Production and Economic Aspects of Vegetable Production in the Republic of Serbia[85]

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Abstract

Vegetable production is a highly intensive branch of agriculture. The basic preconditions of a successful vegetable production, both in an open field and in a greenhouse lie in optimal use of inputs and the integration of all o rganisational and technological activities. The research focuses on a detailed analysis of production process and effects of technological, economic and organisational factors on the contribution margin. Using calculation and statistical methods, the authors analysed the effect of the total area under crops (ha), the method, type, system and technology of production, the method of seedlings procurement, seedlings production, the representation of irrigation systems, the representation of crop feeding systems, the number of production cycles in a year, the elevation, the aspect (of plot/s) and the type of soil on the contribution margin. The total area, production system, irrigation and feeding systems, as well as the method of seedlings procurement are the main parameters affecting the contribution margin.

Key words: vegetable, technology of production, economic indicators, contribution margin.

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[85] This paper is a result of research within the Agreement on conducting and financing scientific research in 2020, signed by the Institute for Science Application in Agriculture and the Ministry of Education, Science and Technological Development of the Republic of Serbia, Agreement No. 451-03-68/2022-14/200045, as well as the Agreement between the Ministry of Education, Science and Technological Development of the Republic of Serbia and the Faculty of Agriculture University of Belgrade, Agreement No. 451-03-68/2022-14/200116.

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Introduction

The Republic of Serbia is one of the key regional producer of vegetables. Vegetable production in Serbia in 2021 and 2022 was carried out on about 120,000 ha (RBS). The quality of inputs, primarily seeds and fertilizers, is directly correlated to competitiveness of vegetable production. Vegetable production is of great importance for Serbian agriculture in general, having great potential for development in predominantly vegetable-growing areas. From the aspect of yields, net profit and labour productivity in agriculture, vegetable production is one of the most intense branches of plant production, amounting to 5 to 8 times higher value of production than wheat in open field and 190 to 250 times higher in greenhouse production (*Vlahović et al., 2010*). Quality seedlings are required for successful vegetable production both in open field and greenhouse production. However, there is almost no quality domestic seeding material available (*Moravčević, 2015*). Demand is met by imports, due to generally undeveloped domestic market and poor levels of production of quality propagation material (*Ilin et al., 2002*). *Ivanišević et al. 2018* analysed tomato production depending on the method of procurement of seedlings, by calculating economic parameters of tomato production when propagating your own seedlings and when purchasing them on the market. When producing 800 tomato seedlings from 1,000 seeds, the total cost amounted to RSD 16,387.26, resulting in price cost of RSD 20.5. Purchase price was 19.24 RSD/kg. In both analysed cases, seedling costs were dominant in the structure of total costs, whereby the production in both cases was economical and profitable. *Gvozdenović et al. (2006)* in their paper described the technology of propagating seedlings in thermal containers and their further growing in open fields. Very significant piece of information is the one of the cost of pepper seedlings production amounting to RSD 0.15 per seedling. *Červenski et al. (2009)* analysed the propagation of seedlings for late cabbage production (cold beds).

Vegetable crops are grown in almost all regions of Serbia. Depending on agroecological conditions, such production can be done in open fields or in greenhouses, yet open field production prevails. Vegetable production is rather intensive, primarily due to the fact the soil can be used multiple times during a production year (two to three different crops can be grown per year), as well as feeding and irrigation systems. Such production results in high yields and high profits per unit area, which is on the other hand in

correlation with intensive labour. In the period 2007-2018, total value of production of agricultural products and services averaged 504.4 billon RSD, whereas the total value of vegetable production in 2018 averaged 39.3 billion RSD. In 2018, the vegetable sector on average made up 7.79% of the total agricultural sector. According to the Statistical Office of the Republic of Serbia, vegetable production in Serbia is done on 120,000 ha (ten-year average), making up 3.5% of the total arable areas. Nevertheless, areas under vegetable crops have been declining, primarily due to a shortage of labour, since labour is a determining factor for conducting and expanding this type of production. Given the areas under vegetable crops, the Republic of Serbia is 67^{th} producer in the world and 10^{th} producer in Europe. The most common vegetable crops in Serbia are the potato, tomato, pepper, melon and watermelon, cucumber, cabbage and kale. The increase in vegetable production in Serbia has been higher than in other countries in the region and in all observed group of countries, while the total production of vegetable has been at the average level of new EU member countries (*Ljiljanić, 2022*).

The methods used in this research are in line with the subject and the goal of the research. The analysis of the contents (*White and March, 2006*; *Weber, 1990*) was used in reviewing relevant domestic and international references in terms of technology, structure of production and characteristics of products. The authors used the methods of descriptive statistics for primary and secondary data, as well as the correlation analysis. As for calculation method, the authors used the analytic calculation of incomplete costs (net income, contribution margin, gross margin) (*Gogić, 2009; Dabbert and Braun, 2012*). The data were collected from 282 farms that predominately produce vegetables in the Rasina, Jablanica and Mačva districts. The data were retrieved from software (online application) "Technological & economic matrices of plant production" of the Institute for Science Application in Agriculture. Apart from those data, the Institute for Science Application in Agriculture also collect data from the sample that comprises 1,250 farms whose predominant type of production is not vegetable production. These online matrices comprise basic data on areas under vegetable and varieties, data on applied production technology and on cost of material, cost of production in terms of direct costs. Moreover, scientific and vocational papers were used to provide insight into modern technological processes applied worldwide and wider understanding of the subject of the research.

Results and discussion

The total sample of 282 farms were taken to perceived production and economic parameters of main vegetable crops in the Republic of Serbia: tomato, pepper, cucumber and cabbage. The following traits were analysed: total area under crops (ha), method of production, type of production, system of production, technology, method of procurement of seedlings, share of irrigation system, share of plant feeding systems, number of production systems in a year, elevation, aspect (of plot/s) and type of soil. Descriptive statistics was used to distribute the sample by key parameters. According to representation of certain production systems, the cucumber and pepper are primarily grown in an open field.

Table 1 shows the total contribution margin per area unit for each individual vegetable crop, and Table 2 shows the total area under a certain vegetable crop, whereas most areas, on average, are under cabbage and least under tomatoes.

Table 1. Contribution margin given by vegetable crops (RSD/ha)

	N	Minimum	Maximum	Mean
Cucumber G	30	218.020,00	10.027.950,00	3.550.902,07
Cabbage O	17	204.533,33	2.883.340,00	1.098.177,36
Pepper O	73	307.500,00	6.926.625,00	2.149.623,56
Pepper G	37	216.500,00	9.308.966,67	3.476.965,48
Tomato O	16	396.250,00	7.824.060,00	2.855.224,58
Tomato G	105	56.833,33	7.986.175,00	2.708.139,79

Source: Authors' calculation

Table 2. Total area under vegetable crops (ha)

	N	Minimum	Maximum	Mean
Cucumber G	30	0,05	1,50	0,41
Cabbage O	17	0,50	3,00	1,30
Pepper O	73	0,08	2,00	0,82
Pepper G	37	0,02	2,20	0,58
Tomato O	16	0,10	1,00	0,41
Tomato G	105	0,02	2,00	0,26

Source: Authors' calculation

When it comes to the representation of different production systems, cucumbers and tomatoes are predominately grown in greenhouses, whereas cabbage and peppers are grown in open fields.

For all vegetable crops in question, the farms predominately procured the seedlings from their own production (Table 3). Tomato seedlings are mostly procured from the market (43%). Pepper seedlings are least procured from the market (8.20%).

Table 3. Distribution by the method of seedlings procurement (%)

	Frequency	Percentage [%]
	Cucumber	
Purchase	4	13.30
Not applicable	0	0
Own production	26	86.70
	Cabbage	
Purchase	3	17.60
Not applicable	0	0
Own production	14	82.40
	Pepper	
Purchase	9	8.20
Not applicable	1	0.90
Own production	100	90.90
	Tomato	
Purchase	52	43
Not applicable	0	0
Own production	69	57

Source: Authors' calculation

When it comes to the method of production, seedlings are mostly produced in containers, namely cucumber, cabbage and tomato seedlings, by over 50% of farmers. Pepper seedlings are still predominately propagated in hot beds. Here it is clearly indicated there is a wide window for improvement and a more rationalised process of seedling production, particularly when it comes to pepper seedlings (Table 4).

Table 4. Method of seedlings production

	Frequency	Percentage [%]
	Cucumber	
Containers	23	76.70
Not applicable	4	13.30
Hot beds	3	10.00
Peat pellets	0	0
	Cabbage	
Containers	9	52.90
Not applicable	6	35.30
Hot beds	2	11.80
Peat pellets	0	0

	Frequency	Percentage [%]
	Pepper	
Containers	40	36.40
Not applicable	8	7.30
Hot beds	62	56.40
Peat pellets	0	0
	Tomato	
Containers	61	50.40
Not applicable	44	36.40
Hot beds	13	10.70
Peat pellets	3	2.50

Source: Authors' calculation

The highest cost of seed per hectare was recorded for tomato, amounting to RSD 752,220.48, followed by cucumber (RSD 253,374.55), pepper (RSD 493,620.84) and cabbage (RSD 81,185.29) (Table 5).

Table 5. Cost of seed given by vegetable crops (RSD/ha)

	N	Minimum	Maximum	Mean value
Cucumber G	30	14.000,00	2.000.000,00	253.374,55
Cabbage O	17	1.500,00	300.000,00	81.185,29
Pepper O	73	7.000,00	1.600.000,00	242.290,26
Pepper G	37	75.000,00	1.100.000,00	493.620,84
Tomato O	16	4.000,00	1.500.000,00	470.927,08
Tomato G	105	57.346,00	2.400.000,00	752.220,48

Source: Authors' calculation

The highest cost for fertilizer per hectare was recorded in tomato production, amounting to RSD 229,524.87. The second highest was recorded in greenhouse pepper production (RSD 214,540.95) and open-field pepper production (RSD 114,578.60), while the lowest cost was recorded in cabbage production (RSD 59,721.76) (Table 6).

Table 6. Cost of fertilizer given by vegetable crops (RSD/ha)

	N	Minimum	Maximum	Mean value
Cucumber G	30	11.400,00	513.680,00	83.988,90
Cabbage O	17	16.840,00	246.250,00	59.721,76
Pepper O	73	17.900,00	486.400,00	114.578,60
Pepper G	37	16.536,00	565.100,00	214.540,95
Tomato O	16	28.600,00	219.750,00	80.194,58
Tomato G	105	11.100,00	904.000,00	229.524,87

Source: Authors' calculation

The highest costs of crop protection per hectare was recorded in greenhouse tomato production (RSD 202,354.48). The second highest was

recorded in greenhouse pepper production (RSD 159,425.63), followed by open-field pepper production, greenhouse cucumber production and cabbage production, respectively (Table 7).

Table 7. Cost of crop protection products given by vegetable crops (RSD/ha)

	N	Minimum	Maximum	Mean value
Cucumber G	30	11.000,00	270.000,00	72.580,66
Cabbage O	17	3.000,00	170.000,00	51.952,94
Pepper O	73	7.296,00	620.000,00	96.282,95
Pepper G	37	6.000,00	750.000,00	159.425,63
Tomato O	16	19.400,00	255.000,00	65.918,75
Tomato G	105	15.000,00	500.000,00	202.354,48

Source: Authors' calculation

The cost of diesel-fuel was the lowest cost in vegetable production, percentage-wise. In greenhouse production such cost was almost equal for cucumber, pepper and tomato production, amounting to approximately 700 RSD/ha, being lower in open-filed production (Table 8).

Table 8. Cost of diesel fuel given by vegetable crops (RSD/ha)

	N	Minimum	Maximum	Mean value
Cucumber G	30	0,00	1.900,00	783,15
Cabbage O	17	0,00	500,00	179,88
Pepper O	73	0,00	2.000,00	521,67
Pepper G	37	0,00	2.000,00	736,47
Tomato O	16	166,67	1.500,00	527,08
Tomato G	105	0,00	3.000,00	706,88

Source: Authors' calculation

Productivity-wise, labour was mostly required in greenhouse production, almost equally in cucumber, pepper and tomato production. In open-field production, labour cost was substantially lower (Table 9).

Table 9. Cost of labour given by vegetable crops (RSD/ha)

	N	Minimum	Maximum	Mean value
Cucumber G	30	0,00	880.000,00	331.554,84
Cabbage O	17	8.000,00	141.666,67	70.188,77
Pepper O	73	0,00	750.000,00	172.887,22
Pepper G	37	0,00	840.000,00	310.221,54
Tomato O	16	0,00	500.000,00	82.962,50
Tomato G	105	0,00	1.100.000,00	296.572,32

Source: Authors' calculation

When it comes to the cost of machinery service (outsourced), the highest cost was in pepper production (Table 10).

Table 10. Cost of machinery service given by vegetable crops (RSD/ha)

	N	Minimum	Maximum	Mean value
Cucumber G	30	0,00	111.993.33	3.733,11
Cabbage O	17	0,00	0,00	0,00
Pepper O	73	0,00	250.000,00	12.592,24
Pepper G	37	0,00	146.533,33	7.185,23
Tomato O	16	0,00	0,00	0,00
Tomato G	105	0,00	119.320,00	1.136,38

Source: Authors' calculation

Table 11 shows the results of the correlation analysis for all four vegetable crops. When it comes to cucumber production, there is clearly a significant correlation between the total contribution margin and the total area under cucumbers. The coefficient of correlation implies there is a high negative correlation between the variable in question. A negative correlation coefficient implies that an increase in the total contribution value leads to a decrease in the total area under cucumbers and vice versa. Moreover, there is no significant correlation between the total contribution margin and other parameters in questions, which is confirmed by a low coefficient of correlation, indicating low interconnection.

Regarding pepper production, there is a significant correlation between the total contribution margin and the system of production. The values of correlation coefficient implies a moderate positive correlation between the observed variable. A positive correlation coefficient implies that an increase in the total contribution margin leads to more vegetables growing in greenhouses, whereas a decrease in the total contribution margin leads to more vegetable growing in open fields. Furthermore, it can be seen there is a significant correlation between the total contribution margin and representation of irrigation systems. A positive correlation coefficient implies that an increase in the total contribution margin leads to a higher percentage of representation of irrigation systems. Moreover, there is no significant correlation between the total contribution margin in pepper production and other parameters, which is confirmed by a low coefficient of correlation, indicating a low interconnection.

Table 11 shows a significant correlation between the total contribution margin in tomato production and the method of seedling procurement. A positive correlation coefficient indicates that an increase in the total contribution margin leads to predominately procuring seedlings from own production, whereas a decrease in the total contribution margin leads to

purchasing seedlings from the market. Furthermore, there is a clear connection between the total contribution margin in tomato production and the percentage of representation of feeding systems. The values of correlation coefficient implies a moderate negative correlation between the variables in question. A negative coefficient of correlation indicates that an increase in the total contribution margin leads to a decrease in the percentage of representation of feeding systems and vice versa. Moreover, there is a significant correlation between the total contribution margin and the cost of diesel fuel. The values of correlation coefficient implies a low positive correlation between the variable in question. A positive correlation coefficient implies an increase in the total contribution margin leads to an increase in the cost of fuel and vice versa. There is no significant correlation between the total contribution margin in tomato production and other parameters in question, which is confirmed by a low coefficient of correlation, indicating a low interconnection.

When it comes to cabbage production, there is no significant correlation between the total contribution margin and the parameters in question, which is confirmed by low correlation coefficient, indicating a low interconnection.

Table 11. Correlation between the total contribution margin and other parameters

Variables	Total contribution margin			
	Cucumber	**Cabbage**	**Pepper**	**Tomato**
Total area under crops	-0.522**	0.063	-0.020	0.161
System of production	-	-0.185	0.327**	-0.027
Method of seedlings procurement	0.012	-0.157	0.003	0.182*
Method of seedlings production	0.285	0.268	-0.124	0.117
% representation of irrigation systems	-	-0.140	0.196*	-0.144
% representation of feeding systems	-0.213	-0.009	0.148	-0.390**
Cost of seed	-0.346	-0.007	0.047	-0.130
Cost of fertilizer	-0.189	0.008	0.124	0.033
Cost of crop protection products	-0.218	-0.193	-0.003	-0.042
Cost of diesel fuel	-0.335	0.282	-0.176	0.230*
Cost of labour	-0.275	0.026	0.036	-0.096
Cost of machinery service	-	-	0.078	0.187

(*Statistical significance at 0.05 ** Statistical significance at 0.01).

Conclusion

The prevailing vegetable crop in the representative sample is the cabbage, whereas tomatoes are grown on the lowest mean values of the total areas under crops. Cucumbers and tomatoes are mostly grown in greenhouses, whereas cabbage and peppers are mostly grown in open fields. One of the key factors of production is the use of quality and certified seeding material

(seedlings). Currently, it is predominantly procured from own production with a tendency of specialisation and shifting to purchasing quality material. Farmers who grow tomatoes are most likely to purchase the seeding material (43%), while on the other hand, pepper growers still opt for their own production of seeding material, in hot beds predominantly, while only 8.20% of pepper growers purchase seedlings. Farmers who produce their own seedlings are most likely to use containers. The highest cost of seed were recorded in tomato production, amounting to 752,220.48 RSD/ha, in cucumber production 253,374.55 RSD/ha, pepper 493,620.84 RSD/ha and cabbage production 81,185.29 RSD/ha. The highest cost of fertilizer per hectare was recorded in tomato production, amounting to 229,524.87 RSD/ha. The second highest cost was recorded in greenhouse pepper production 214,540.95 RSD/ha, open-field pepper production 114,578.60 RSD/ha and cabbage production 59,721.76 RSD/ha. As for the cost of crop protection products per hectare, the highest cost was recorded in greenhouse tomato production, amounting to RSD 202,354.48, followed by greenhouse pepper production (RSD 159,425.63), open-field pepper production, greenhouse cucumber production, open-field tomato production and cabbage production, respectively. The cost of diesel-fuel was not significant, compared to other costs. When it comes to labour cost, labour was mostly required in greenhouse production, almost equally in cucumber, pepper and tomato production, and considerably lower in open-field production.

The correlation analysis of cucumber production has shown there is a significant correlation between the total contribution margin and the total area under cucumbers. The greenhouse production of peppers significantly defines the gross margin. Moreover, the irrigation system defines the gross margin to a significant extent. There is a significant correlation between the total contribution margin in tomato production and the method of seedlings procurement. A positive correlation coefficient indicates that an increase in the total contribution margin leads to procuring the seeding material from own production, whereas a decrease in the total contribution margin leads to predominately purchasing the seeding material.

A lack of labour and a need for more professional and more specialised production implies the necessity of purchasing quality seeding material as one of the key factors of competitive production.

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