Economic analysis of field crop production on a family farm

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A B S T R A C T

An economic analysis of field crop (wheat, corn, triticale and sunflower) production on a family farm, representing a case-study average farm, during one production year involved calculation of production costs, gross margin, economic efficiency and rate of profitability. Calculations showed that the highest amount of gross margin was achieved with corn, followed by sunflower, triticale and wheat. The calculated values of the coefficient of efficiency were in the respective order: 3.59 for corn, 2.16 for sunflower, 1.89 for triticale and 1.79 for wheat. The share of variable costs was also indicated, with special emphasis on high costs of mineral fertilizers and machinery.

Keywords: costs, economic efficiency, wheat, corn, triticale, sunflower

И З В О Д

Економском анализом ратарске производње (пшенице, кукуруза, тритикалеа и сунцокрета) на породичном Газдинству, које је студијом случаја узето као просечно, у току једне производне године обрачунати су трошкови производње, бруто маржа, остварена економичност и стопа рентабилности. Калкулације су показале да је највећи износ бруто марже остварен код кукуруза, а затим код сунцокрета, тритикалеа и пшенице. Редослед ових резултата прате и вредности коефицијента економичности, који код кукуруза износи 3,59; сунцокрета 2,16; тритикалеа 1,89 и пшенице 1,79. Такође је указано на учешће варијабилних трошкова, при чему се посебно истичу високи износи трошкова минералног ђубрива и трошкова употребе механизације.

Кључне речи: трошкови, економичност, пшеница, кукуруз, тритикале, сунцокрет

1. Introduction

In Serbia, there are 569,310 agricultural farms, and production is organized on 3,476,788 ha of agricultural land. According to the official statistical data and the 2018 survey, in relation to the 2012 Census of Agriculture, the number of agricultural farms has decreased by about 10% and the utilization of agricultural land has increased by 1.1%. Most agricultural farms are located in western Serbia, over 40,000 in the Zlatibor region. The average farm size has increased to 6.1 ha in Serbia, 12.3 ha in Vojvodina, 4.7 ha in the Belgrade region, 4.2 ha in Šumadija and western Serbia, and 4.3 ha in southern and eastern Serbia. The number of farms up to 2 ha in size has decreased. The average age of farm owners is 61 years, and the machines they own are older than 20 years in 83% of cases. The percentage of female agricultural holders has increased to 19%. Family farms own mostly fragmented land broken up into an average of 5 plots of about 90 acres each.

Field crop production on family farms accounts for 82.75% of the country's total agricultural production,

with corn making up 88%, wheat 73%, sunflower 65% and soybean 50% of the total production (Munćan et al., 2014). Todorović (2017) confirmed that most of the production of major field crops is realized on family farms, e.g. sunflower constitutes 66.8% of the total sown area. Unfortunately, the number of profitable family farms in Serbia has significantly declined; without incentives, farms would have negative production results. According to the research by Bojnec and Latruffe (2013), 13.38 ha of land are needed for profitable farms and over 86.06 ha for companies. The performance of farms in Slovenia before and after EU accession in terms of technical efficiency is positively related to farm size. The survival of small farms in Slovenia can be explained by high support through subsidies, which are negatively related to the technical efficiency of farms, but are positively related to their profitability.

When observed from the aspect of ownership structure, and social and demographic conditions, the importance of family farms is great, but their economic importance is very small. This is because they are small farms, based on the work of family members, engaged

in semi-intensive or simple commodity production, with very low economic results. The work of family farm members is valued less than the amount paid for the work of hired workers. Incomes in small-scale agricultural production cannot keep up with incomes in the economy; therefore, there is rural-to-urban migration, especially of young people. Since the low gross margin per unit of product and the small volume of production cannot provide a small producer with a satisfactory income to continue to engage in production, under such circumstances the small producer is mostly pushed out of the market. The question as to how long small producers will be able to survive under such business conditions is extremely uncertain.

In addition to natural, climatic and soil factors, appropriate organizational and economic conditions are needed for the rational organization of agricultural production. These conditions, which determine the results of production, include the choice of crops for cultivation, type of production, cultivation technology, crop rotation, cropping plan, yields, machinery supplies, labor, etc.

Organizational and economic factors have an impact on both the production process and performance in field crop production, with farm size, expressed as the area of arable land, standing out (Todorović and Munćan, 2009). The amount of investment depends on the available arable land, capacity and use of available labor, volume and value of production, and amount of economic results achieved on the farm (Vasiljević and Sredojević, 2005). An increase in farm size leads to a change in the optimal cropping plan, increasing the degree of utilization of live labor of household members, increasing the utilization of own agricultural machines, reducing total fixed costs per ha and per hour of work, and increasing gross margin at the farm level (Munćan, 2011).

The optimal cropping plan on the family farm can be determined by operational research using a mathematical model (Mućan et al., 2021), and the share of field crops would be wheat 30%, corn 50% and sunflower 20% of the total arable land. With this crop plan, the total gross margin would increase by 2%.. By introducing vegetable crops in the cropping plan, the gross margin would increase up to twice in relation to the production of field crops only. An alternative for achieving better economic results is to practice the organic production of field crops (Mijatović et al., 2018).

Economic efficiency can be seen as the ability of producers to produce at low unit costs compared to the competition. In this sense, large producers can produce agricultural products at low unit costs compared to small producers. A low profit per unit of product combined with a small volume of production will not provide the small producer with a satisfactory income to continue to engage in production.

Producers will have to adopt technologies that will enable them to reduce costs per unit of product, given that in market conditions, economic results are the basic measure of the success of agricultural production. High quality and cheap production are becoming increasingly imperative, in order for agricultural producers to achieve and / or maintain competitive advantages (Bošnjak and Rodić, 2010; Orović et al., 2015). Therefore, the importance of researching problems related to the application of new processing technologies, machines and tools in field crop production is growing.

The aim of the research is to show the results of an economic analysis of field crop (wheat, corn, sunflower and triticale) production on a family farm during one production year, as well as to determine the current situation on the farm, applied agricultural techniques and optimal costs during the production process.

2. Materials and methods

The research was conducted in the Podunavlje (Danube River Basin) District on the Šiljić family farm at the village of Selevac, which is located 18 km away from Smederevska Palanka. Basic data were collected by surveying the holders of selected family Farms in the research area. Based on the case study of the average Farm and one-year monitoring of field crop production in the 2019/2020 season, production resources and economic results at the Farm were determined: available land, cropping plan, average yields, applied agricultural techniques, costs of material, cost prices, selling prices of products and the realized value of production of wheat, corn, triticale and sunflower.

Different measurement ratios can be used as indicators of the economic efficiency of field crop production on the family farms surveyed (Bošnjak and Rodić, 2004, 2010) as well as financial performance indicators (Munćan et al., 2010). Taking this into account, indicators measuring the ratio of costs to revenues of field production were used to measure the economic efficiency of field crop production on the family farms surveyed. The economic analysis did not include: work of members of the family farm, own production resources, the value of agricultural land, depreciation of machinery, and subsidies and incentives for agriculture.

Based on the collected data from the Farm, the following economic indicators were calculated: total costs, production value, gross margin, and coefficient of efficiency, rate of profitability in the production of wheat, corn, triticale and sunflower.

Ratios of economic indicators:

Production value = Total yield per ha x Purchase price of the product

Variable production costs = Sum of all variable costs

Gross margin = Value of production - Variable production costs

Coefficient of Efficiency Coef. E = Value of production / Variable production costs

(inefficiency *Coeff. E <1*, efficiency limit *Coeff. E = 1*, efficiency *Coeff. E > 1*).

Rate of profitability (in %) R = Profit x 100 / Total value of production

3. Results and discussions

The family Farm analyzed in the research had 5.4 ha of land, of which 92.59% was arable land, and the rest was a vegetable garden. In the cropping plan for the 2019/2020 production year, crop production was practiced on 5 ha of land, i.e. corn, triticale and sunflower were grown on 1 ha each, and wheat on 2 ha, and the remaining area of 0.4 ha was under vegetable crops for the needs of the Farm.

In the production of field crops, the Farm used its

own machinery, including a 558 tractor, a plow, a harrow, a disc harrow, a sprayer and a trailer, which were purchased 20–30 years before the analysis. There was little use of own machinery in the production of field crops. At an annual level, the tractor was used for only 50 hours of work for plowing, seedbed preparation, pesticide application and transport (Koprivica et al., 2021).

In the production of field crops on the family Farm,

total costs included the costs of material (seeds, mineral fertilizers, plant protection products and fuel), and the costs of other people's services in sowing, harvesting and baling straw. Every year, the Farm bought certified varietal seeds of all field crops. Realized yields, selling prices of field crops in the 2019/2020 production year as well real producer prices (cost prices) are shown in Table 1.

Table 1.
Realized yields, cost prices and selling prices of field crops on the Farm

Field Crops	Yield (t)	Cost price		Selling price	
		RSD kg^{-1}	EUR kg^{-1}	RSD kg^{-1}	EUR kg^{-1}
Wheat	4.9	12.93	0.11	23	0.196
Corn	8.0	7.29	0.062	26	0.22
Triticale	5.5	11.52	0.098	22	0.187
Sunflower	3.0	16.46	0.14	36	0.306

Table 2.
Costs of field crop production on the Farm in Euros

Costs	Wheat	Corn	Triticale	Sunflower
Seed Costs	93.53	78.59	67.36	84.2
Fertilizer Costs	202.31	193.51	275.03	127.75
Herbicide Costs	14.61	27.33	7.32	18.1
Fuel Costs	51.57	51.57	51.57	51.57
Material Costs	**362.02**	**351**	**401.28**	**281.62**
Service Costs	172.45	142.46	142.46	142.47
Total Costs	**534.47**	**493.46**	**543.74**	**424.09**

Calculations are given for all field crops per 1 ha. Wheat was sown on 2 ha on the family Farm. In the total costs of wheat, the largest amount is accounted for by the cost of fertilizers, 202.31 EUR (Table 2), with a share of 37.85%, followed by the cost of services for the use of machinery, 172.45 EUR, with a share of 32.27%. Other costs included: seed costs 17.49%, fuel costs 9.65% and herbicide costs 2.74% (Figure 1). The amount of costs of other people's services was explained by the fact that the Farm did not have its own machinery, such as seeders for small grains and root crops, combine harvesters and straw presses. The economic parameters of wheat production were positive, with a gross margin of 426 EUR per ha, the coefficient of efficiency of 1.79 and a rate of profitability of 44.33% (Table 3).

The largest amount of costs in the calculation of wheat production is accounted for by mineral fertilizers, as determined by Todorović and Filipović

(2010), with a share of fertilizer costs of 35.75% in total costs. Also, the same authors pointed out that the limit for positive wheat production is a yield of 3.58 t ha^{-1}. They suggested that costs be reduced through a change in production technology using machines for reduced tillage. Kanisek et al. (2001) and Grubor et al. (2015) showed that, under reduced tillage, in relation to conventional tillage, the costs of wheat production were reduced by 8–9%. Also, the mentioned authors, as well as Ristić (2010), pointed out that the realized yield and the purchase price of wheat have a decisive influence on the realized gross margin. The contribution of wheat, regardless of its lowest gross margin among crops in the cropping plan of the analyzed family farms, was 30% in the research of Todorović and Mućan (2009) and 40% on the family Farm in our research.

Table 3.
Economic performance of the Farm

| Economic parameters	Wheat	Corn	Triticale	Sunflower
Production value	**960**	**1760**	**1028.5**	**918**
Realized Yield	4.9t	8t	5.5t	3t
Sales Price	0.196	0.22	0.187	0.306
Total Costs	**534.47**	**493.46**	**543.74**	**424.09**
Material Costs	362.02	351	401.28	281.62
Service Costs	172.45	142.46	142.46	142.47
Gross Margin	**425.53**	**1266.54**	**484.76**	**493.91**
Cost Price	0,11	0.062	0.098	0.14
Coeff. Efficiency	1.79	3.59	1.89	2.16
Rate of Profitability	44.33	71.96	47.13	53.80

In the production of corn, the costs of mineral fertilizers have the largest share, 39.21%, followed by the costs of other people's services, 28.87%, and the costs of seeds, 15.93% (Figure 2). For a corn yield of 8 t ha^{-1}, the value of production was 1760 EUR, gross margin 1267 EUR per ha, and the coefficient of efficiency 3.59, which can be explained by favorable purchase price and yield, and profitability rate was 71.96% (Table 3). The realized yields of corn on the Farm with regard to applied agricultural practices, cultivated hybrid and plant density are in accordance with the research of Madić et al. (2017).

In the production of triticale, the costs of mineral fertilizers accounted for 50.57% of the total costs and were the highest, followed by the costs of other

people's services, 26.2%, and the costs of seeds, 12.38% (Figure 3). The higher amount of fertilizer costs was explained by the use of cultural practices and NPK fertilizers with a higher rate of phosphorus 160 kg ha^{-1}, which was confirmed by the research of Biberdžić et al. (2012). Compared to other crops, the production of triticale resulted in the highest amount of total costs of 543.74 EUR. After corn, triticale achieved the highest amount of production value of 1029 EUR. With a yield of 5.5 t ha^{-1}, and a gross margin of 484.76 EUR, the coefficient of efficiency of 1.89 and the rate of profitability of 47.13% were achieved, at the lowest purchase price, compared to the other field crops (Table 3).
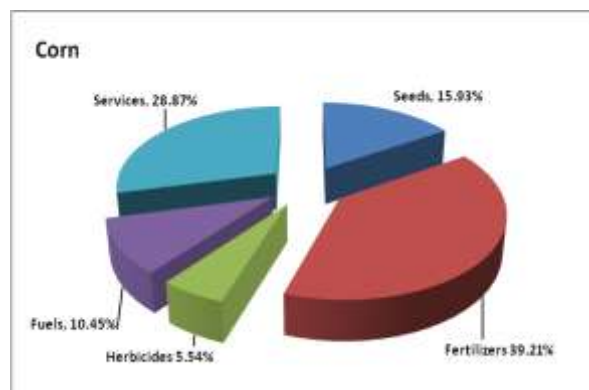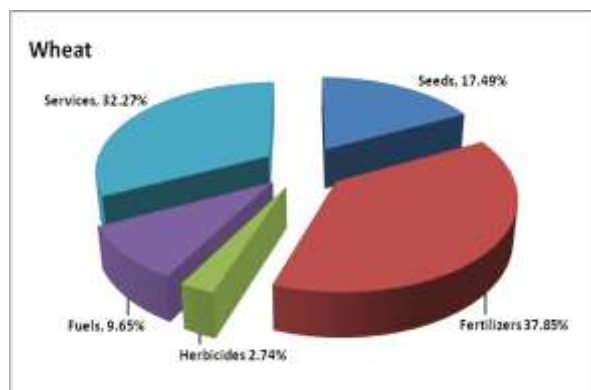
Figures 1. and 2. Share of costs in total costs for wheat and corn
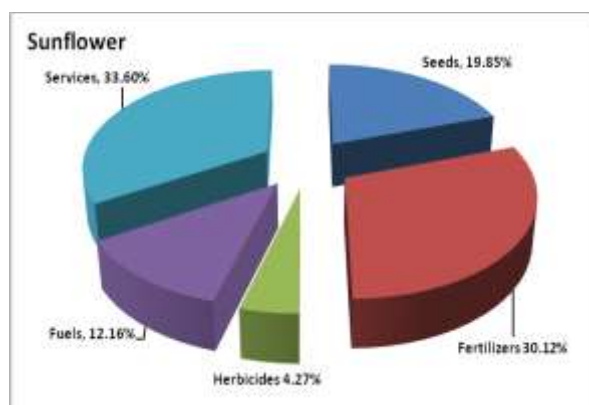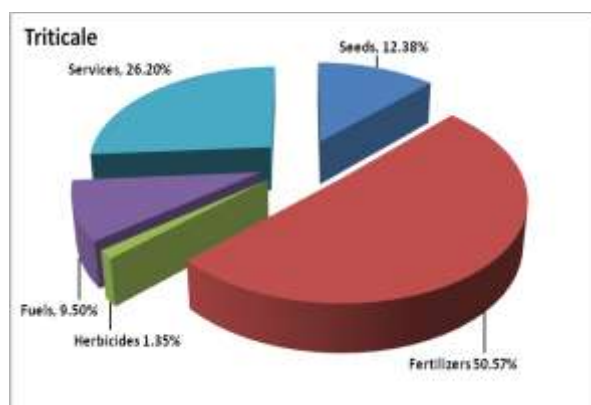
Figures 3. and 4. Share of costs in total costs for triticale and sunflower

In the production of sunflower, the largest share was accounted for by the costs of other people's services, 33.6%, and the costs of mineral fertilizers, 30.12% (Figure 4). The yield of sunflower was 3 t ha^{-1}, and selling price was highest in relation to the other field crops, i.e. 36 RSD or 0.31 EUR (Table 1). Total costs amounted to 424 EUR and were the lowest, as was the cost of mineral fertilizers, 128 EUR, compared to the other field crops. Its gross margin was 493.91 EUR, coefficient of efficiency 2.16 and rate of profitability 53.8% (Tables 2. and 3) .

As reported by Todorović et al. (2010), a sunflower yield of 3 t ha^{-1} can cover only production costs, with minimum profit achieved. Good economic performance at the Farm in the observed year was the result of the purchase price of sunflower and low production costs compared to the other crops.

The costs of mineral fertilizers have a large share in total costs in almost all field crops. These costs can

be reduced by the rational use of fertilizers and use of foliar mineral fertilizers that satisfy plant nutrient requirements across development stages. Therefore, the Farm conducts annual soil analyses in order to make fertilization rational and uses organic fertilizers when possible. The intensity of crop production on family farms can be raised to a higher level by the judicious use of mineral fertilizers, as one of the fastest, simplest and most economically rational operations. Unfortunately, farmers, despite soil tests and recommendations from extension services regarding the optimal use of mineral fertilizers, in most cases (73%) do not follow these received recommendations (Munćan et al. 2014).

In all field crops, machinery costs had a significant share, and they were broken down into fuel costs, when the Farm used its own machinery, and costs of other people's services, when the Farm hired machinery. These were mainly the costs of services for sowing,

harvesting, baling, etc. Kneževic and Popović (2011), and Jovanović and Bošnjak (2001) determined a share of machinery costs of 33.26% in total production costs on the average family farm, where machinery costs in sunflower production amounted to 33.5%, and Bošnjak et al. (1998) reported that the share of tractors and combines was 34.69%. Also, Bošnjak and Rodić (2004) stated that machinery costs increased not only on family farms, but also on large farms, and showed a tendency to grow year by year. Thus, for example, the share of machinery costs in 1985 was 19.07%, in 1995 – 34.58%, in 1997 – 25.26% and in 2001 – 39.78% of the total costs.

Unfavorable price relations, the so-called disparities, for agricultural products and input prices of fertilizers, seeds, pesticides, etc. negatively affect the farm's economic performance. Purchase prices of corn, wheat, triticale and sunflower are growing much slower than the prices of fertilizers, seeds, pesticides and fuels. The shares of the costs of fertilizers, pesticides, seeds and fuel as variable production costs greatly affect economic results (Bošnjak et al. 1998; Biberdžić et al., 2012; Todorović, 2017).

Economic results on the Farm can be influenced by increasing yield and rationally reducing costs, when and as much as possible, under all cultural practices. With the average yields of corn 8 t ha^{-1}, wheat 4.9 t ha^{-1}, triticale 5.5 t ha^{-1} and sunflower 3 t ha^{-1}, the highest gross margin was achieved in corn, followed by sunflower, triticale and wheat. The economic analysis showed positive results, and economical and profitable production for all field crops, as shown in Table 3. The value of the realized gross margin should cover labor costs of Farm members, as well as depreciation and other fixed costs.

4. Conclusions

The family Farm analyzed belongs to the group of average farms in Serbia. The analysis of field crop (corn, wheat, triticale and sunflower) production showed production results achieved in the growing season analyzed. The calculations indicated a significant share of mineral fertilizer costs in the total costs, which were 30.12% for sunflower, 37.85% for wheat, 39.21% for corn and 50.57% for triticale. Farmers can reduce fertilizer costs by the rational use of fertilizers but they cannot influence fertilizer prices, which increased in 2021 and 2022 by as much as 120%, showing a tendency to significantly increase in the coming period. The main goal of producers is to achieve the best possible economic results, and the only way to do that is to produce high yields while rationally reducing costs. Since high yields require adequate fertilization, and since fertilizer prices are rising, producers do not have great opportunities to achieve economic profitability. It should be emphasized that most farms in Serbia organize this production under dry farming conditions because possibilities for irrigation are limited.

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Declaration of competing interest

The authors declare that there is no conflict of interest.

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