EVALUATION OF ECONOMIC SUSTAINABILITY ECOLOGICAL PRODUCTION VEGETABLES ON FAMILY FARMS IN SERBIA[1]

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Abstract: *The tendency of conventional agriculture to achieve high yields has imposed a need for specialization of production and intensive application of mechanization, irrigation, pesticides, mineral fertilizers and new plant varieties. In this way, on the one hand, the profit of farmers is significantly increasing, while on the other hand serious harmful consequences are caused to the environment. Therefore, in recent decades developed different models of sustainable agriculture, which are environmentally friendly and socially just, but they are often criticized that was not economically payable as conventional production method. The research was conducted in the period from January to October 2018, following the production of tomatoes, cv. Big beef, in a greenhouse, on two family farms. The paper presents a gross margin of conventional and ecological production of tomatoes, then gives an overview of the structure of the variable costs and the critical value of production, as well as the way of changing the gross margin due to the growth of variable costs and / or decline in yields and product prices. The results of the research showed that the total value of environmentally friendly production of tomatoes in the greenhouse increased by 29.6% compared to conventional production of the same crop. However, costs of laboratory analyzes of the quality of soil, irrigation water and fruits, as well as labor costs significantly increase the amount of variable costs in ecological production, which results in lower gross margin for 13.5% compared to conventional cultivation practices. It was also found that the decline in production value has a greater impact on the gross margin than the increase in the cost of the production both in environmentally friendly and conventional agriculture.*

Keywords: *ecological production, economic sustainability, calculation of production costs, gross margin*

Classification JEL: *Q12, Q15, Q16*

INTRODUCTION

The increasing pressure because of the growth in the global population has imposed the need for intensive use of mechanization, large quantities of agrochemicals and new crop varieties in order to increase crop productivity. According to FAO data, 4,088.168 tons of pesticides and 197,504.394 tons of fertilizers were consumed in the agricultural sector, only in 2016. Such an intensive system of food production has led to environmental pollution and numerous risks for human health considering that it primarily serves the needs, not of humans or the planet, but the needs of capital (Tirado, 2015).

The current situation in world agriculture shows that the demand for quality food is permanently grows, particularly in industrially developed countries, while the production capacity of many areas is drastically reduced. Therefore, in recent decades, various models of sustainable agriculture have been developed, which imply the rational use of natural resources without challenging technical progress (Roljević Nikolić and Vuković, 2017). Although they differ from each other depending on the regional specificities of the production area, common to all environmentally sustainable production systems and techniques in agriculture is that they take care of preserving and improving the health of the environment and humans, they are economically profitable and socially righteous (Roljevic, 2014).

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Eco-based farming systems are the most often criticized by lower productivity (Röös et al., 2018), although the yield obtained is only part of the range of environmental, social and economic benefits that agriculture provides. For example, in the organic production system, which is the most often compared to conventional farming practices in researches, lower yields were observed in the range of 5 to 34% (Seufert et al., 2012) and even up to 80% (Ponisio et al. , 2015) which depends on the crop variety, agroecological factors and applied agrotechnical measures. When it comes to vegetable crops, yields are, on average, 33% lower in the organic production systems (Seufert et al., 2012). On the other hand, products obtained in an environmentally friendly way are characterized primarily by health safety and correctness, quality and good taste, for which insightful consumers are ready to pay a significantly higher price. The prices of certified products obtained in an environmentally friendly way are, on average, 50% higher than conventional products, which reflects higher costs in production, processing and distribution (Seufert et al., 2017).

Beside crop productivity and yield, an important issue in ecologically sustainable agricultural systems is the labour participation, which is, on average, 10% - 20% higher per hectare of used agricultural land than conventional ones, which on the other hand highly depends on the production orientation of the farms (Nieberg and Offermann, 2000). On horticulture farms, labour requirements are much higher on ecological than on conventional farms. A low intensity of employment is registered for conventional farms (Cisilino and Madau, 2007).

In order to establish the economic sustainability and profitability of a production line, it is necessary to monitor all costs appeared in the production process, especially variable costs, where significant differences can be observed from year to year. The coverage of variable costs as a percentage of total revenues indicates the profitability of some production and enables comparison of different agricultural systems and crops (Hadelan et al., 2015). The aim of this paper is through the coverage of variable costs to examine the economic effects of environmentally friendly vegetable production in a protected area, apropos that compared plants, with the controlled use of external inputs, creates health-safe products. Conventional cultivation practices involve the use of all agrotechnical measures and the necessary agrochemicals in order to obtain maximum yield.

The survey was conducted on two family farms. The first farm is located in the northern part of Serbia, on the territory of the town of Pancevo (the village of Glogonj) and is characterized by a long-standing orientation towards environmentally friendly vegetable production. The second farm is located in the southern part of Serbia, in the territory of the city of Jagodina (the village of Suljakovac) and is committed to a conventional system of growing vegetables in a protected area.

Manufacturers recorded every operation, including the date of completion, the time and labor invested, as well as the materials and equipment used, with real market prices at the time of purchase. The record of this information was necessary to make analytical calculations based on variable costs, apropos to compare the economic effects of environmentally friendly and conventional vegetable growing practices. Better comparability of the obtained results is ensured by expressing all revenues and costs within the observed production per uniform unit of production area (one acre) in national currency (RSD) and monetary union currency (EUR).

The calculation of variable costs coverage (coverage margin) in the production of a particular crop on the farm is calculated on the basis of the total realized revenues generated by the production of that crop less the total variable costs generated. Total realized revenues imply the market value of the primary and secondary products plus the incentives associated with the observed production line. with conventional cultivation practices examine the level of economic sustainability of the concept of organic production on small family farms in Serbia.

MATERIALS AND METHODS

An examination of the economic effects and sustainability of the concept of environmentally friendly vegetable production on small family farms was conducted by monitoring the production cycle of tomatoes (*Lycopersicon esculentum* Mill., cv. Big beef) in the protected area, from February to September 2018. For comparison of results, tomatoes were grown in two ways: in environmentally friendly and conventional cultivation practices.

In the context of this paper, environmentally friendly production implies a system of sustainable management in agriculture, where rational use of land, water and genetic resources of

The variable costs in vegetable production have most of the inputs needed to realize the planned production activities, such as: seeds, seedlings, mineral and organic fertilizers, substrates, pesticides and biostimulants of growth, fuels and lubricants, agricultural mechanization services, hiring labour, and in some cases even and members of the farm, manuals and more (Subić and Jeločnik, 2019).

For the analytical calculations on the basis of variable costs in this research was used the following formula:

PVT = Q – VT, while Q = (q x c) + p

Where analytical elements represents:

PVT – contribution margin (coverage of variable costs);

Q – achieved production value;

VT – gained variable costs;

q – volume of product per unit of measure;

c – price of product per unit measure;

p – subsidies per unit of production area.

The easiness and speed of application of the mentioned method is of particular importance for farms that are not under pressure from the obligation to keep business records on the farm (Vasiljević and Subić, 2010), because through them they are in a position to gain insight into the financial result they generate. The method is an excellent tool to support the decision-making process during the economic analysis of the existing situation within the applied production lines, since it provides an adequate assessment of the sustainability of the adopted technical and technological approach and the achieved results (Jeločnik et al., 2016).

Considering that in the conditions of organic production climate and market conditions have a very significant impact on the results of the farm business, it is necessary to analyze the production results in uncertain conditions. For this purpose, the most commonly is used the method of determination of critical production values, apropos values at which the coverage margin equals zero, where the calculation of indicators is carried out according to the following formulas (Nastić et al., 2014):

Critical price: KC = (VT - p) / OP

Critical yield: KP = (VT - p) / OC

Critical variable costs: KVT = (OP x OC) + p , pri čemu je:

OP – expected yield;

OC – expected pice;

p - subsidy;

VT – varijable costs.

Also, in conditions of uncertainty, the method of "sensitivity analysis" is used to monitor the pace of change in the coverage margin because of the decrease in yield or sales price, apropos because of the increase in variable production costs (Subić and Jeločnik, 2012).

RESULTS AND DISCUSSIONS

With calculations on the basis of variable costs determine the ability of the manufacturer to cover the variable costs upon realization of the product and to obtain a certain value from which after covering the fixed costs would make a profit (Subić and Jeločnik, 2019). Table 1 shows the production results achieved on the farm which is characterized by a focus on environmentally friendly vegetable production in the protected area. In the shown production line, on the observed farm, analytical calculation on the basis of variable costs shows the following:

- It was achieved the positive coverage margin (EUR/a 236.43), which should be sufficient for covering fixed production costs and achieving a positive financial result;
- It was achieved the average sales price amounted to EUR/kg 0.56, based on the following budget: total realized production value (EUR/a) / total realized production volume (kg/ar) = 703.02 / 1,250.00);
- Realized incomes are 1.5 times higher than the generated variable costs.

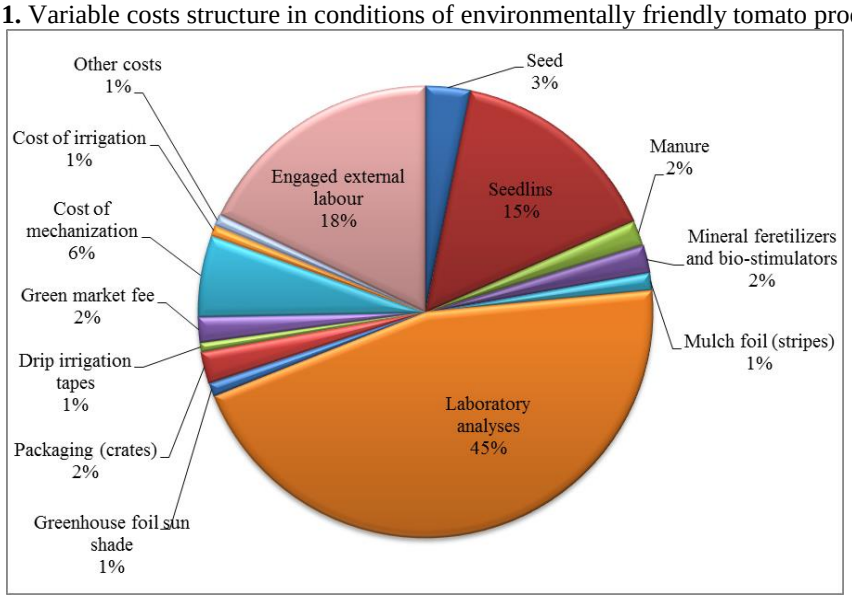
Table 1. Cover margin of environmentally friendly production of tomatoes in a greenhouse:

Element	Quantity	UM	Price per UM (in RSD)	Total RSD/ar	Ukupno EUR/ar
A – Incomes					
Tomato	1,250.00	kg	-	-	-
I class (90%)	1,125.00	kg	70.00	78,750.00	666.02
II class (10%)	125.00	kg	35.00	4,375.00	37.00
Insurance premium				-	-
Subsidies				-	-
Value of production (total A)				**83,125.00**	**703.02**
B - Varijable cost					
Seed	250.00	seed	7.00	1,750.00	14.80
Sedlins	250.00	stalk	33.50	8,375.00	70.83
Manure	1,000.00	kg	1.00	1,000.00	8.46
Mineral fertilizers and bio-stimulators				1,100.00	9.30
Pesticides				76.20	0.64
Binder	0.71	hank	145.00	103.57	0.87
Mulch foil (stripes)	62.50	m	11.00	687.50	5.81
Laboratory analyses	1.00	set	25,000.00	25,000.00	211.43
Greenhouse foil sun shade	1.00	set	535.00	535.00	4.52
Packaging (crates)	125.00	pcs	10.00	1,250.00	10.57
Drip irrigation tapes	62.50	m	6.00	375.00	3.17
Green market fee	14.00	day	200.00	1,000.00	8.46
Cost of mechanization				3,199.00	27.06
Cost of irrigation				420.00	3.55
Other costs				450.00	3.81
Engaged external labour				9,848.29	83.26
Varijable costs (total B)				**55,169.56**	**466.58**
C – Contribution margin (A-B)				**27,955.44**	**236.43**

Analyzing the variable costs structure of environmentally friendly production of a given crop in a protected area (Table 1 and Graph 1), the following are noted:

- Low cost share of plant protection products (0.1%) and mineral fertilizers (2%);
- High cost share of laboratory analyzes of soil, water and fruit (45%). However, it should have in mind that several crops are also grown in the greenhouse during the year which also are involved in covering this type of cost. Beside, soil and water analyzes are done every other year, while fruit analysis is required for each crop grown in the greenhouse during the year;
- A high share in variable costs also are labour costs (18%), which represent a significant factor in the sustainability of crop production based on ecological principles.

Graph 1. Variable costs structure in conditions of environmentally friendly tomato production



Based on the data from the coverage margin calculation, critical values of tomato cultivation were determined based on the principles of environmentally friendly production practices (Table 2). Based on the results obtained, it can be observed that the critical production values, at which the coverage margin equals zero, have the following values:

- Critical price amounts EUR/kg 0.37;
- Critical yield amounts kg/a 829.61;
- Critical variable costs amount EUR/a 703.02.

Table 2. Critical production values

Description	RSD(kg)/ar	EUR(kg)/ar
Expected yield (OP)	1,250.00	1,250.00
Expected price (OC)	66.50	0.56
Subsidy (p)	-	0.00
Varijable costs (VT)	55,169.56	466.58
Critical price: KC = (VT - p) / OP	**44.14**	**0.37**
Critical yield: KP = (VT - p) / OC	**829.61**	**829.61**
Critical variable costs: KVT = (OP x OC) + p	**83,125.00**	**703.02**

Note: Tomato fruits are classified into two classes, so the expected price represents the average price per 1 kg of tomatoes.

The sensitive analysis of environmentally friendly tomato production in the greenhouse, based on analytical calculation results, is shown in Tables 3 and 4. This analysis shows the degree of sensitivity, apropos the level of change in the coverage margin because of decreasing in yield or sales price (Table 3), as well as because of growth of variable production costs (Table 4).

Table 3. Change in coverage margin because of falling yield or falling price

Fall of tomato yield or price (%)	Value of contribution margin (RSD/ar)	Value of contribution margin (EUR/ar)
5.00	23,799.81	201.28
10.00	19,643.56	166.13
15.00	15,487.31	130.98
20.00	11,331.06	95.83
25.00	7,174.81	60.68
30.00	3,018.56	25.53
35.00	-1,137.69	-9.62

Table 4. Change in coverage margin because of rising variable costs

Growth of variable costs (%)	Value of contribution margin (RSD/ar)	Value of contribution margin (EUR/ar)
5.00	25,197.61	213.11
10.00	22,439.17	189.78
15.00	19,680.72	166.45
20.00	16,922.27	143.12
25.00	14,163.83	119.79
30.00	11,405.38	96.46
35.00	8,646.93	73.13
40.00	5,888.48	49.80
45.00	3,130.04	26.47
50.00	371.59	3.14
55.00	-2,386.86	-20.19

The values shown in Tables 3 and 4 show that the coverage margin of environmentally friendly tomato production in the protected area is more sensitive to a fall in production value than to a rise in variable costs. At the same time, the margin of coverage is at zero in the event of a fall in production value by 33.63%, or due to a rise in variable costs by 50.67%.

The production results achieved on the farm applying the conventional vegetable growing system in the protected area are shown in Table 5. In the shown production line, on the observed farm, the analytical calculation on the basis of variable costs shows the following:

- It was achieved a positive margin (EUR/a 273.46), which should be sufficient to cover fixed costs and profit;
- It was achieved a average sales price amounted to EUR/kg 0.38, based on the following estimate: total realized production value (EUR/ar) / total realized production volume (kg/ar) = 494.76 / 1,300.00);
- Realized incomes are almost 1.8 times higher than the generated variable costs.

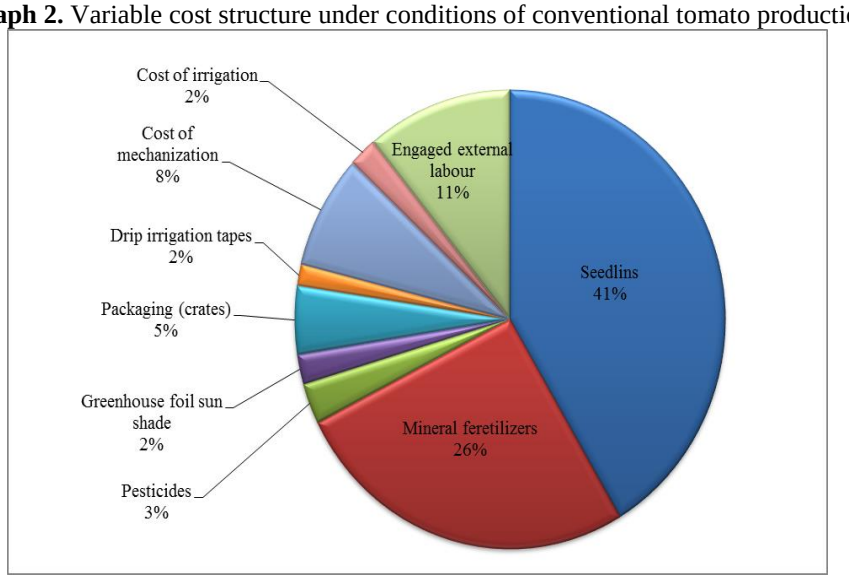
Table 5. Cover margin of conventional tomato production in the greenhouse

Element	Quantity	UM	Price per UM (in RSD)	Total RSD/ar	Ukupno EUR/ar
A – Incomes					
Tomato	1,300.00	kg	**45.00**	**58,500.00**	**494.76**
Insurance premium				-	-
Subsidies				-	-
Value of production (total A)				**58,500.00**	**494.76**
B - Variable costs					
Seed	0.00	seed	0.00	0.00	0.00
seedlings	270.00	stalk	40.00	10,800.00	91.34
Manure	-	kg	-	-	-
Mineral fertilizers				6,800.00	57.51
Pesticides				750.00	6.34
Binder	0.80	hank	145.00	116.00	0.98
Mulch foil (stripes)	-	m	-	-	-
Laboratory analyses	-	-	-	-	-
Greeenhouse foil sun shade	1.00	set	550.00	550.00	4.65
Packaging (crates)	125.00	pcs	10.00	1,250.00	10.57
Drip irrigation tapes	100.00	m	4.00	400.00	3.38
Green market fee	-	day	-	-	-
Cost of mechanization				2,100.00	17.76
Cost of irrigation				550.00	4.65
Other costs				-	-
Engaged external labour				2,850.00	24.10
Varijable costs (total B)				**26,166.00**	**221.30**
C - Contribution margin (A-B)				**32,334.00**	**273.46**

By analyzing the variable cost structure of conventional cultivation practices of given crop in a protected area (Table 5 and Chart 2), it is noted that:

- The largest share of variable costs is purchase of seedlings costs (41%) and mineral fertilizers costs (26%);
- Labor costs account for 11% of total variable costs;
- Costs of mechanization, which include performing basic and additional land cutivation, fertilization, planting of seedlings, measures of care and protection of crops, as well as transportation of fruits make 8% of variable costs of conventional production of tomatoes in the protected area;
- Other costs have a significantly smaller share of variable costs.

Graph 2. Variable cost structure under conditions of conventional tomato production



Critical values of tomato cultivation in conventional cultivation practices were also established on the basis of the coverage margin calculation (Table 6). Based on the results obtained, it can be observed that the critical production values, at which the coverage margin equals zero, have the following values:

- Critical price amounts EUR/kg 0.17;
- Critical yield amounts kg/ar 581.47;
- Critical variable costs are EUR/ar 494.76.

Table 6. Critical values of conventional tomato production in a protected area

Description	RSD (kg/ar)	EUR (kg/ar)
Expected yield (OP)	1,300.00	1,300.00
Expected price (OC)	45.00	0.38
Subsidy (p)	0.00	0.00
Varijable costs (VT)	26,166.00	221.30
Critical price: KC = (VT - p) / OP	**20.13**	**0.17**
Critical yield: KP = (VT - p) / OC	**581.47**	**581.47**
Critical variable costs: KVT = (OP x OC) + p	**58,500.00**	**494.76**

The sensitive analysis of conventional tomato production in the greenhouse, established on the basis of analytical calculation results, is presented in Tables 7 and 8.

Table 7. Change in coverage margin in conventional production because of falling yield or falling tomato price

Fall of tomato yield or price (%)	Value of contribution margin (RSD/ar)	Value of contribution margin (EUR/ar)
5.00	29,409.00	248.72
10.00	26,484.00	223.99
15.00	23,559.00	199.25
20.00	20,634.00	174.51
25.00	17,709.00	149.77
30.00	14,784.00	125.03
35.00	11,859.00	100.30
40.00	8,934.00	75.56
45.00	6,009.00	50.82
50.00	3,084.00	26.08
55.00	159.00	1.34
60.00	-2,766.00	-23.39

Table 8. Change in coverage margin in conventional tomato production because of rising variable costs

Growth of variable costs (%)	Value of contribution margin (RSD/ar)	Value of contribution margin (EUR/ar)
10.00	29,717.40	251.33
20.00	27,100.80	229.20
30.00	24,484.20	207.07
40.00	21,867.60	184.94
50.00	19,251.00	162.81
60.00	16,634.40	140.68
70.00	14,017.80	118.55
80.00	11,401.20	96.42
90.00	8,784.60	74.29
100.00	6,168.00	52.17
120.00	934.80	7.91
130.00	-1,681.80	-14.22

The results of the sensitive analysis showed that the coverage margin of conventional tomato production in a protected area is more sensitive to a fall in production value than to a rise in variable costs. At the same time, the margin of coverage of conventional production becomes negative in case of a fall in production value by over 55%, that is, due to an increase in variable costs by over 120%.

CONCLUSIONS

The analysis of the realized coverage margin, apropos gross financial result at the level of family farms applying two different concepts (environmentally friendly and conventional) in the production of the same crop in the protected area, points to the following conclusions:

- ✓ The yield of tomatoes in environmentally friendly production is lower by 3.8% compared to the conventional practice of growing the same crop apropos variety;
- ✓ The total value of environmentally friendly tomato production is bigger for 29.6% compared to conventional production of the same crop;
- ✓ The high share of variable costs in organic (66.4%) compared to conventional production (44.7%), influences that the realized incomes in organic production is 1.5 and in conventional one 1.8 times higher than the generated variable costs;
- ✓ Laboratory analysis costs (45%) and labour costs (18%) have the largest share in the variable cost structure of environmentally friendly tomato production;
- ✓ The largest share in the variable costs structure of conventional production of the same crop, in addition to the purchase of seedlings (41%), have the costs of acquiring fertilizers (26%), while significantly less resources are allocated for hiring labour (11%);

- ✓ The results of a sensitive analysis showed that the coverage margin of both tomato production methods (environmentally friendly and conventional) in the protected area is more sensitive to a fall in production value than to an increase in variable costs.
- ✓ Although the margin of coverage in terms of environmentally friendly production is 13.5% lower than conventional, the results showed that such a system of growing tomatoes on family farms is economically sustainable, because it provides a positive and stable income for producers.

Considering that in the variable costs structure of environmentally friendly production, significant expenditure relates to laboratory analyzes, if this item were included in the variable cost structure of conventional production, the realized margin of coverage would be reduced by the same cost, while the final result would be lower compared to the realized margin of coverage of environmentally friendly tomato production.

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