MINERAL OR ORGANIC FERTILIZATION: FINANCIAL ASPECTS

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Abstract

Farm manure is not disposed in a proper way in Croatia and often farmers consider it as undesirable by-product. Furthermore, stock manure is quite inexpensive fertilizer, even when farmers are forced to buy it to increase soil fertility. The aim of paper was to research costs of mineral and organo-mineral fertilization including applied farm machinery costs and fertilization costs taking into account level of soil fertility and nutrient status. According to nutrient status, fertilizer recommendations were calculated for soil of low fertility, medium fertile and fertile soils. Four fertilization methods were economically analyzed: mineral fertilization (complex fertilizers), mineral fertilization (single fertilizers), organic plus mineral (complex) and organic plus mineral (single). Fertilization costs are calculated in three year production model – wheat, maize and sunflower production. The highest costs are related to combined organic and mineral fertilization 2.729,05 (single mineral fertilizers) and 2.548,60 €/ha (complex fertilizers) for low fertility soils. Higher application of organic fertilization can solve a few problem of agriculture in Croatia: solving manure disposal problem considering environmental EU requirements, increasing soil fertility and crops' yield what is positively related to farm profitability and decreased costs impacts directly on saving money for farmers.

Keywords: Organic fertilization, mineral fertilization, economic effect, fertilization costs, work effect

Introduction

Over the past decades, uncontrolled population growth and rapid urbanization and industrialization resulted in environmental problems (Tinmaz and Demir, 2006). Current large-scale livestock production, epizootic, diseases and increasing globalization created the need for biosecurity in order to minimize the risk of disease transmission to the food chain (Albihn and Vinneras, 2007).

Farmers in Croatia have problems with manure disposal considering environmental requirements from EU and CAP. Mostly, farm manure is not disposed in a proper way and often farmers consider it as undesirable by-product. There are many researchers who proved positive impact of organic fertilization on crop yield and, more important, on soil fertility and microbial activity in soil.

In some cases authors found similar impact of organic and chemical fertilizers on yield (Chan et al., 2008; Reeve and Drost, 2012; Ghorbani et al., 2008), but we found that the lower price of the organic fertilizers produced on farm on economic farm result should be considered. On the other hand, Lee et al. (2006), Csizinszky (2000), Warman (2000), Delate (2008) and Sotomayor-Ramirez et al. (2010) found that growth and yield due to organic fertilization even surpasses conventional production of vegetables. Stock manure has enhanced impact on mineral fertilization reduction because of its high fertilization and environmental value (Lončarić et al., 2009).

Furthermore, stock manure is quite inexpensive fertilizer, even when farmers are forced to buy it to increase soil fertility. On-farm produced stock manure applied on fields can solve some problems for Croatian farmers: solving manure disposal problem considering environmental EU requirements, increasing soil fertility and crops' yield are positively related to farm profitability, but also stock manure can be replaced for a certain amount of mineral fertilizers.

The aim of paper was to research costs of mineral and organic plus mineral fertilization including applied farm machinery costs and fertilization costs taking into account level of soil fertility and nutrient status.

Material and Methods

The starting point of fertilization cost calculation was nutrient status of soil (Table 1).

Table 1. Soil fertility according to chemical properties and nutrient status

Soil	pH_{H2O}	pH_{KCl}	humus	AL-P_2O_5		AL-K_2O	
Poor	5,70	4,98	1,94	8,15	(B) Poor	12,57	(B) Poor
Medium fertile	5,97	5,17	2,87	13,75	(C) Well supplied	20,11	(C) Well supplied
Fertile	6,41	5,35	3,33	23,11	(D) High supplied	30,77	(D) High supplied

According to nutrient status, fertilizer recommendations were calculated for soil of low fertility, medium fertile and fertile soils. Fertilization recommendations were done according to soil pH, humus content and available phosphorus and potassium for three crops: wheat, maize and sunflower – three year production system.

Different fertilization methods are considered in paper:

- Mineral fertilization only, complex fertilizers (N:P:K 5:15:30, urea, CAN) - MC
- Mineral fertilizer only, phosphorus or potassium single fertilizers (MAP 12:52:0, KCl (62% K_2O), Urea, CAN) - MS
- Organic fertilization (cattle manure) in combination with mineral fertilization, complex fertilizers - OMC
- Organic fertilization (cattle manure) in combination with mineral fertilization, single fertilizers – OMS

Determining the costs of the different methods of fertilization is based on the work study which identifies elements for the design of work effects (norms). Norm presents effect achieved by skilled worker with certain machines with medium work intensity and dedication at work during a day shift. Knowing effects has multiple applications. It is used for planning the required number of people and machines to perform specific tasks in agricultural engineering within agro-technical deadlines. Furthermore, norm is used for planning technological production map for certain crops that contains a list of activities, agro-technical requirements for raw materials, general time in which the work would be done, the composition of aggregate for the driving machine, connected tools and required number of people to perform the work. Hour consumption of human labor and machinery per area unit can be calculated via norm. After determining the expenditure of machines in hours per hectare, it is calculated cost of labor and aggregate in € per hour. It is structured of tractor work, connected tools and earning of worker in € per hour. The price of tractor work is consisted of variable and fixed costs. Group of variable costs depends on time used by tractor within the year, and these are the costs of fuel, the cost of oil and grease, amortization costs and costs of tractor maintenance. The group of fixed costs is consisted of accommodation costs, insurance, interest payments and overhead costs related to the machine management.

Connected tools are aggregated with suitable driving machine (tractor). For connected tools also are calculated amortization costs, insurance, interest payments and tool accommodation costs. The total price of aggregate work hour is consisted of tractor's costs, related machinery and worker's wage. It is multiplied by the number of hours (7-8) and gets

the financial value of the total cost of aggregate in a one shift. This value is divided with the machine effect or norm. This is the final price of machinery aggregate in € ha^{-1}.

Costs and work effects of mechanization activities connected to fertilizer apply is shown in table 2 (mineral fertilization) and 3 (organic plus mineral fertilization). According to those results, organic fertilization is much more complex, expensive and time consuming operation compared to mineral fertilization – 227,82 and 12,78 €/ha, respectively.

Table 2. Mineral fertilization working activities, costs and effects

Operation	Effect (norm) ha	Working hour per ha		Costs
		Machinery	People	€/ha
Supply and transport of mineral fertilizers	60	0,12	0,24	2,75
Loading of mineral fertilizers 300 kg/ha	90	0,08	0,08	1,50
Spreading	18,4	0,38	0,76	8,53
Total		0,58	1,08	12,78

Table 3. Organic fertilization working activities, costs and effects

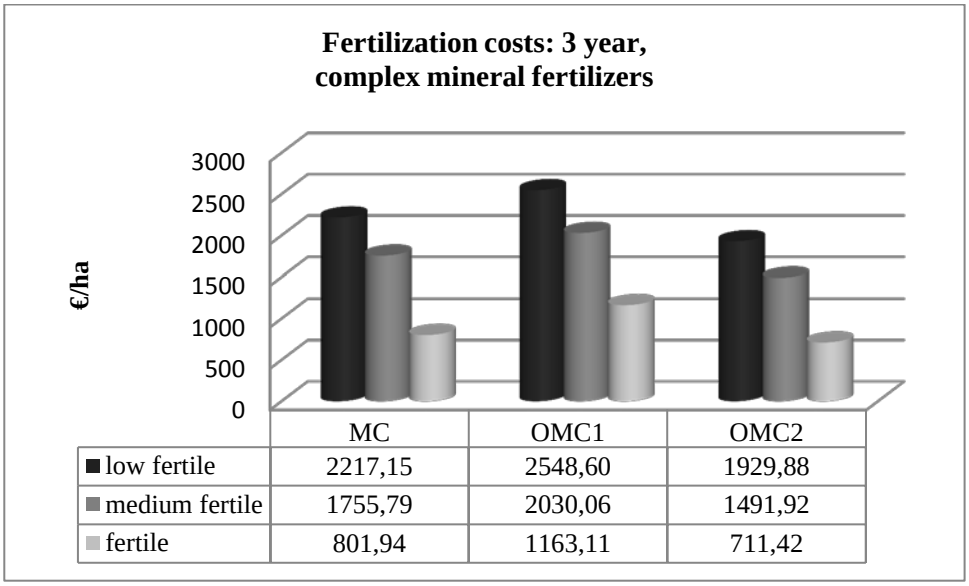
Operation	Effect (norm) ha	Working hour per ha		Costs
		Machinery	People	€/ha
Loading of manure with tractor loader	23	3	3	37,25
Spreading of manure - 30 t/ha	1	7	7	190,57
Total		10	10	227,82

I.

Agricultural production in the Republic of Croatia, in principle, was based on the use of stock manure until the 1970s with low mechanization levels. The work has been performed manually. The process of equipping small private farms with tractors generally started around 1965, and more significant about 10 years later. Since then, the application of fertilizers begins. At the same time in most European countries, small family farms cherish the application of manure and retain organic production, too. Our farmers widely accept the technology of large enterprise systems in the struggle for high yields. After the decomposition of large businesses enterprises (in state ownership) we develop small and medium farms that seek to use manure to improve the physical, chemical and biological properties of the soil. Soils with low level of nutrients do not present a favorable habitat for some crops, especially vegetables that we largely import.

Furthermore, manure management in Croatian agriculture is neglected agro-technical operation due to its complexity of manure spreading on fields.

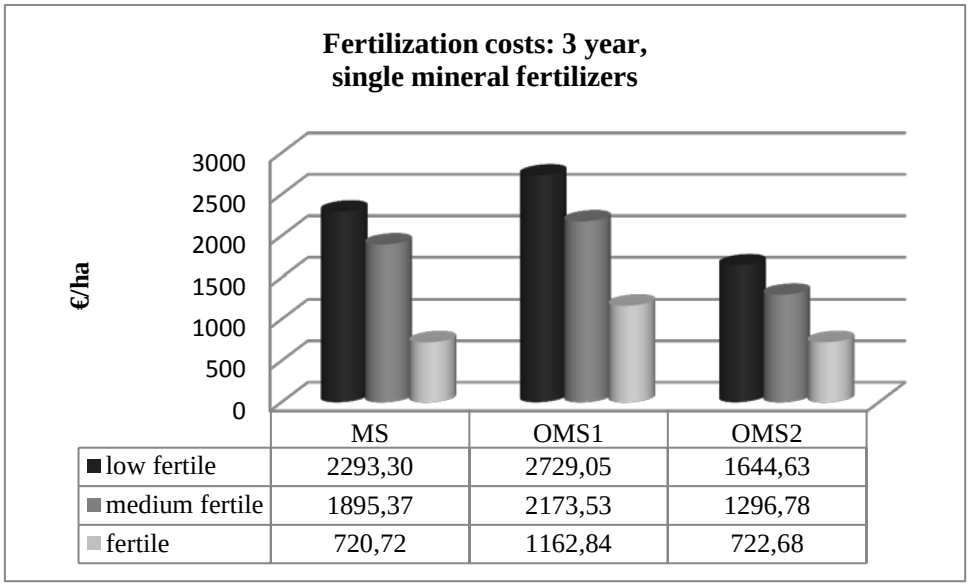
In paper, fertilization costs were calculated in three year production model – wheat, maize and sunflower production. Expectedly, combination of organic and mineral fertilization was the most expensive fertilization because the machinery costs are very high (Graph 1. and 2). We predicted two scenarios: if manure is purchased according to market price (7€ per ton) – OMC1 and OMS1 version, and if manure is produced on farm - OMC2 and OMS2 version. Soil fertility has important impact on fertilization costs because of the different nutrient demand. As it is shown in Graph 1 and 2, the highest costs are related to OMS2 and OMC2 version 2729,05 and 2548,60 €/ha, respectively, for low fertility soils. That fact we were not expected, because fertilization recommendation is more precise if using single mineral fertilization but it can be explained with high prices of single fertilizers in Croatia. Organo-mineral fertilization, if manure was produced on farm, is the cheapest fertilization – 711,42 and 722,68 € per ha on fertile soil.



	MC	OMC1	OMC2
low fertile	2217,15	2548,60	1929,88
medium fertile	1755,79	2030,06	1491,92
fertile	801,94	1163,11	711,42

Graph 1. Comparison of fertilization costs in 3 year production (wheat, maize, sunflower) using complex mineral fertilizers

Presented costs are related only to fertilization operations and price of fertilizers. Very important fact is that organic fertilization effect positively on crop yield and consequently on profitability of production. Besides, it is important for reducing crop stress in unfavorable agro-ecological conditions.



	MS	OMS1	OMS2
low fertile	2293,30	2729,05	1644,63
medium fertile	1895,37	2173,53	1296,78
fertile	720,72	1162,84	722,68

Graph 2: Comparison of fertilization costs in 3 year production (wheat, maize, sunflower) using single mineral fertilizers

Table 3. Participation of machinery and fertilizers costs

	Machinery costs (%)			Fertilizer costs (%)		
	low fertile	medium fertile	fertile	low fertile	medium fertile	fertile
MC	6,83	7,68	11,97	93,17	92,32	88,03
MS	6,39	7,25	12,76	93,61	92,75	87,24
OMC1	29,16	31,60	45,67	70,84	68,40	54,33
OMC2	45,18	49,47	73,50	54,82	50,53	26,50
OMS1	26,93	30,12	46,27	73,07	69,88	53,73
OMS2	42,62	48,09	74,05	57,38	51,91	25,95

As we can see on Table 3, direct fertilizer costs are more present in low fertile soils, expectedly, because of higher nutrient demand, and vice versa, less present on fertile soil. Furthermore, mineral fertilization has highest fertilizers cost in fertilization cost structure because of high price of fertilizers and high effectiveness of machinery. Machinery costs participated the most in combined fertilization include on farm produced manure, because, fertilizers cost are lower in that case (OMC2 and OMS2). We can notice the savings arising from organo-mineral fertilization (Table 4) as a difference between values (amount×price) of fertilizers in mineral fertilization and fertilizers in organo-mineral fertilization (amount of mineral fertilizer was reduced by application of adequate manure amount).

Table 4. Fertilizers value and financial saving due to combined organic and mineral fertilization compared to mineral fertilization (€/ha), three year crop production

Fertilizer	Low fertile soil	Medium fertile soil	Fertile soil
Organic fertilization (cattle manure) in combination with mineral fertilization, complex fertilizers – OMC			
Manure	524,93	459,32	393,70
NPK	370,94	315,30	163,83
Urea	159,36	144,87	133,28
CAN	144,58	136,97	114,14
∑	674,88	597,14	411,25
Saving*	149,94	137,82	17,55
Organic fertilization (cattle manure) in combination with mineral fertilization, single fertilizers – OMS			
Manure	524,93	459,32	393,70
MAP	111,55	88,58	98,43
KCl	289,86	238,44	0,00
Urea	131,54	119,95	99,67
CAN	144,58	136,97	114,14
∑	677,53	583,94	312,24
Saving*	152,60	124,62	-81,46

** compared to all nutrients added by mineral fertilizers*

Conclusion

Economic analysis of different fertilization methods proves that organic fertilization effectiveness in replacing mineral fertilization depends on soil fertility. Because of high machinery costs, combination of organic (purchased out of farm) and mineral fertilization is 13-39% more expensive than entirely mineral fertilization. When manure is produced on farm, the costs are lower up to 46% compared to mineral fertilization. Higher application of organic fertilization can solve a few problem of agriculture in Croatia: solving manure disposal problem considering environmental EU requirements, increasing soil fertility and crops' yield what is positively related to farm profitability and decreased costs impacts directly on saving money for farmers.

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