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ECONOMIC ANALYSIS OF RASPBERRY PRODUCTION IN SERBIA AT THE LEVEL OF VARIABLE COSTS IN 2024

ABSTRACT: Raspberry production in the Republic of Serbia plays a crucial role in the agricultural economy, particularly for small-scale farms in mountainous regions. The Willamette cultivar, being widely cultivated variety, holds dominant economic significance. This study presents an economic analysis of raspberry production based on data collected from 174 selected farms during the 2024 production year. Family labor utilization was estimated based on normative labor requirements for various manual agricultural operations, as determined through consultations with experts from Serbia's agricultural advisory services and relevant literature sources.

The analysis focuses on the structure of variable costs, distinguishing between recorded expenditures and total variable costs inclusive of imputed family labor costs. Results reveal substantial variability in yields, input usage, labor intensity, and market prices, despite favorable agroecological conditions. On average, yields on the selected farms significantly exceeded the national average.

Labor costs—particularly family labor—emerged as the most influential component of total variable costs, accounting for

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approximately 40.35% of the average. When family labor is included, the average gross margin per hectare decreases by 42.8%, underscoring the importance of comprehensive cost accounting. The study highlights the necessity of incorporating family labor valuation in economic assessments to avoid misinterpretation of profitability.

These findings establish a foundation for enhancing advisory practices, refining cost estimation methodologies, and informing policy initiatives aimed at improving the sustainability and competitiveness of raspberry production in Serbia.

Keywords: Willamette cultivar, variable costs, gross margin

INTRODUCTION

Raspberry production in the Republic of Serbia holds significant agronomic and economic importance, particularly for small-scale farms in mountainous and sub-mountainous regions. The Willamette cultivar, characterized by its adaptability and yield potential, dominates Serbian raspberry orchards and serves as the cornerstone of national raspberry exports. Since the mid-1980s, the Willamette raspberry cultivar has maintained a leading role in Serbia's commercial raspberry sector, representing more than 90 % of the total cultivated area (Nikolić et al., 2008; Leposavić, 2023). Willamette proves highly suitable for raspberry cultivation in Serbia thanks to its strong adaptation to regional agroecological conditions, exceptional yield capacity, and outstanding characteristics for freezing and international trade. Given the increasing volatility in input prices, labor availability, and market conditions, a detailed economic analysis of raspberry production is essential for assessing farm-level profitability and informing policy interventions.

The data utilized in this study originate from the institutional database of the Institute for the Application of Science in Agriculture. They were gathered from a targeted sample of farms primarily engaged in raspberry production (hereinafter referred to as "selected farms"), identified in accordance with the Rulebook on the Methodology of Agricultural Advisory Services (Official Gazette No. 65/14). This Rulebook forms an integral component of the Regulation governing the annual development program for agricultural advisory activities, as enacted for each respective calendar year.

This study focuses on the economic performance of selected raspberry farms in Serbia during the 2024 production year, with particular emphasis on variable cost structures. The analysis is based on primary data collected from 174 farms cultivating Willamette raspberries under conventional open-field

conditions. The selected sample encompasses a wide range of farm sizes, production intensities, and marketing strategies, thereby enabling a representative assessment of economic outcomes for farms that apply recommended agrotechnical practices.

The research methodology involves disaggregating variable costs into recorded expenditures and imputed family labor costs. This distinction is critical, as family labor—although often unaccounted for in farm records—represents a substantial share of total production costs and directly influences gross margin calculations. By incorporating normative labor input values and prevailing wage rates, the study provides a more comprehensive and realistic estimate of economic performance. Quantity of total labor in working days per manual operation were estimated to 95 w.day/ha for plantation maintenance, transportaion and other operations and with 50 kg/w.day for fruit harvest, using various sources (Milinković, et.al, 2005; Veljković et al., 2006; Lukić et al., 2015) and author's consultations with experts from State funded advisory services from the cities of Belgrade, Kraljevo, Užice, Valjevo and Čačak.

The findings aim to support producers, researchers, and policymakers in understanding the cost dynamics of raspberry production and in developing strategies to enhance farm profitability, labor efficiency, and long-term sustainability. Through rigorous cost analysis and gross margin evaluation, this research contributes to the broader discourse on horticultural economics and rural development in Serbia.

RESULTS AND DISCUSSION

The analysis was conducted on 174 farms in 2024 cultivating raspberries on a total area of 101.12 ha on selected farms and results varied significantly. The smallest area of raspberry plantations was 15 ares, the largest area was 2.5 ha, with the average weighted size of the plantations being 0.578 ha.

Table 1. Achieved results in 2024 production year

Value / Indicator	Area (ha)	Yield (kg/ha)	Income (€/ha)	Price (€/kg)	Income with incentives (€/ha)
Min	0.15	3000.00	5122.08	1.71	5361.11
Max	2.50	27000.00	57623.36	3.83	57905.07
Average	0.58	10501.45	22402.76	2.13	22561.34

Source: author's calculation

Realized quantities of raspberries produced varied widely with a range of variation of 24000 kg/ha and an average of 10501 kg/ha. The prices at which raspberries were sold also varied greatly between 1.71 €/kg and 3.83 €/kg. Some farmers delivered their products to cold stores at lower prices, while some farms obtained a higher price through retail. The average price at which all the produced raspberries from the selected farms were sold was 2.13 €/kg. The mentioned differences in produced quantities and realized prices caused large differences in income between individual farms. The average realized income per unit of area was 22561 €/ha, in which State subsidies contributed approximately 1 % to total income.

Of the variable costs, the survey recorded the costs of mineral fertilizers and manure, plant protection agencies, diesel fuel, mechanized services, hygiene products, external labor per work operation, as well as other variable costs. In the Gross Margin calculation, variable costs are grouped into the following categories: material costs (primary and auxiliary), variable machinery costs, external labor costs, mechanized service costs, and family labor costs.

Table 2. Material costs per unit of planting area (€/ha)

Indicator / Cost	Fertilizer	Plant protection	Diesel fuel	Others material costs	Total (no.€/ha; €/kg)
Number of farms *	162	164	169	48	174
Min (€/ha)**	17.07	102.44	23.78	47.81	191.10
Max (€/ha)	1343.12	1792.73	580.67	1422.80	5139.32
Average (€/ha)	489.90	510.21	176.95	52.79	1229.85
Average (€/kg)	0.05	0.05	0.02	0.01	0.12

Source: author's calculation

Note: *number of farms on which a certain cost was recorded; **for farms that recorded the certain cost

The expenses associated with mineral fertilizers and animal manure are accounted for within the overall fertilizer cost category. Additional production material costs encompass hygiene products, single-season binders, and water. However, expenditures for plastic clips used to secure shoots—given their multi-year utility are excluded from the calculation of variable costs.

Table 2 indicates substantial variability in material costs across the surveyed farms in 2024. The average weighted material cost, calculated per unit of planting area, amounted to 1229.85 €/ha for the sample of 174 farms. Within the structure of total variable costs per unit of final product, material inputs contributed an average of 0.12 €/kg. These relatively low material input costs are primarily attributable to high yield levels, which reflect the favorable agroecological conditions prevailing during the 2024 production season.

The success of raspberry production is predominantly contingent upon the availability and proficiency of skilled manual labor. Consequently, it is essential to conduct a thorough analysis of labor consumption and associated costs. Manual operations are typically executed through a combination of hired external labor and unpaid family labor, each contributing distinct economic implications to the overall production system.

Table 3. Costs of externally engaged labor force (w.day/ha)

Indicator / working operation	Soil cultivation	Fertilization	Pruning of young shoots	Pruning of old shoots	Harvest	Spraying
Number of farms*	109	85	146	110	174	74
Min Labor input ** (w.day/ha)	2.00	1.30	1.90	1.30	5.30	1.10
Max Labor input (w.day/ha)	35.00	26.70	80.00	50.00	366.70	20.00
Average Labor input (w.day/ha)	6.50	4.70	16.70	8.10	135.20	3.50
Normative labor input (w.day/ha)	20.00	9.00	20.00	10.00	50*** kg/day	6.00

Source: author's calculation

Note: *number of farms that hired external labor for a specific work operation; **for farms that hired external labor; ***productivity of manual picking

The analysis revealed that in 2024, not all surveyed farms employed external labor across all manual work operations, with the exception of raspberry harvesting. Specifically, external labor was engaged on 109 farms for soil cultivation, 85 for fertilization, 146 for the removal of young shoots,

110 for pruning and removal of old shoots, and 74 for the application of plant protection agents. Raspberry harvesting emerged as the sole manual operation consistently performed with the assistance of external labor on every selected farm. Moreover, harvesting represents the activity with the highest average engagement of external labor across the sample. From Table 3, it can be seen that in 2024, external labor costs were subject to large variations between farms. The average external labor input was 174.7 w.day/ha.

Spraying can be performed manually or mechanized. The expenses associated with hiring external mechanization for spraying are classified under external mechanization service costs. In contrast, the quantity and cost of external labor engaged in manual spraying are documented separately within the labor input records.

The daily wage rates paid to external laborers on the selected farms in 2024 exhibited considerable variation, both across different work operations and among individual farms.

Table 4. Unit Prices of Work Operations Performed by Externally Hired Labor (€/w.day)

Indicator / Operation	Soil Cultivation	Fertilization in the row	Removal of young shoots	Removal of old shoots	Harvest	Spraying
Lowest price (€/w.day)	25.60	25.60	25.60	25.60	25.60	25.60
Highest price (€/w.day)	42.66	42.66	51.19	51.19	59.73	42.66
Average (€/w.day)	40.10	40.93	40.39	40.67	42.07	41.36

Source: author's calculation

Survey (2024) results indicate that daily wage rates are primarily influenced by the geographical location of the farm. For the purpose of cost estimation, family labor expenses on each farm were calculated using the same daily wage rates applied to corresponding work operations performed by externally hired labor.

Additional family labor costs encompass operations such as shoot tying and wire tensioning, various forms of transportation, irrigation activities, as well as the loading and transport of both input materials and harvested products.

Table 5. Variable costs on selected farms in 2024

Indicator/ Cost	Production material	External labour	Mechnised services	Variable Costs 1	Family labour	Variable Costs 2
Min (€/ha)	170.74	160.06	42.68	634.92	1128.75	4234.25
Max (€/ha)	4219.45	18638.67	2580.01	21120.03	26739.37	31639.24
Average (€/ha)	1229.85	7327.43	181.27	8738.56	5911.10	14649.66
Average (€/kg)	0.12	0.70	0.02	0.83	0.56	1.40
Average (%)	8.40%	50.02%	1.24%	59.65%	40.35%	100.00 %

Source: author's calculation

Table 5 reveals substantial variability in the levels of variable costs across the surveyed farms in 2024. It is essential to delineate between the average recorded variable costs (Variable Costs 1) and the total variable costs (Variable Costs 2), which encompass the estimated average costs of family labor. The recorded variable costs were derived from survey data and reflect actual expenditures incurred during the 2024 production cycle. In contrast, family labor costs were estimated using normative labour input values and prevailing market rates for external labor.

In 2024, the average variable costs excluding family labor were calculated at 8738.56 €/ha. When combined with the estimated family labor costs of 5911.11 €/ha, the total average variable costs amounted to 14649.66 €/ha.

When expressed per unit of raspberry production, the total variable costs equated to 1.40 €/kg, of which 0.83 €/kg (59.65 %) represented recorded variable costs, and 0.56 €/kg (40.35 %) corresponded to estimated family labor costs.

Table 6. Gross margin of selected farms in 2024

Indicator / Value	Min (€/ha)	Max €/ha)	Average (€/ha)	Average (€/kg)
Value of production	5361.11	57905.07	22561.34	2.15
Variable Costs 1	634.92	21120.03	8738.56	0.83
Variable Costs 2	4234.25	31639.24	14649.66	1.40
Gross margin 1	1102.19	53005.21	13822.78	1.32
Gross margin 2	-2454.54	26265.84	7911.69	0.75

Source: author's calculation

Large differences in the value of production, as well as in variable costs, in 2024 also affected large differences in gross margins on selected farms. The average gross margin without family labor costs (Gross margin 1) was 13822.78 €/ha, or 1.32 €/kg. The average gross margin with calculated family labor costs (Gross margin 2) was 7911.69 €/ha, or 0.75 €/kg. Incorporating estimated family labor costs into the total variable costs (Variable Costs 2) resulted in a reduction of the average gross margin by 5911.10 €/ha, equivalent to a 42.8 % decline.

In 2024, the surveyed family farms recorded an average raspberry yield of 10501.45 kg/ha, substantially exceeding the national average of 4.0 t/ha reported for Serbia (SORS, 2025). This yield aligns with the production levels typically employed in economic analyses of raspberry cultivation, which range from 10 t/ha to 11 t/ha as reported in previous studies. (Veljković, et al, 2024; Kljajić, et al, 2017; Apáti, 2014). The achieved average production value per unit of product, amounting to 2.15 €/kg of raspberries, exceeds the national average annual purchase price of 2.01 €/kg for Serbia in 2024 (SORS, 2025). This discrepancy is due to differences in purchase prices, diverse sales channels, and the impact of government subsidies, including support for basic land cultivation, insurance premium incentives, and excise tax refunds on diesel fuel.

CONCLUSION

The economic assessment of raspberry production on selected farms in the Republic of Serbia for the 2024 season highlights pronounced variability in production results, cost composition, and profitability indicators. Although agroecological conditions were generally favorable, significant differences

emerged in terms of yield levels, input utilization, labor requirements, and achieved market prices. Notably, the average yield recorded on the selected farms substantially exceeded the national average for raspberry production.

An important finding of this study is the critical role of labor—particularly family labor—in shaping the economic viability of raspberry production. Family labor accounted for approximately 40.35 % of total variable costs, emphasizing its economic significance despite being traditionally excluded from formal accounting records. When family labor costs are incorporated, the average gross margin per hectare is reduced by 42.8 %, highlighting the importance of comprehensive cost accounting for accurate profitability assessment.

The distinction between recorded variable costs (Variable Costs 1) and total variable costs including imputed family labor (Variable Costs 2) is essential for methodological transparency and policy relevance. Omitting family labor cost underestimating production expenses and overstating farm profitability, particularly in labor-intensive crops such as raspberries.

Given the variability in farm performance and cost structures, future advisory and policy efforts should prioritize labor efficiency, cost optimization, and market access strategies. Moreover, standardized methodologies for estimating family labor costs—whether through normative input coefficients, expert assessments, or farm-level surveys—should be integrated into routine economic evaluations to ensure comparability and reliability.

This research contributes to the broader understanding of horticultural economics in Serbia and provides a foundation for evidence-based decision-making aimed at improving the sustainability and competitiveness of raspberry production systems.

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DECLARATION OF CEMPETING INTERESTS

Authors must disclose any personal and/or financial relationships with other people or organizations that could inappropriately influence (bias, non-compliance with the academic code) their work.

REZIME
EKONOMSKA ANALIZA PROIZVODNJE MALINE NA NIVOU VARIJABILNIH TROŠKOVA U SRBIJI U 2024 GODINI

Proizvodnja maline u Republici Srbiji ima značajnu ulogu u poljoprivrednoj ekonomiji, posebno za mala gazdinstva u brdsko-planinskim regionima. Sorta Vilamet, kao najzastupljenija, ima dominantan ekonomski značaj. Ova studija predstavlja ekonomsku analizu proizvodnje maline zasnovanu na podacima prikupljenim sa 174 odabrana gazdinstva tokom proizvodne 2024. godine. Utrošak porodične radne snage je procenjen na osnovu utrošaka radne snage za različite radne operacije pomoću konsultacija sa stručnjacima poljoprivrednih stručnih savetodavnih službi Srbije i literature.

Analiza je fokusirana na strukturu varijabilnih troškova, uz jasno razgraničenje između evidentiranih izdataka i ukupnih varijabilnih troškova koji uključuju procenjene troškove porodičnog rada. Rezultati ukazuju na značajnu varijabilnost u prinosima, korišćenju inputa, intenzitetu rada i ostvarenim tržišnim cenama, uprkos povoljnim agroekološkim uslovima u posmatranoj godini. Značajno je napomenuti da je prosečan prinos na odabranim gazdinstvima znatno viši od republičkog proseka.

Troškovi rada, naročito porodičnog rada, pokazali su se kao najuticajnija komponenta ukupnih varijabilnih troškova, sa udelom od 40.35 % u proseku. Kada se porodični rad uključi u obračun, prosečna bruto marža po hektaru opada za 42.8 %, što naglašava važnost sveobuhvatnosti obračuna troškova. Studija ističe potrebu za uključivanjem vrednovanja porodičnog rada u ekonomske analize kako bi se izbegle pogrešne interpretacije profitabilnosti.

Ovi nalazi pružaju osnovu za unapređenje savetodavne prakse, preciznije metodologije obračuna troškova i oblikovanje mera politike usmerenih ka održivosti i konkurentnosti proizvodnje maline u Srbiji.

Ključne reči: Willamette sorta maline, varijabilni troškovi, bruto marža

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