of this the census confirms that the largest material flow in agriculture concerns silage, grain, hay and further follows universal stores and haylage towers.

Comparison of the development during the decade 1990-2000 shows, that capacities increase for storing fruits and vegetables, especially cooled storages with controlled atmosphere. Farmers are aware that market must be supplied continuously, not only once after the harvest with quality products which are in good shape for consumption. At the same time it is possible in these new stores to make some additionally operations, such as cleaning, sorting, packing vegetables for consumers, which contributes to increase of value added.

CONCLUSIONS

Investigation of 84 agricultural enterprises made possible to identify the main material flows in firms operating in the altitude of 400-600 m above the sea level. The main material flows are silage, haylage, harvested grain, farm manure and farm sewage. Storing capacities are mostly sufficient, but utilization of storage during the year varies with regard to one or two production cycles per year. New storing capacities are build for grain and hay.

During the years new technologies for storing hay, silage, straw, were developed. Therefore new buildings are not needed. In agriculture materials can be rolled into balls and covered by plastic foils. Storing is done under open sky. To compare the advantages of traditional and new technologies it is necessary to know storing costs, which

management usually doesn't know.

In addition to this investigation we made findings related to the average internal enterprise transport distances and the number of internal production centers. The result is that with growing area the number of production centers grow, but average internal transport distance grows substantially slower.

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