
GROSS MARGIN ANALYSIS OF RASPBERRY PRODUCTION ON SELECTED FAMILY HOLDINGS IN SERBIA

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ABSTRACT

This study analyzes the economic performance and risk exposure of raspberry production on selected family farms in Serbia, identified by agricultural advisory services as regional leaders. Using gross margin calculations for the period 2020–2024, the results show that an average gross margin was €14,546/ha or €1.57/kg. Strong year-to-year fluctuations in gross margin were observed, ranging from €0.53/kg in 2023 to €2.97/kg in 2022. These variations were primarily attributable to volatility in raspberry market prices and escalating labor costs, which together accounted for more than 80% of total variable expenses. Sensitivity analysis indicated that most simulated scenarios yielded positive gross margins, suggesting a favorable outlook for the selected Serbian farms. The findings underscore the sector's dependence on labor and unstable markets, highlighting the need for technological modernization, labor-saving innovations, and targeted institutional support to sustain competitiveness in the global raspberry market.

Introduction

Raspberry production is organized in different culture systems under various natural, social, business, etc., conditions all over the world. Raspberries are produced in different intensity systems, from very extensive to super intensive. Various risks and

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uncertainties are connected with raspberry production, which can have a decisive role in the success or failure of investments in raspberry plantations. Those risks and uncertainties depend on many factors, such as intensity level, natural conditions for production, subsidies policy in the country, export and import rules, etc.

In the Republic of Serbia, raspberries are produced in different production systems, which include production on field and production in protected environments. Raspberry production on fields can be organized in very different intensity levels which under the influence of risks can lead to very different economic results.

Table 1. Raspberry production systems and varieties according to use and ripening

Cultivation system	Varieties (examples)	Main characteristics	Ripening time	Main use
Extensive	Willamette, Meeker, Lloyd George, Fertödi zamatos, Polka, Heritage, Autumn Bliss	Hardy varieties, low input, lower planting density, stable but lower yield, suitable for traditional/organic farming	Early–mid (summer), remontant	Processing, fresh (limited)
Semi-intensive	Willamette, Meeker, Glen Ample, Tulameen, Polka, Heritage	Moderate agronomy, stable yield, suitable both for processing and fresh market	Early–mid (summer), remontant	Fresh market + processing
Intensive	Glen Ample, Tulameen, Lashka, Fertödi zamatos, Polka, Imara, Kwanza, Willamette	High yield per hectare, large high-quality fruit, requires irrigation, trellis system, regular crop management	Mid–late summer, remontant	Fresh market (export) + processing
Super-intensive	Kwanza, Imara, Enrosadira, Amira, Maligna selections (Adriana, Loretta, Sofia...), Tulameen, Glen Ample	Grown in tunnels/ greenhouses, fertigation, extended harvest season, premium fruit quality, maximum yield per m ²	Remontant (long harvest season)	Premium fresh consumption, export

Source: authors's presentation

All factors influencing the production and economic parameters of raspberry production could be seen as certain, risky or uncertain. Apart from the certain factors which are constant, it is very important to be aware of the potential impact of risky and uncertain factors, especially when the decision about investing is about to be made. Distinguishing between risk and uncertainty is crucial in agricultural decision-making. Risk involves situations where outcome probabilities are known or can be estimated statistically, while uncertainty refers to cases where such probabilities are indeterminable (Knight, 1921; Jakovljević et al., 2025; Andrei & Darvasi, 2012). Risk assessments are often subjective, shaped by individual perspectives (Popescu & Andrei, 2011; Hardaker, 2016). According to ISO 31000, risk is “the effect of uncertainty on objectives,” encompassing both positive and negative outcomes. In agriculture, risk is

typically categorized into five types: production, market, institutional, personal, and financial (Komarek et al., 2020; Erokhin et al., 2022), each reflecting distinct sources of variability and vulnerability.

From the past research and experiences, a need occurred to investigate the nature of risks and uncertainties in raspberry production in more detail. This paper is part of the authors' research that should bring new insights into factors affecting production results and profitability of raspberry production in the Republic of Serbia and in general. This research mainly aims to identify risks in raspberry production in Serbia, detect their origin and differences in risk occurrence and to measure its possible effects on economic performance on the level of variable costs.

Production risks include factors that could affect the growth and production results of raspberry in quantitative and qualitative terms. Production risks could be roughly subdivided into natural and technological-technical risks.

In this category fall the following risks: risks related to raspberry cultivars and the quality of planting material, risks that originate from natural (agroecological) conditions for raspberry production, production systems and intensity, presence of diseases at the national, regional, or farm level, risks of technical and constructional failure, extreme weather events, etc.

Natural condition-related risks include a range of adverse climatic and meteorological events that may significantly affect agricultural production outcomes. These commonly include storm winds, early autumn frosts, late spring frosts, drought, hail, extreme temperatures, and intense solar radiation.

Market risks include price and cost changes and market access. In the last few years, there have been considerable changes in the raspberry industry in general. Those changes were caused mainly by the Coronavirus pandemic and the war in Ukraine, which can be seen as uncertain and unpredictable events. The usual and biggest market risks in the raspberry industry in Serbia are price changes of raspberries and human labour.

Institutional risks come from changes in the policies and regulations that affect agricultural production, e.g., raspberry production. Institutional risks are mostly not under farmers' control, and farmers have minimal influence. This risk category includes changes in subsidy policies, export and import regulations, and phytosanitary, agricultural and ecological regulations that affect raspberry production.

Personal (human) risks are specific to an individual and include factors like health, relations, motivation, qualification level, working ethics, etc., which could influence farm results.

The shortage of external labor is an increasingly prevalent issue and risk, both in raspberry production and in agriculture more broadly. Manual operations include the removal of young shoots, tying of canes and wire tensioning, pruning of old canes, in-row fertilization, and harvesting. Additionally, plant protection treatments are often carried

out manually. The engagement of manual labor is also required for operations involving mechanization, such as irrigation, spraying, transport, and other auxiliary tasks.

Financial risks refer to all aspects of financing the investment and operation of raspberry production. There is the risk that the financial means for financing the operation wouldn't be sufficient. Changes in bank interest rates for long-term and short-term credits also fall in this category.

Materials and methods

In this research authors used the data from structured interview, data from the Institute for science application in agriculture (IPN) data base and information from previous researches and literature.

Data gathered from structured questionnaire originate from State funded advisory services from the cities of Kraljevo, Užice, Valjevo, Čačak and Šabac. Those data include information about most frequent risks in raspberry production in Serbia such as the risk type, frequency of occurrence, negative effects to plants and fruits and risk mitigation measures.

The IPN base dataset was compiled from a selection of agricultural farms whose principal economic activity is the cultivation of raspberries (hereinafter referred to as "selected family holdings"). These farms were identified in accordance with the provisions outlined in the Rulebook on the Methodology for Conducting Advisory Services in Agriculture (Official Gazette No. 65/2014), which constitutes an integral component of the Regulation on the Annual Program for the Development of Agricultural Advisory Services, adopted individually for each calendar year.

Using data from the IPN dataset spanning the 2020–2024 production years, gross margin analysis was employed to assess the economic viability of raspberry cultivation among selected family farms. The dataset encompassed detailed records on cultivated area, yield levels, and variable input costs associated with field-based raspberry production. The data includes the quantity of external work (working days) for each manual operation. On the other hand, family labor costs are a significant factor that influences the overall cost of agricultural production but is often overlooked. Usual methods for evaluation of family labor costs are called market wage substitution method (Picazo-Tadeo et al., 2005) or opportunity cost method (Folbre, 2015). This method assigns a local market wage to the hours worked by family members, treating them as if they were hired labor. Quantity of family labor was calculated by subtracting external working days from total working days, for each operation separately. Quantity of total labor in working days per manual operation was estimated to 95 (w.day/ha) for plantation maintenance, transportaion and other operations and with 50kg/w.day for fruit harvest, using various sources (Veljković et al., 2006; Miljković & Arsić, 2025; Apáti, F., 2014; Institut za voćarstvo, Čačak, 2015; Kljajić et al., 2017) and author's consultations with experts from State funded advisory services from the cities of Belgrade, Kraljevo, Užice, Valjevo and Čačak. The daily wage rates vary depending on the type of agricultural operation, as well as the geographical

location of the farm. The cost of family labor was evaluated based on the wage rate paid by the farm to external labor for the corresponding operation. In cases where no external labor was hired for a specific task, the average daily wage rate of external labor on that farm was used as the valuation basis.

To evaluate the resilience of economic outcomes under uncertainty, a sensitivity analysis was conducted. This involved simulating variations in key parameters—such as working day cost and production value volatility—and quantifying their respective impacts on gross margins. The findings provide insight into the economic performance and risk exposure of selected family raspberry producers, offering a basis for informed decision-making and policy support in the sector. The adopted unit of observation for the analysis is 1 hectare.

Results

Raspberry production in Serbia is conducted under different natural and organizational-economic conditions, with very different variable costs expenditures, which leads to different production and economic results. Table 2 provides an overview of average yields recorded on selected family holdings as well as across Serbia as a whole over the examined five-year period.

Table 2. Average yield of raspberry production in Serbia on selected holdings and in general (2020-2024.)

Yield / Year	2020	2021	2022	2023	2024	2020-2024
Average Yield – Serbia* (kg/ha)	4,939	5,315	5,892	5,189	5,048	5,266
Average Yield – selected holdings (kg/ha)	8,839	9,209	9,831	8,002	10,402	9,240

Source: author's calculation; *SORS data.

There is a marked discrepancy between the average raspberry yield at the national level in Serbia and the yields recorded on selected family farms. Selected family holdings are deliberately chosen based on criteria such as productivity, technological advancement, and their capacity to serve as demonstrative models for best practices. Furthermore, substantial yield variation exists among individual selected family farms themselves, primarily due to mentioned differences in production conditions and cost expenditures. Key contributing factors include agroecological characteristics, access to irrigation, mechanization levels, labor availability, and the degree of adoption of modern cultivation techniques. These disparities underscore the importance of targeted support and knowledge transfer to enhance productivity across the broader sector (Kljajić & Subić, 2022; Mihajlović & Todorov, 2024; Veljković et al., 2024; Grčak et al., 2019).

For the purpose of easier and more detailed explanation of the detected risks in raspberry production in Serbia, the previously mentioned division of risks into five categories will be employed.

Production risks: The selection of raspberry cultivars under specific production conditions significantly influences their resilience to environmental stressors and disease pressure, as well as the yield quantity and fruit quality. Moreover, choosing an appropriate cultivar for a given location affects the timing of ripening and the potential for market placement at higher purchase prices. Based on criteria such as market demand, yield potential, and adaptability to local growing conditions, certain raspberry cultivars are recommended for cultivation in Serbia (Leposavić, 2023).

The risk of disease occurrence and the severity of its impact on yield and plantation—both in terms of production and economic outcomes—depend on a range of factors, some of which are related to production systems, while others stem from human-related risks. Natural conditions for raspberry cultivation represent a critical determinant of production success. Certain natural risk factors can be mitigated or eliminated entirely, while the severity of others can be reduced through the careful selection of an appropriate cultivation site and cultivar.

Market risks in raspberry production in Serbia can be easily depicted with variations in material costs, labour prices for working day (€/w.day), and raspberry prices for chosen time period.

Table 3. Average Raspberry price and external labor daily allowance (2020-2024)

Indicator / Year	2020	2021	2022	2023	2024
Raspberry price (€/kg)	1.82	3.49	4.24	1.80	2.12
Index (2020 = 100%)	100%	192%	249%	97%	128%
Daily allowance (€/working day)	25	30	39	38	42
Index (2020 = 100%)	100%	119%	155%	152%	165%

Source: author's calculation based on IPN database data

Table 3 reveals that, over the observed five-year period, both the purchase price of raspberries and the daily wage rates for external labor were subject to substantial fluctuations. Notably, in 2024, the average daily wage increased by 165%, while the purchase price of raspberries rose by 128%, compared to the baseline year of 2020. These price variations highlight the extent of volatility, which must be considered when conducting risk assessments and sensitivity analyses. During the same period, there were no significant changes in the exchange rate of the Serbian dinar against the euro, with monthly average values ranging between 116.973 RSD/€ and 117.728 RSD/€.

Institutional risks: in raspberry production in Serbia, there are government measures aimed at encouraging the establishment and maintenance of raspberry plantations. These measures include subsidies for the procurement of high-quality planting material, support structures such as poles and wire, irrigation systems, hail protection systems, shading nets, deep soil cultivation, soil analysis, diesel fuel acquisition, as well as basic incentives for crop production. The amount of support depends on the geographical location of the farm and may cover 50% or up to 65% of the purchase

value of the primary input. It is evident that government subsidies play a crucial role in the establishment of plantations, whereas production-related, such as subsidies for incentives are of lesser economic impact.

The most important regulations that define the conditions and levels of agricultural subsidies in raspberry production include: the Rulebook on Defining Areas with Difficult Working Conditions in Agriculture (“Official Gazette of the Republic of Serbia”, No. 132/21); the Rulebook on Incentive Programs for Enhancing Competitiveness through Investments in Physical Assets of Agricultural Holdings, supporting the establishment of perennial fruit and hop plantations (“Official Gazette RS”, No. 17/23); the Rulebook on Incentives for Investments in Physical Assets of Agricultural Holdings for the Procurement of New Machinery and Equipment to Improve Primary Crop Production (“Official Gazette RS”, Nos. 48/18, 29/19, 78/20, and 119/21); the Rulebook on Conditions, Procedures, and Application Forms for Exercising the Right to Insurance Premium Subsidies for Crops, Fruits, Perennial Plantations, Nurseries, and Livestock (“Official Gazette RS”, Nos. 61/17 and 44/18 – amended law).

Personal (human) risks are specific to an individual and include factors like health, relations, motivation, qualification level, working ethics, etc., which could influence farm results.

Worker motivation and training are of critical importance in raspberry production, as errors in performing operational tasks can have adverse effects on plant health and vigor, fruit quantity and quality, labor productivity, and overall production costs. Certain tasks are more sensitive than others, and improper execution may lead to more pronounced consequences and elevated risk levels.

Financial risks: in Serbia, various financing mechanisms are available for raspberry production on family farms. These include self-financing, subsidized loans provided by the Ministry of Agriculture, Forestry and Water Management and local municipalities, commercial bank loans, as well as financing from cold storage operators for the procurement of fertilizers, plant protection products, and occasionally planting material. Survey results indicate that raspberry producers rarely utilize commercial loans due to high interest rates. Subsidized loans are used when available. On mixed farms with multiple production lines, self-financing is commonly practiced, often without proper cost tracking. Family holdings frequently rely on financing from cold storage operators, with debt repayment made in the form of agricultural products.

Table 4. Some frequent risks in raspberry production in Serbia

Risk	Frequency of occurrence	Damage	Possible losses (%)	Method of reducing risk
Hail occurrence	Occasional, depends on geographical area	Damage to shoots and berries	Damage to 20% shoots, yield reduction 40% - 80%	Anti-hail nets
Sunburn / sunscald	Every year	Fruits and leaves damage, reduced fruit quality	Yield reduction of up to 20%, increase in the share of II Class fruit	Shade nets
Drought	Every year	Drying of shoots, reduction in fruit mass and quantity	Yield reduction of up to 50%	Introduction of an irrigation system
Excessive rainfall	Occasional	Drying of shoots, weaker shoot growth, risk of root disease, fruit rot	Yield reduction of 30% - 80%	Selection of orchard location and soil, soil preparation before planting, raising orchards on berms / beds on flatter terrain
Labor: availability, lack of motivation, lack of training, absenteeism	Every year	Yield reduction via a decrease in the quantity of harvested fruit	Yield reduction of up to 25%	Establish orchards on smaller areas or introduce mechanized harvesting where possible
Labor: religious holidays	Every year, in some areas	Harvest delay, irregular harvesting	Yield reduction of up to 20%	?
Risk of making incompetent decisions, failure to follow expert advice (inadequate and excessive fertilizing and irrigation, etc.)	Every year	Drying of shoots	Yield reduction of 10% - 30%, or more in unfavorable years	Continuous education of agricultural producers
Raspberry price unpredictability	Every year	Negative economic results	Change in family holding income $>\pm 50\%$	Product and production diversification

Source: Questionnaire, 2025.

The survey, conducted through questionnaires among selected Serbian agricultural advisory services, enabled the identification of the predominant risks associated with raspberry production, which are summarized in Table 4. Analysis of Table 1 and 4 further

indicates that risk factors are not uniformly distributed across production systems. Risks arising from natural conditions for raspberry cultivation are more pronounced in extensive systems, whereas price fluctuations exert a stronger impact on economic outcomes in intensive systems, reflecting the larger production scale per unit area.

Drawing on the compiled data regarding variable costs and the estimated value of family labor, the gross margin was calculated for the examined period, with results presented in Table 5.

Table 5. Gross margin calculation for selected family holdings (2020-2024)

Indicator / Year	2020	2021	2022	2023	2024	2020-2024
Number of family holdings	285	221	193	139	181	1019
Production area (ha)	201.9	139.0	110.7	82.2	104.5	638.4
Average Yield (kg/ha)	8,839.6	9,209.0	9,831.5	8,001.6	10,401.9	9,239.9
Average Income (€/ha)	16,078.5	32,136.9	41,714.0	14,439.3	22,037.1	24,785.3
Average incentives (€/ha)	192.2	110.5	61.9	160.5	236.7	155.0
Average income with incentives (€/ha)	16,270.7	32,247.5	41,775.9	14,599.8	22,273.8	24,940.3
Material Costs (€/ha)	1,303.4	2,166.2	2,001.2	1,674.4	1,244.0	1,650.3
External labour costs (€/ha)	4,092.9	4,973.6	5,651.7	4,629.2	7,039.5	5,106.5
Family labor costs (€/ha)	2,337.2	2,897.9	4,855.2	4,052.7	4,740.9	3,510.5
Mechanization services (€/ha)	9.5	-	22.9	11.6	93.2	23.7
Other variable costs (€/ha)	178.6	124.4	28.6	3.6	84.3	102.8
Variable costs without family labour (€/ha)	5,584.3	7,264.2	7,704.4	6,318.8	8,460.9	6,883.4
Variable costs - Total (€/ha)	7,921.5	10,162.1	12,559.6	10,371.5	13,201.9	10,393.8
Gross Margin - without family labor (€/ha)	10,686.4	24,983.3	34,071.5	8,281.0	13,812.9	18,056.9
Gross Margin without family labor (€/kg)	1.21	2.71	3.47	1.03	1.33	1.95
Gross Margin -Total (€/ha)	8,349.2	22,085.4	29,216.3	4,228.2	9,071.9	14,546.4
Gross Margin - Total (€/kg)	0.94	2.40	2.97	0.53	0.87	1.57

Source: author's calculation

Variable costs excluding family labor expenses ranged from €5,584.3/ha in 2020 to €8,460.9/ha in 2024. Total variable costs during the same period ranged from €7,921.5/ha (2020) to €13,201.9/ha (2024), with a five-year average of €10,393.8/ha. The gross margin excluding family labor costs was lowest in 2023, amounting to €8,281.0/ha, equivalent to €1.03/kg of raspberries, and highest in 2022, amounting to €34,071.5/ha, or €3.47/kg of produced raspberries. When family labor costs are included, the lowest coverage margin was €4,228.2/ha, or €0.53/kg in 2023, and the highest was €29,216.3/ha, or €2.97/kg in 2022. The five-year average gross margin, including family labor costs, amounted to €18,056.9/ha, or €1.57/kg of produced raspberries.

When observing the share of individual cost components within total variable costs, it is evident that labor expenses accounted for the largest proportion, ranging from 77.5% to 89.2%, with an average of 82.9% over the five-year period under analysis. On the other hand, when examining the factors that determined the production value, it is evident that price fluctuations were significantly more pronounced than yield variations.

The preceding analysis indicates that labor costs and raspberry prices represent the most volatile variables, exerting the greatest influence on gross margin outcomes. For the sensitivity analysis, a baseline scenario was established with labor costs of €12,000€ per hectare and a raspberry price of €2.70 per kilogram. The average yield was set at 9 t/ha, while other variable costs were assumed to amount to €1,700 per hectare. This baseline reflects recent production conditions and is considered representative for projections in the near future.

Table 6. Sensitivity analysis of gross margin in raspberry production (€/kg)

Raspberry price (€/kg) / Labour Costs (€/ha)		-60%	-40%	-20%	Base price	20%	40%	60%
		1.08	1.62	2.16	2.7	3.24	3.78	4.32
-30%	8,400	-0.01	0.50	1.04	1.58	2.12	2.66	3.20
-20%	9,600	-0.14	0.36	0.90	1.44	1.98	2.52	3.06
-10%	10,800	-0.28	0.23	0.77	1.31	1.85	2.39	2.93
Base cost	12,000	-0.41	0.10	0.64	1.18	1.72	2.26	2.80
10%	13,200	-0.54	-0.04	0.50	1.04	1.58	2.12	2.66
20%	14,400	-0.68	-0.17	0.37	0.91	1.45	1.99	2.53
30%	15,600	-0.81	-0.30	0.24	0.78	1.32	1.86	2.40

Source: author's calculation

As presented in Table 6, gross margin remains positive across a broad range of feasible parameter combinations, reaching 1.18€/kg under the reference scenario with labor costs of 12,000 €/ha and a raspberry price of 2.70 €/kg. In contrast, a 60% reduction in the raspberry price under baseline labor costs results in a negative gross margin of -0.41 €/kg. When the baseline price of 2.70 €/kg is combined with a 30% increase in labor costs, the gross margin remains positive at 0.78 €/kg. Conversely, a 40% decline in raspberry price coupled with a 10% increase in labor costs drives the gross margin slightly below zero (-0.04 €/kg).

Discussions

The results of the present study demonstrate that raspberry production on selected family farms in Serbia can generate a positive gross margin over the observed five-year period, averaging €14,546/ha or €1.57/kg of raspberries. Nevertheless, significant inter-annual fluctuations were recorded, with margins ranging from as low as €0.53/kg in 2023 to €2.97/kg in 2022. These variations confirm the high sensitivity of profitability to changes in labor costs and raspberry purchase prices. Labor costs alone accounted for more than 80% of total variable costs, highlighting their critical role in the economic performance of farms. Sensitivity analysis showed that even moderate changes in key

parameters—such as a 20–30% decline in farm-gate price or increase in labor costs—could shift gross margins into negative values.

When compared to international research, similar patterns emerge. Wróblewska, Pawlak, and Paszko (2019) reported that in Poland, Serbia, and Ukraine, the main drivers of profitability were fluctuations in the farm-gate price of raspberries and the high share of manual labor in total costs. However, Poland benefits from somewhat lower labor costs and higher mechanization, which partially offsets price volatility. In Hungary, Apáti (2014) emphasized that profitability is strongly dependent on the intensity of the production system, with high-input plantations achieving above-average yields but simultaneously being more exposed to climatic and market risks. These findings correspond closely to the present results, where higher yields on selected family holdings secured higher margins, but only under favorable price and labor cost conditions.

The differences between extensive, semi-intensive, intensive, and super-intensive systems, as outlined in Serbian and regional studies (Veljković et al., 2008; Kljajić & Subić, 2022), further confirm that production intensity is a double-edged sword: while it increases potential yields (up to 20–25 t/ha under optimal agro-technical measures), it also amplifies exposure to risk due to higher fixed and variable costs. The average yield of 8.9 t/ha reported in this study is above the Serbian national average of around 5.3 t/ha (SORS data), which is logical given that these holdings were selected by agricultural advisors as leaders in their specific region, indicating that they are more technologically advanced and better organized.

Several studies emphasize that the appropriate application of agrotechnical measures and the choice of suitable cultivars significantly improve profitability. Radosavljević (2016) demonstrated that proper agronomic practices can double yields from 7 t/ha to 13 t/ha on family farms, while Milić et al. (2019) confirmed the profitability of raspberry production in Vojvodina, where mechanized harvesting reduced labor costs and allowed profits of around €5,940/ha. These findings highlight the critical role of technology adoption in improving gross margins, especially in regions outside the traditional raspberry-producing areas of Western Serbia.

Risk analysis also shows strong alignment with earlier studies. Jirgena et al. (2013) documented that climatic and market shocks are the most destabilizing factors in berry production across Europe. In Serbia, drought, hail, and sunburn remain frequent and damaging risks (Veljković et al., 2006; Laposavić, 2023). The present study confirms that climate variability significantly impacts production results, while institutional risks—such as subsidy changes and unstable policy frameworks—continue to create additional uncertainty.

Institutional support, in the form of subsidies and regulatory frameworks, plays an important stabilizing role. Radosavljević (2016) emphasized the need for targeted policy measures to support small family farms, while recent analyses (Official Gazette RS, 2017–2023) show that subsidies for planting material, anti-hail nets, irrigation systems, and basic crop incentives are crucial for reducing establishment costs. Without such instruments, the economic viability of raspberry production would be significantly threatened, particularly under rising labor costs.

Overall, this study contributes to the literature by quantifying the gross margins and demonstrating, through sensitivity analysis, just how fragile profitability can be under realistic variations of key parameters. Compared with the international and domestic literature, the results highlight both the strengths (relatively high yields on advanced family farms) and weaknesses (overdependence on labor and volatile farm-gate prices) of the Serbian raspberry sector.

Conclusions

The analysis of gross margins in raspberry production on selected family farms in Serbia confirms that this sector remains profitable on average, but it is highly sensitive to changes in prices and labor costs. The dominance of labor expenses—exceeding 80% of total variable costs—makes the system particularly vulnerable to rising wages and labor shortages. When compared to studies from Poland, Hungary, and Ukraine, it is evident that Serbian producers face similar structural challenges but with higher exposure to risk due to limited mechanization and high labor intensity (Wróblewska et al., 2019; Apáti, 2014). Domestic research further confirms that profitability can be ensured only through the consistent application of advanced agro-technical practices, adoption of mechanization where possible, and adequate institutional support (Radosavljević, 2016; Milić et al., 2019; Kljajić & Subić, 2022).

The sensitivity analysis revealed a wide range of practically attainable values for the gross margin. Most of the simulated scenarios yielded positive outcomes, while a smaller portion resulted in negative or near-zero margins. These findings suggest a potentially favorable position for the selected agricultural holdings in Serbia. However, for more precise conclusions, it is essential to consider farm size, total production costs, and investment calculations.

For long-term sustainability, it is necessary to develop systemic instruments for risk management, such as crop insurance schemes, producer cooperatives, and stabilization funds, while simultaneously promoting technological modernization and labor-saving innovations. Only through such measures can the Serbian raspberry sector maintain competitiveness in an increasingly volatile global market.

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Conflict of interests

The authors declare no conflict of interest.

References

1. Andrei, J. V., & Darvasi, D. (2012). Perspectives and challenges in financing the new Common Agricultural Policy, a new paradigm. *Journal of Food, Agriculture & Environment*, 10 (1) No. 1 part 2, 904-907.
2. Apáti, F. (2014). Economic Evaluation of Hungarian Raspberry Production. *International Journal of Horticultural Science* 2014, 20(3-4): 53–56. Doi: <https://doi.org/10.31421/IJHS/20/3-4/1135>
3. Erokhin, V., Tianming, G., Chivu, L., & Andrei, J. V. (2022). Food security in a food self-sufficient economy: A review of China’s ongoing transition to a zero hunger state. *Agricultural Economics/Zemědělská Ekonomika*, 68(12).
4. Folbre, N. (2015). Valuing non-market work. UNDP Human Development Report Office, Think Piece. Retrieved from <https://hdr.undp.org/system/files/documents/folbrehdr2015final.pdf>
5. Grčak D., Grčak M., Grčak D., Đekić V., Aksić M., Nikolić K., Gudžić S. (2019): The raspberry: An analysis of production in the Republic of Serbia from 2006 to 2016. *Acta agriculturae Serbica*, 24(47), 19-25. Doi: <https://doi.org/10.5937/AASer1947019G>.
6. Hardaker, B. (2016). Comment 2 on ‘Risk and uncertainty’ by Quiggin and Anderson. *Australian Journal of Agricultural and Resource Economics*, 60(4), 552–553. Doi: <https://doi.org/10.1111/1467-8489.12184>
7. Institut za voćarstvo, Čačak. (2015). Elaborat zasnivanja i održavanja zasada maline (Izveštaj projekta: Tehničko-tehnološki modeli intenzivnih zasada voćaka i jačanje ljudskih kapaciteta u funkciji unapređenja voćarske proizvodnje Republike Srbije). Ministarstvo poljoprivrede i zaštite životne sredine Republike Srbije. [in English: Institute of Fruit Growing, Čačak. (2015). Establishment and maintenance of raspberry orchards (Project report: Technical-technological models of intensive fruit orchards and strengthening human capacities for the improvement of fruit production in the Republic of Serbia). Ministry of Agriculture and Environmental Protection of the Republic of Serbia].
8. Jakovljević, N., Dmitrović, V., & Jeremić, N. . (2025). Triple materiality: concept, structure and perspective. *BizInfo Blace*, 16(2), 93-98. <https://doi.org/10.71159/bizinfo250022J>
9. Jirgena, H., Hazners, J., Kaufmane, E., Strautina, S., Feldmane, D., & Skrivele, M. (2013). “Risks and Returns in Strawberry, Raspberry and Cherry Production with Various Methods.” *Economics and Rural Development* 9(2): 16–26. Retrieved from <https://portalcris.vdu.lt/server/api/core/bitstreams/f7c7d222-3000-4d6b-ad2c-95299ea1b4de/content>.
10. Kljajić, N. & Subić, J. (2022). Economic Effects of Raspberry Production on the Family Farm. In *Agrarian Economy and Rural Development – Trends and Challenges*. International Symposium, 13th Edition, edited by Steliana Rodino and Vili Dragomir: 31–39. Bucharest: ICEADR. Retrieved from <https://symposium.iceadr.ro/archive/archive/>

11. Kljajić, N., Subić, J., & Sredojević, Z. (2017). Profitability of raspberry production on holdings in the territory of Arilje. *Economics of Agriculture*, 64(1), 57–68. Doi: <https://doi.org/10.5937/ekoPolj1701057K>
12. Knight, F. H. (1921). *Risk, uncertainty and profit* (Vol. 31). Houghton Mifflin. Retrieved from: https://oll-resources.s3.us-east-2.amazonaws.com/oll3/store/titles/306/Knight_0192_EBk_v6.0.pdf
13. Komarek, A. M., De Pinto, A. & Smith, V. H. (2020). A review of types of risks in agriculture: What we know and what we need to know. *Agricultural Systems*, 178, 102738. Doi: <https://doi.org/10.1016/j.agsy.2019.102738>
14. Leposavić, A. (2023). *Savremena proizvodnja maline*. Institut za voćarstvo, Čačak, Poljoprivredni fakultet, Kruševac. [in English: Leposavić, A. (2023). *Modern Raspberry Production*. Institute of Fruit Growing, Čačak, Faculty of Agriculture, Kruševac]. ISBN: 978-86-920869-3.
15. Mihajlović, M., & Todorov, J. (2024). Analiza uticaja nedostatka resursa i satisfakcija stanovništva. *Održivi razvoj*, 6(1), 47-62. <https://doi.org/10.5937/OdrRaz2401047M>
16. Milić, D., Užar, D., Radojević, V., Đajić, S. & Zekić, V. (2019). Ekonomski efekti proizvodnje maline na porodičnom gazdinstvu na teritoriji AP Vojvodine. *Agroekonomika* 85, 43–53. [in English: Milić, D., Užar, D., Radojević, V., Đajić, S., & Zekić, V. (2019). Economic effects of raspberry production on family farms in the territory of AP Vojvodina. *Agroekonomika*, 85, 43–53.] Retrieved from https://agroekonomika.rs/images/Brojevi/ae85/Agroekonomika_85.pdf
17. Miljković, M., & Arsić, I. (2025). Determinisanje promena organizaciono-upravljačkih procesa u sistemu upravljanja. *Finansijski Savetnik*, 30(1), 55-74. <https://fa-journal.com/index.php/fa/article/view/3>
18. Picazo-Tadeo, A., J. & Reig-Martínez, E. (2005). Calculation of shadow wages for family labour in agriculture: An application to citrus farming in Spain. *Cahiers d'Economie et de Sociologie Rurales*, 75, 5-21. Doi: <https://doi.org/10.22004/ag.econ.201781>
19. Popescu, G., & Andrei, J. (2011). From industrial holdings to subsistence farms in Romanian agriculture. Analyzing the subsistence components of CAP. *Agricultural Economics*, 57(11), 555.
20. Radosavljević, K. (2016). Enhancing agri-competitiveness: A cost-benefit analysis of raspberry production on a family farm. *Economics of Enterprise*, 64(7-8), 492-498. Doi: <https://doi.org/10.5937/ekopre1608492R>
21. Republic of Serbia. (2017). Rulebook on Conditions, Procedures, and Application Forms for Exercising the Right to Insurance Premium Subsidies for Crops, Fruits, Perennial Plantations, Nurseries, and Livestock. Official Gazette RS, No. 61/17.
22. Republic of Serbia. (2018). Rulebook on Conditions, Procedures, and Application Forms for Exercising the Right to Insurance Premium Subsidies for Crops, Fruits, Perennial Plantations, Nurseries, and Livestock (Amended). Official Gazette RS, No. 44/18.

23. Republic of Serbia. (2018). Rulebook on Incentives for Investments in Physical Assets of Agricultural Holdings for the Procurement of New Machinery and Equipment to Improve Primary Crop Production. Official Gazette RS, No. 48/18.
24. Republic of Serbia. (2019). Rulebook on Incentives for Investments in Physical Assets of Agricultural Holdings for the Procurement of New Machinery and Equipment to Improve Primary Crop Production. Official Gazette RS, No. 29/19.
25. Republic of Serbia. (2020). Rulebook on Incentives for Investments in Physical Assets of Agricultural Holdings for the Procurement of New Machinery and Equipment to Improve Primary Crop Production. Official Gazette RS, No. 78/20.
26. Republic of Serbia. (2021). Rulebook on Defining Areas with Difficult Working Conditions in Agriculture. Official Gazette RS, No. 132/21.
27. Republic of Serbia. (2021). Rulebook on Incentives for Investments in Physical Assets of Agricultural Holdings for the Procurement of New Machinery and Equipment to Improve Primary Crop Production. Official Gazette RS, No. 119/21.
28. Republic of Serbia. (2023). Rulebook on Incentive Programs for Enhancing Competitiveness through Investments in Physical Assets of Agricultural Holdings, Supporting the Establishment of Perennial Fruit and Hop Plantations. Official Gazette RS, No. 17/23.
29. Veljković, B., Glišić, I., & Laposavić, A. (2008). An analysis of raspberry production conditions in Serbia. *Acta Agriculturae Serbica*, 13(25), 9–16. Retrieved from https://www.researchgate.net/publication/268409685_An_Analysis_of_Raspberry_Production_Conditions_in_Serbia
30. Veljković, B., Marković D., Koprivica R. & Gavrilović M. (2024). Calculations in raspberry production on family farms in Western Serbia. In *Proceedings of the 2nd International Symposium on Biotechnology*: 175–181. Doi: <https://doi.org/10.46793/sbt29.23bv>
31. Wróblewska, W., Pawlak, J. & Paszko, D. (2019). Economic Aspects in the Raspberry Production on the Example of Farms from Poland, Serbia and Ukraine. *Journal of Horticultural Research*, 27(2), 71-80. Doi: <https://doi.org/10.2478/johr-2019-0019>
32. Вељковић, Б., Петровић, С., Лепосавић, А. & Глишић, И. (2006). Профитабилност производње малине на подручју Србије. *Економика пољопривреде*, 53(4), 1013-1022. [in English: Veljković, B., Petrović, S., Laposavić, A., & Glišić, I. (2006). Profitability in raspberry production in Serbia. *Economics of Agriculture*, 53(4), 1013–1022.] Retrieved from <https://ea.bg.ac.rs/index.php/EA/article/view/1415/1202>