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ECONOMIC ANALYSIS OF ORGANIC MANURE APPLICATION IN HUNGARY

ANALIZA EKONOMICZNA ZASTOSOWANIA OBORNIKA NA WĘGRZECH

Key words: economics, organic manure, Hungary

Słowa kluczowe: ekonomika, obornik, Węgry

JEL codes: N5, O13, Q19

Abstract. The main objective of this study is to carry out a complex economic analysis of organic manure application. Researches were carried for years 2010-2015. Organic manure, a by-product of animal husbandry, is one of the oldest and most valuable materials in agriculture. The primary purpose of using organic manure is to improve soil fertility. Since the 90s, Hungary has been facing changes in the ownership of agricultural ventures, the number of big farms decreased and the amount of livestock was reduced in the main sectors of animal husbandry. Hungary, as a member of the European Union, has to conform to the current environmental protection regulations which also refer to the disposal of organic manure that can only be performed if significant investments are made. It can be concluded that the economic efficiency of organic manure application is primarily determined by transport distance and the specific transport method. In addition, the establishment of manure containers can be considered to be unproductive investments which affect the economic efficiency of using organic manure negatively.

Introduction

Organic manure, a by-product of animal husbandry, is one of the oldest and most valuable materials in agriculture. Organic manure can be produced self-sufficiently and in a multitude of ways [Agrárkamara 2007]. According to ancient records, manuring was an often practiced method in agricultural production even before Common Era as it appeared both in Egypt and Mesopotamia, while even Homeros made a mention of the manuring of grape in Odysseia. In the 1800s, lands were manured significantly in England, but they were unable to produce the proper amount of organic manure only by cattle breeding. Therefore, the missing organic matter was replenished mainly from bone manure and guano. Guano is sea bird droppings which was transported on the sea from the Chincha Islands on the Pacific Ocean to Europe. The significance of this source of organic manure is well illustrated by the fact that in 1984, only 7 ships transported guano, which increased to 683 by 1845 [EPA 2016].

This research focuses on the complex economic evaluation of the organic manure produced in animal husbandry sectors. In addition to the definition of the related fundamental concepts and the currently valid legal regulations, special focus was put on the amount of organic manure produced in the country, as well as its nutrient content and forms of use. Transportation and logistics cost are examined in detail.

Research material and methodology

Secondary data collection was performed as part of this study. The available closely related technical literature sources and legal provisions were processed. Livestock unit was calculated from the livestock data published by the Hungarian Central Statistical Office (HCSO) and the Research Institute of Agricultural Economics (AKI). As a next step, we calculated the amount of manure produced by farm animals between 2010-2015, using the Zutavern formula. The active ingredient content of the produced manure was compared to artificial fertiliser with average active ingredient content. In addition, the transportation costs of organic manure were analysed based on the data obtained from Agrárgazdaság Kft in order to provide an approximate value of the transport costs of 1 kg active ingredient.

Technical literature review

Farming results in various products which are produced in different periods, in different quantities and can be sold at different prices. The primary objective of production is the main product, while twin products and by-products may also result. Twin products result from the same production process as the main product and they represent significant value. On the contrary, by-products are produced in addition to main and twin products and they have lower value of use; therefore, they can be sold at a lower price [Nábrádi et al. 2008].

By-products and waste materials produced during animal husbandry, fattening, slaughtering and processing may cause harm to human and animal health. For this reason, the proper management and disposal of these products are indispensable duties. By-products of animal origin include the carcasses of animals perished due to natural causes or various diseases, waste materials from feeding and the produced organic manure. However, these materials are also considered to be hazardous waste. Properly treated products may serve as a feedstock for various industrial sectors [Szél, Gál 1980, Hegedűs et al. 1998].

Animal excrement, organic manure

Replenishment of organic matter is indispensable for the purpose of protecting and improving soil fertility. Organic manure application is one of the potential pillars of organic matter management, since the replenishment of organic manner can be performed in various ways, e.g. by applying crop production products (roots and field residues, green manure), municipal and industrial waste (peaty excrement, compost), sewage sludge and livestock management by-products (dry and liquid manure) [Pupos 2001].

According to György Mészáros [2005], "organic manure is the complex of waste materials excreted by the livestock population, that is the mixture of waste and bedding, also in a processed form." Based on Decree no. 1069/2009 of the European Parliament and the European Council, organic manure or soil amelioration materials are considered to be "materials of animal origin; manure, non-mineralised bird droppings, the content of the digestive tract, compost and breakdown residues which serve to maintain and improve the nutrient supply of plants, as well as the physical and chemical characteristics and biological activity of the soil – either separately or jointly" [NÉBIH 2013].

Manure production is the concomitant result and by-product of animal husbandry; therefore, the produced quantity can be used and transported following the proper management, storage and processing [Mészáros 2005]. The effect of the produced organic manure is exhibited in the soil by means of its nutrient supply ability. Full value soil and plant manures act on the physical characteristics, structure and water management of the soil by means of providing humus materials [Agrárkamara 2007]. On the contrary, if prescriptions and professional requirements are not conformed to, the manure could become environmentally polluting, its active ingredient content is low and its quantity could multiply, which may result in extra costs during application [Mészáros 2005].

Farmyard manure contains the mixture of solid and liquid excrement of animals and their bedding. This material provides plants with nutrients for a long time, while it has a favourable impact on the conditions, structure and biological processes of the soil. Furthermore, farmyard manure has a positive effect on less favourable soil types, making yield more balanced. The quantity and quality of farmyard manure is affected by the composition of the livestock population in terms of species and the purpose of rearing, the age and health conditions of animals, the method of stabling, the material and quantity of bedding, the duration of pasturing, as well as feeding and the manure management. Older or sick animals chew and digest less effectively as a result of their conditions; therefore, their excrement is richer in nutrients, while that of young and healthy animals is poorer in nutrients as a result of better chewing and digestion [Kádár 1974, Agrárkamara 2007].

The sole mixture of excrement and bedding is not considered to be farmyard manure. The mixture of the fresh excrement which is moved out of the barn and bedding cannot be used immediately, it has to be stored, during which fermentation and ripening takes place for a certain period.

In the case of the lack of proper ripening, the harmful carbohydrate effect will prevent plants from proper development. Following the application of farmyard manure on the field, it starts to break down in the soil. This process is greatly affected by soil acidity and quality [Agrárkamara 2007].

Liquid manure is produced during livestock management without bedding. This type of manure consists of excrement, urine, leaked drinking water, water for rinsing and washing and a small amount of waste. Liquid manure can be separated to solid and liquid fractions. The solid fraction can be precipitated and separated and treated as farmyard manure. The remaining fraction is not the same as the dung water which is produced during livestock management with bedding. However, according to the current regulations, both materials are treated equally in terms of disposal and utilisation [Agrárkamara 2007].

The average nutrient content of 1 t low quality organic manure is (1) N: 4 kg/t; (2) P_2O_5: 2.5 kg/t; (3) K_2O: 4 kg/t, medium quality: (1) N: 6 kg/t; (2) P_2O_5: 3.5 kg/t; (3) K_2O: 6.5 kg/t, good quality: (1) N: 8.5 kg/t; (2) P_2O_5: 5.5 kg/t; (3) K_2O: 9 kg/t [Loch, Nosticzius 2004]. The nutrient content of medium quality liquid manure has the following specific values: (1) N: 0.3 kg/m^3; (2) P_2O_5:0.1 kg/m^3; (3) K_2O:0.26 kg/m^3. As it turns out from the correlation, 1 m^3 of liquid manure contains 0.66 kg active ingredient [Pupos 2011].

It is important to mention biogas production as a different use of organic manure. According to Attila Bai [2005], biogas is "a gaseous material similar to natural gas, produced during the anaerobic fermentation of organic matter which can be used in a multitude of ways." During fermentation, the organic matter content of organic manure decreases by 28-48% in the case of performing a half-dry procedure. On the contrary, only nitrogen showed loss (1.5%) during fermentation in a closed system, while the same value was 30-40% in the case of composting. The reason for this phenomenon is that the specific nutrient content of organic manure is approximately double of first class farmyard manure. The favourable values are accompanied by further positive biological impacts, such as higher proportion of ammonium and nitrogen and alkaline pH. As a result, the use of organic manure in crop production could potentially result in 50% yield surplus in comparison with composting and 30% yield surplus when compared to artificial fertilisers [Bai 2005].

Rules of manure storage and manure containers

The rules of manure storage aim at preventing environmental pollution by specifying the prescriptions of the proper, professional and safe storage of manure produced during livestock management. The main purpose of these rules is the protection of surface and subsurface waters. The Govt. Decree no. 49/2001 (IV.3.) on the "Protection of waters from nitrate pollution of agricultural origin" represents the EU's nitrate directive in the Hungarian legal system. Accordingly, the maximum amount of nitrogen to be applied with organic manure on agricultural land is 170 kg/ha/year, which includes the amount resulting from pasturing, as well as the amount applied with wastewater and sewage sludge. Manuring is forbidden between 1st December and 15th February, especially on frozen soil which is saturated with water and covered with snow. In addition, the application of liquid manure and dung water is prohibited on slopes where leaching nutrients may reach surface waters. However, direct application and injection into the soil is allowed in these areas. On areas with inclination higher than 20%, manure can only be applied if the field is covered with vegetation or if the manure is incorporated into the soil immediately. Furthermore, manuring is forbidden within the 10 m radius of surface waters, as well as fountains or wells containing drinking water, unless it is specified otherwise by a legal provision [Decree no. 49/2001].

The Govt. Decree no. 219/2004 (VII.21.) on the "Protection of subsurface waters" regulates the management and application of manure. The Ministry of Agriculture and Rural Development Decree no. 59/2008. (IV.29.) focuses on the detailed rules of the action program necessary for the protection of waters from nitrate pollution of agricultural origin, as well as the order of data provision and registry [Decree no. 59/2008].

"Greening" is a reform which was introduced as part of the Common Agricultural Policy in 2015. Greening refers to the agricultural activities which are favourable from environmental and climatic aspects. The aim of this reform is to make those performing agricultural activities

contribute to the preservation of environmental and natural resources. Farmers applying for area payments must conform to specific conditions, the three special areas of which are the maintenance of grasslands, produce diversification and the designation of areas of ecological significance. The amount of area payment is 80 EUR per hectare [Kovács et al. 2015].

According to the communication issued by the Government Office, each animal farm is obliged to be equipped with proper manure storage facilities from 22nd December 2015. Liquid manure and dung water can be stored in containers or pools capable of storing liquid manure produced for six months and equipped with appropriate technical protection. The farmyard manure container should also be capable of storing manure produced for at least six months and built on an isolated foundation with seepage cut-off and equipped with liquid manure interceptors and shafts. If grazing is performed, the capacity of the farmyard manure container has to be designated on the basis of the period for which animals are kept in the barn. The farmyard container must be capable of storing enough manure so that no application is performed in the prohibitory period [Decree no. 49/2001].

A smaller, detached, "U"-shaped, 225 m^2 large manure container with 2 m tall pillars, reinforced supporting walls, 4 m wide square concrete surface, foil coverage and manhole costs around 32 000 EUR, while roofed containers are much more expensive, as their establishment may cost up to 160-320 000 EUR, depending on their design and size.

Research results

Table 1 shows the comparison of the active ingredient content of manure and artificial fertiliser. The NPK active ingredient proportion of the fertiliser was 15:15:15 and it was compared to a medium quality manure. As regards nitrogen content, it can be concluded that the maximum value of 170 kg set out in the nitrate directive can be approached if 1 ton of fertiliser (150 kg) is applied, while 30 times as much manure needs to be applied to conform to the 150 kg requirement. In terms of prices, it can be seen that the price of fertiliser is much higher than that of manure. In order to provide proper active ingredient application, multiple (thirty) times more organic manure needs to be applied. For this reason, logistics costs, more specifically transport costs will be significant as it will be shown in detail.

Table 1. Calculation of active ingredient equivalent
Tabela 1. Obliczenie ekwiwalentu aktywnego składnika

Year/ *Rok*	Artificial fertilisers/*Nawozy sztuczne [EUR/t]*				Manure/*Obornik [EUR/t]*			
	1 t	nitrogen/ *azot*	phosphorus pentoxide/ *fosfor*	potassium oxide/ *potas*	1 t	nitrogen/ *azot*	phosphorus pentoxide/ *fosfor*	potassium oxide/ *potas*
		0.15 t	0.15 t	0.15 t		0.005 t	0.0025 t	0.006 t
		N 15%	F 15%	K 15%		N 0.5%	F 0.25%	K 0.6%
2007	192	29	29	29	1.62	0.008	0.004	0.010
2008	401	60	60	60	4.67	0.023	0.012	0.028
2009	288	43	43	43	3.79	0.019	0.009	0.023
2010	256	38	38	38	2.45	0.012	0.006	0.015
2011	353	53	53	53	2.85	0.014	0.007	0.017
2012	417	63	63	63	3.65	0.018	0.009	0.022
2013	385	58	58	58	3.67	0.018	0.009	0.022
2014	353	53	53	53	3.09	0.015	0.008	0.019
2015	385	58	58	58	3.37	0.017	0.008	0.020

Source: own calculation based on Hungarian Central Statistical Office (HCSO) and the Research Institute of Agricultural Economics (AKI)
Źródło: obliczenia własne na podstawie danych Węgierskiego Głównego Urzędu Statystycznego (HCSO) i Naukowego Instytutu Ekonomiki Rolnictwa (AKI)

Transport of organic manure

The Accounting Act and the accounting policies of the enterprise set out the costs of organic manuring and the system of accounting for these expenses. The production of organic manure on the farm saves costs; therefore, only the loading and transports costs need to be covered. The main constraint of organic manure use is the size of the farm's own livestock population. According to Tibor Pupos [2001], one should seize the opportunity to purchase.

Our calculations focused on two transport methods: transport with a truck (Tab. 2) and transport with a tractor and a trailer (Tab. 3). The capacity of the truck was considered to be 24 tons, which is the maximum weight to be transported on public roads, according to the current legal provision, while the capacity of the trailer is 8 tons. The market price of organic manure used in our calculations was 2.56-4.17 EUR/t. Table 2 shows the results of transport with truck and it can be concluded that, if loading and application are not included, but only transport and manure price are considered, costs are between 4.17-6.57 EUR based on the provided parameters.

In the case of the tractor – trailer combination shown in table 3, the obtained transport costs were 0.48 EUR higher which may result from capacity utilisation. These values were between 4.65-7.05 EUR.

According to the calculations of T. Pupos [2001], 100 kg farmyard manure contains 1.35 kg active ingredient. Accordingly, the application of 1kg active ingredient cost around 0.32 EUR in the examined year. After performing the same calculation for transport with a truck and taking 13.5 kg/t active ingredient content as a basis, the respective costs were between 0.31-0.49 EUR in the case of the given parameters, while these values were between 0.34-0.52 EUR when calculated for the tractor – trailer combination.

Table 2. Transport of organic manure with truck
Tabela 2. Transport obornika na samochodzie ciężarowym

Organic manure price/*Cena obornika [EUR/t]*	Transport distance/*Odległość transportowa [km]*					
	5	10	15	20	25	30
	Price/*Cena [EUR]*					
2.56	4.17	4.33	4.49	4.65	4.81	4.97
2.88	4.49	4.65	4.81	4.97	5.13	5.29
3.21	4.81	4.97	5.13	5.29	5.45	5.61
3.53	5.13	5.29	5.45	5.61	5.77	5.93
3.85	5.45	5.61	5.77	5.93	6.09	6.25
4.17	5.77	5.93	6.09	6.25	6.41	6.57

Source: own construction and calculation based on farm data
Źródło: obliczenia własne na podstawie danych z gospodarstw

Table 3. Transport of organic manure with a tractor and a trailer
Tabela 3. Transport obornika ciągnikiem z przyczepą

Organic manure price/*Cena obornika [EUR/t]*	Transport distance/*Odległość transportowa [km]*					
	5	10	15	20	25	30
	Price/*Cena [EUR]*					
2.56	4.65	4.81	4.97	5.13	5.29	5.45
2.88	4.97	5.13	5.29	5.45	5.61	5.77
3.21	5.29	5.45	5.61	5.77	5.93	6.09
3.53	5.61	5.77	5.93	6.09	6.25	6.41
3.85	5.93	6.09	6.25	6.41	6.57	6.73
4.17	6.25	6.41	6.57	6.73	6.89	7.05

Source: see tab. 2
Źródło: patrz tab. 2

Summary and conclusions

Based on the performed calculations, it can be concluded that the amount of manure has been increasing in Hungary since 2012, when there was a change in the livestock population. The amount of manure exceeded 11 million tons in 2015. The active ingredient equivalent analysis of manure and artificial fertiliser led to the conclusion that thirty times as much manure is needed as artificial fertiliser in order to reach the maximum nitrogen amount that can be applied.

The replenishment of organic matter is indispensable in order to protect and improve soil fertility. However, the timely acquisition of the proper amount of good quality organic manure at an affordable price is not an easy task. If it is not produced on the farm, farmers need to buy organic

manure. During purchase, the main cost factors are transport distance and price. If application is not taken into consideration and only transport costs are included in the calculation, the cost of transporting 1 kg active ingredient is around 130 HUF. If this amount is compared to the calculations of T. Pupos carried out in 2001, it can be concluded that costs increased by more than 30 HUF in 15 years. The 2001 calculation also involved application costs which are left out from the current calculations; therefore, manure application will represent further expenses for farmers.

Altogether, it can be concluded that the economic efficiency of organic manure application is primarily determined by transport distance and the specific transport method. In addition, the establishment of manure containers can be considered to be unproductive investments which affect the economic efficiency of using organic manure negatively.

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Streszczenie

Głównym celem artykułu jest kompleksowa ocena ekonomiczna stosowania obornika na Węgrzech. Badania dotyczyły lat 2010-2015. Stwierdzono, że efektywność ekonomiczna stosowania nawozu organicznego zależy przede wszystkim od sposobu transportu i odległości na jaka jest transportowany. Ponadto wykazano, że tworzenie płyt obornikowych może być uznane za inwestycję nieopłacalną, która negatywnie wpływa na efektywność ekonomiczną użycia nawozów organicznych.

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