ORGANISATIONAL AND ECONOMIC INDICATORS OF GRAPE PRODUCTION: THE CASE OF THE SERBIAN AUTOCHTHONOUS GRAPEVINE VARIETY PROKUPAC

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ABSTRACT

Improvements in the quality of Serbian wines and the growing recognition of the domestic wine sector have created more favourable conditions for investment in new vineyards. The economic sustainability of grape production depends on suitable production conditions, while increasing attention is given to autochthonous varieties, particularly Prokupac, which is used to produce red and rosé wines. This study analyses the organisational and economic indicators of Prokupac grape production and evaluates the economic feasibility of establishing new vineyards. Based on field data collected in the Šumadija wine-growing region (PDO), the analysis uses a technological production chart, analytical cost calculation, and three dynamic investment appraisal methods: Net Present Value (NPV), Internal Rate of Return (IRR) and Dynamic Payback Period (DPP). The results show a positive financial result of EUR 2,727.52/ha, with labour accounting for 50.06% of production costs. The investment indicators suggest economic feasibility under the assumed conditions.

Introduction

Viticulture has a long tradition in the Republic of Serbia and represents a very important branch of agriculture. The success of grape production depends on numerous factors, primarily natural conditions (climate, soil, etc.), but also organisational and economic factors (Dimitrijević et al., 2018). Investments in vineyard establishment

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require substantial financial resources, while the investment payback period may be considerably longer compared to some other perennial plantations (Sredojević et al., 2015; Petrović et al., 2025). Due to the specific characteristics of grape production, particularly the production conditions that vary considerably between different regions, production costs, labour organisation and investments in the establishment of new vineyards may also differ significantly (Stevanović et al., 2018; Schwerz et al., 2023). For these reasons, it is necessary to examine the organisational and economic indicators of grape production.

Regarding global grape production, it is noticeable that the total area under vineyards has gradually declined in recent years. The tendency for the reduction in vineyards has been identified within the last ten years. Based on the numbers provided by the International Organisation of Vine and Wine (OIV), the global area of vineyards stood at 7.09 million hectares in 2024. In comparison with 2020, it has decreased by 4.05%, and in contrast with 2015 by 4.76%. Even though the area under cultivation of grapes has been declining, the total grape production has been quite steady. Total grape production in 2024 was 77.73 million tonnes, representing about 0.7% more compared to 2015 (OIV, 2025). The major producers of grapes in the world include China (producing 17 million tonnes), Italy (with 7.3 million tonnes), and USA (producing 6.4 million tonnes) (OIV, 2025). Out of the total grape production across the world in 2024, about 47% was used in the production of wine and grape must and juice. The rest of the grape quantity was used for different purposes, out of which 46% was used as fresh grapes, while 7% of the grapes were used for the production of raisins (OIV, 2025; Agulheiro-Santos et al., 2021). However, in Europe, the majority of grapes harvested are used for wine-making purposes, whereas in Asia, the harvest of table grapes and grapes to be dried takes place much more often. It is these diverse uses that explain the significance of grapes as the raw material used in the food processing industry, the importance of grape production going far beyond agriculture (Alston & Sambucci, 2019).

These developments point to an increasing role of productivity and efficient land use in contemporary grape cultivation, leading to increased yield (Ohana-Levi & Netzer, 2025). However, at the same time, fluctuations in prices were registered over the period under analysis, as the prices of energy and mineral fertilizers went up. The biggest rise in the prices of inputs and thus costs of grape cultivation occurred in 2020-2022 and was associated with market disruptions because of the COVID-19 pandemic and military conflict around the globe (Ben Hassen & El Bilali, 2022; Belewu et al., 2024). Moreover, impacts of climate change in the form of drought are likely to further raise the prices of agricultural and food products (Accetturo & Alpino, 2023; Oo, 2026). At the same time, disturbances in international supply chains were noticed, leading to increased costs of agricultural production (Bodnár & Schuler, 2022; Kuik et al., 2024). It is necessary to point out that the impact of individual factors mentioned above was not estimated separately in this research, and the factor, which impacted the changes on the market the most, was not defined. Due to the mentioned market changes, the overall value of global grape production also increased (Table 1).

Table 1. Global value of grapes production (billion USD, current prices)

Element/year	2015	2016	2017	2018	2019	2020
Value	64.67	64.36	69.10	73.23	74.51	81.99
Element/year	2021	2022	2023	2024	Average	
Value	84.79	81.99	103.58	97.30	79.55	

Source: FAOSTAT, 2026.

Regarding the viticulture sector in the Republic of Serbia, it has undergone significant structural changes over a long period. These changes are primarily reflected in the reduction of vineyard areas and the number of agricultural holdings engaged in grape production. In 2023, the total area under vineyards in the Republic of Serbia decreased by 17.8% compared to 2012, while the number of agricultural holdings engaged in grape production declined by approximately 34.6% (SORS, Census of Agriculture, 2024). The same census also shows that the average vineyard area per agricultural holding increased from approximately 0.28 ha to 0.35 ha, which still represents a relatively small landholding (Ivanišević et al., 2015; SORS, 2024). According to available data from the Statistical Office of the Republic of Serbia, the productive vineyard area in 2025 amounted to 17,437 ha, while total grape production reached 140,718 tonnes, with an average yield of 8.1 t/ha. In 2024, total grape production amounted to 129,739 tonnes, with 17,719 ha of productive vineyards and an average yield of 7.3 t/ha. Accordingly, grape production increased by approximately 8.5% in 2025, despite a slight reduction in the productive vineyard area (SORS, 2026).

There are 22 wine-growing region identified in the Republic of Serbia, among them, there is the Šumadija wine-growing region (Protected Designation of Origin - PDO) which includes the territory of the area where the surveyed producers are situated. Šumadija wine-growing region was chosen as the research area since the production of grapes has a long tradition in this region, which also possesses the favourable natural conditions for the cultivation of grapes. According to the Census of Agriculture (SORS, 2013), the Šumadija wine-growing region included 1,119.79 ha of vineyards and approximately 5,000 agricultural enterprises, of which most were engaged in the cultivation of grapes for winemaking purposes. The municipality of Topola belonging to the Oplenac wine-growing subregion possessed the largest area of vineyards (Jakšić, 2014). According to the Census of Agriculture (SORS, 2024), Topola Municipality had the largest number of agricultural holdings with vineyards (781), followed by Kragujevac. Furthermore, the Šumadija wine-growing region has a relatively large number of wineries which play an important role in the purchase of grapes from local producers. Some of the developments that have occurred in recent years include the creation of new vineyards, better quality plant material, the use of mechanized operations, and improvements to the training of the vines on the trellis system. These changes are associated with a growing focus on the production of higher-quality grapes and wines (Jakšić et al., 2023). These developments also help explain why increasing attention has been paid to the promotion of wines produced from local and autochthonous grapevine varieties in Serbia in recent years. In the long term, increasing the area under vineyards planted with autochthonous

grapevine varieties, as well as producing wines from these varieties, may contribute to greater market recognition and improved competitiveness of domestic grape and wine producers (Petrović et al., 2024; Tello et al., 2024; Jeločnik et al., 2024a).

In addition to natural conditions, socio-economic factors may also have a significant influence on business performance in grape production. These primarily include the size of farms, labour availability, the level of mechanisation, access to processing facilities and distance from markets (Gogić, 2010a). Other factors that may also have an influence include input procurement conditions, agricultural policy measures and the availability of financing sources. Furthermore, organisational factors may also affect business performance, as they provide the basis for efficient and economically viable production (Kalanović et al., 2007). To ensure such production, farm managers and decision-makers must organise and carry out all production operations in a timely manner, while ensuring sufficient labour and the necessary production inputs (Dimitrijević et al., 2019; McCorkle et al., 2019). All these factors must be analysed when making decisions about investments in vineyard establishment, as the economic benefits are realised over a long period (Kalanović Bulatović & Milić, 2014; Signorini et al., 2022; Tingey-Holyoak et al., 2024). Research conducted in Serbia indicates that subsidies can significantly influence the economic efficiency of vineyard establishment and facilitate the financing of investments on agricultural holdings (Vasiljević et al., 2017). In addition, well-developed processing facilities and opportunities to combine grape production with winemaking enable the creation of added value and may positively influence the economic sustainability of production (Jeločnik et al., 2024b). Therefore, a comprehensive analysis of work organisation, production costs and required investment expenditure is necessary to assess the economic viability of grape production. Based on the above, the main objective of this research is to analyse the organisational and economic indicators of Prokupac grape production. Particular attention will be given to work organisation, production costs and investment assessment, as well as determining the economic feasibility of establishing new vineyards planted with this autochthonous grapevine variety. The obtained results may provide useful information for grape growers, wine producers and agricultural policymakers, contributing to investment decisions based on relevant data and the long-term economic sustainability of production.

Materials and Methods

For this study, data was gathered using surveys and interviews with grape growers from the Šumadija wine-growing region (PDO). Production conditions for the companies were very similar, and the expected period of vineyard exploitation was set at 40 years. After the vineyard entered into full production, grape yield and selling price, as well as costs of production, were supposed to stay at the same level until the 35th year of vineyard exploitation, when the yield would begin to decrease. With regard to the residual value of the vineyard in the final year of vineyard exploitation, it was assumed that the value of physical assets would be very small, while the residual value

of the investment would be equal to the total working capital invested. The value of the permanent working capital at the end of the year of vineyards' use was taken into account as cash flow. One should add that all calculations were done without any support, meaning that all investments would have been covered by the producer's own money. Moreover, one should say that all calculations are concerned with grapes meant for the production of high quality wine, including geographically identified ones, and hence, their yield is rather low but the price is higher. However, the calculations are concerned only with the production of grapes and possible earnings connected with it, but not with winemaking or geographically indicated products. Acquisition cost of the land was not considered while calculating the investments. Additionally, irrigation system, anti-hail nets and other investments were not included in the calculations since the surveyed producers do not use them. The surveyed producers generally do not insure their grape production or vineyards, which may, to some extent, affect certain economic indicators, particularly considering the increasingly pronounced impacts of climate change, as agricultural insurance may help mitigate the associated risks (Petrović et al., 2020). It is also important to note that producers have sufficient access to both family and hired labour and use their own agricultural machinery. The analytical cost calculation also included the costs of family labour, determined on the basis of total annual labour input, expressed in working days, with family labour valued at the same wage rate as hired (paid) labour. The costs of using the producers' own agricultural machinery included fuel, maintenance, and depreciation costs.

The methodology involved the development of a technological production chart covering all agricultural operations performed during the regular production cycle, as well as an analytical calculation of production costs. These calculations provided the basis for estimating investment expenditure and applying dynamic methods to appraise investments in the establishment of perennial plantations (Gogić, 2014; Ivanović & Marković, 2018; Ivanović & Todorović, 2024). The following dynamic methods were applied to assess investment efficiency: Net Present Value (NPV), Internal Rate of Return (IRR), and Dynamic Payback Period (DPP). The calculations were based on the assumption that the investment assessment is performed at the beginning of vineyard establishment. The analysis covered the entire 40-year vineyard exploitation period, allowing investment costs and benefits to be assessed over the productive lifespan of the vineyard. The total investment required to establish 1 ha of vineyard with the Prokupac grapevine variety was determined as the sum of investments in fixed capital and permanent working capital. The required permanent working capital was calculated based on annual production costs, the period during which funds are tied up, and the corresponding turnover ratios, following the methodology of Gogić (2014). Alternatively, the required investment in permanent working capital can be estimated by assuming that it amounts to 10% of the investment in fixed assets, or 20% in the case of investments in perennial plantations. However, a more detailed calculation methodology was applied in this study, allowing for a more precise determination of the required investment in permanent working capital by taking into account the specific characteristics of the

production process, the period during which funds are tied up, and the corresponding turnover ratios. Investment in fixed capital was determined based on the costs incurred during the vineyard establishment period (from Year 0 to Year 3), capitalised at an annual intercalary interest rate of 2.75% to account for the opportunity cost of using the producer's own financial resources. The net value of production generated in Year 3, after deducting harvesting and transportation costs, was offset against the calculated investment costs, thereby covering most of the costs incurred in that year. Year 3 marks the end of the investment period, as the vineyard reaches full production capacity in Year 4, when the value of production exceeds total production costs. Static methods of investment assessment were not applied due to the long exploitation period of vineyards. It is also important to emphasise the specific characteristics of grape production when analysing these indicators, particularly the fact that grape yields are absent or very limited during the initial years of vineyard exploitation, while certain production costs are still incurred (Gogić, 2010b; Carbone et al., 2019). All calculations and data were expressed per hectare of vineyard, while monetary values were presented in euros (EUR), using an exchange rate of 1 EUR = 117.3652 RSD.

The results of the research provide information to support decision-making regarding investments in the establishment of new vineyards, as well as the identification of key factors that may influence the achievement of positive business performance in grape production. Potential research limitations primarily relate to the use of data collected from only one wine-growing region, although the proposed analytical model can be applied to any other wine-growing region. Another limitation concerns the assumption that grape prices and production costs remain constant throughout the observed period. This is particularly relevant considering global changes in agricultural and food commodity prices, as well as the increasing promotion of wines produced from the autochthonous Prokupac grapevine variety, which may lead to higher market prices for grapes of this variety. Furthermore, the exclusion of subsidies and other forms of financial support from the calculations represents an additional limitation, as access to such support could significantly improve both business performance indicators and the economic efficiency of the investment compared with the obtained results. Lastly, the outcome of the research can be influenced by the wine-growing zone where production occurs, the methods used during production, the type of grapevine used, how the investment is financed, the qualification for subsidies and other incentives, among others.

Results and Discussion

Technological production chart embraces all agricultural operations carried out during one cycle of production and the frequency of their execution, labour input and agricultural machinery used. Moreover, the technological chart takes into account work performance indicators including the precise time needed for performing each particular operation. It provides an opportunity for deeper analysis of the technological and organisational requirements of production and helps to obtain the indicators serving as a basis for analysis of production costs and then estimation of economic efficiency of

investments in the establishment of the vineyard. The interviewed producers have the required agricultural machinery and enough number of labour force, both family and hired one, that allows carrying out all the operations timely. These conditions create the basis for successful production of grapes. The average density of planting is 4,400 vines per hectare, which was taken as a basis for cost calculation and investment analysis. In addition, the grape yield was limited to provide production of high-quality grapes and its average yield per the interviewed producers is 9,645.25 kg/ha that corresponds to approximately 2.2 kg per vine.

Table 2. Schedule of Vineyard Operations and Input Requirements for Prokupac Grape Production (1 ha)

Operation	Timing	Extent	Workers	Labour (worker-days/ha)	Labour (h/ha)	Machinery (h/ha)
Mechanical pre-pruning	Jan–Feb	1 pass	1	0.48	4.76	4.76
Manual winter pruning	Jan–Feb	1 pass	1	9.09	90.91	–
Shredding of prunings	Feb	1 pass	1	0.18	1.82	1.82
Replacement of posts and wire tensioning	Mar	1 pass	2	3.08	30.77	–
Cane bending and tying	Mar	1 pass	1	4.17	41.67	–
Shallow soil cultivation	Mar–Apr	1 pass	1	0.16	1.64	1.64
Plant-protection spraying	Apr	1 pass	1	0.21	2.08	2.08
Loading, transport and unloading of mineral fertiliser	Apr	0.25 t	3	0.05	0.50	0.17
Loading and spreading of mineral fertiliser	Apr	1 pass	1	0.16	1.63	1.63
Inter-row mowing	May	1 pass	1	0.15	1.54	1.54
Shallow soil cultivation	May	1 pass	1	0.20	1.95	1.95
Shoot thinning	May	1 pass	1	5.88	58.82	–
Shoot positioning in trellis	May	1 pass	1	4.00	40.00	–
Plant-protection spraying	May	2 passes	1	0.42	4.17	4.17
Shoot thinning	Jun	1 pass	1	5.00	50.00	–
Mechanical green pruning	Jun	1 pass	1	0.48	4.76	4.76
Plant-protection spraying	Jun	3 passes	1	0.62	6.25	6.25
Shallow soil cultivation	Jun	1 pass	1	0.20	1.95	1.95
Inter-row mowing	Jul	1 pass	1	0.15	1.54	1.54
Lateral shoot tipping	Jul	1 pass	1	5.00	50.00	–
Plant-protection spraying	Jul	2 passes	1	0.42	4.17	4.17
Manual leaf removal	Jul	1 pass	1	5.00	50.00	–
Inter-row mowing	Aug	1 pass	1	0.15	1.54	1.54
Cluster thinning	Aug	1 pass	1	6.67	66.67	–
Plant-protection spraying	Aug	1 pass	1	0.21	2.08	2.08
Manual leaf removal	Sep	1 pass	1	2.86	28.57	–
Loading, transport and unloading of crates	Sep–Oct	960 crates	3	0.58	5.76	1.92
Manual grape harvesting	Sep–Oct	9.6 t	1	21.33	213.33	–

Operation	Timing	Extent	Workers	Labour (worker-days/ha)	Labour (h/ha)	Machinery (h/ha)
Loading and transport of grapes	Sep–Oct	9.6 t	3	1.44	14.40	4.80
Shallow soil cultivation	Oct–Nov	1 pass	1	0.16	1.64	1.64
Total annual requirements	—	**30 operations**	—	**78.49**	**784.92**	**50.40**

Source: Authors' calculations based on collected data.

Based on these data presented in Table 2, farm owners can calculate and estimate the number of workers required to perform specific agricultural operations, taking into account the total working time needed for each operation. It can be concluded that grape production of the Prokupac variety is highly labour-intensive, requiring a total of 784.92 labour hours per production cycle (equivalent to 78.49 working days, assuming a 10-hour working day), while machinery use amounts to 50.40 working hours annually. Grapevine protection was among the most frequently performed operations, with an average of nine applications per year during the period analysed. Considerable labour input is also required for operations such as manual pruning, defoliation, yield reduction, and grape harvesting, with one worker able to harvest approximately 450 kg of grapes per day. Based on the presented data, calculations of production input, labour, and agricultural machinery costs were performed, and the corresponding results are presented in Table 3. The organisational indicators of grape production provide the basis for the analytical calculation of production costs, as well as for decision-making related to the planning and initiation of grape production activities. Furthermore, determining the structure and level of production costs enables an assessment of the economic performance of grape production, while the obtained data also provide an important basis for investment calculations and the projection of future cash flows. In this way, a link is established between the technological and organisational characteristics of production and the economic evaluation of investments in vineyard establishment.

Table 3. Analytical Calculation of Prokupac Grape Production (EUR/ha)

Indicator / cost item	Value	Share (%)
1. Grape yield (kg/ha)	9,645.25	–
2. Selling price (EUR/kg)	0.85	–
I Production value (1 × 2)	**8,198.46**	**–**
II Direct materials (3+4+5)	**910.60**	**16.64**
3. Mineral fertilisers	213.20	3.90
4. Plant-protection products	618.30	11.30
5. Other consumable materials	79.10	1.45
III Mechanisation and production services	**736.57**	**13.46**
6. Own machinery	736.57	13.46
IV Vineyard depreciation	**618.63**	**11.31**
V Direct labour (gross wages) (7+8)	**2,738.80**	**50.06**
7. Permanent labour	1,078.27	19.71

Indicator / cost item	Value	Share (%)
8. Seasonal labour	1,660.53	30.35
VI Other direct overheads	**36.86**	**0.67**
VII Financing costs (9+10)	**409.48**	**7.48**
9. Interest on fixed capital	351.35	6.42
10. Interest on permanent working capital	58.13	1.06
VIII Marketing and selling costs	**20.00**	**0.37**
IX Total production costs including selling (II+III+IV+V+VI+VII+VIII)	**5,470.94**	**100.00**
Unit cost of grapes (EUR/kg)	0.57	–
X Financial result (I-IX)	**2,727.52**	**–**

Source: Authors' calculations based on collected data.

The calculation of revenues and costs associated with Prokupac grape production per hectare provided the basis for the analytical production calculation presented in Table 3. The average grape yield amounted to 9,645.25 kg/ha, which, at an average selling price of 0.85 EUR/kg, resulted in a total production value of 8,198.46 EUR/ha. Regarding production costs, total costs amounted to 5,470.94 EUR/ha, with labour costs accounting for the largest share of total production costs, at 50.06% (2,738.80 EUR/ha). This finding further confirms the importance of the data presented in Table 2, highlighting that efficient work organisation and labour requirement planning can significantly influence the economic performance of grape production. In terms of cost structure, direct material costs (mineral fertilisers, plant protection products, and other auxiliary materials) represented the second-largest component, accounting for 16.64% of total production costs, followed by machinery costs, with a share of 13.46%. The financial results, calculated as the difference between total production value and total production costs, amounted to 2,727.52 EUR/ha, while the calculated unit cost of grape production was 0.57 EUR/kg. These data provide the basis for further analyses related to investment calculations and the assessment of the economic feasibility of investments.

Table 4. Calculation of Permanent Working Capital Requirements for Prokupac Grape Production (EUR/ha)

Component	Annual base	Days tied up	Turnover ratio	Capital required
Gross operating-capital requirement	5,412.81	304	1.20	4,510.68
Trade payables: materials and services	1,647.17	17	21.50	76.61
Vineyard depreciation	618.63	30	12.17	50.83
Accrued gross wages	2,738.80	30	12.17	225.05
Other liabilities, taxes and fixed-capital interest	388.21	30	12.17	31.90
Other operating liabilities	20.00	30	12.17	1.64
Total short-term operating financing	**5,412.81**	—	—	**386.03**
Permanent working-capital investment	—	—	—	**4,124.64**

Source: Authors' calculations based on collected data (following Gogić, 2014).

Table 4 presents the calculation of the required investment in permanent working capital for Prokupac grape production on an area of 1 ha. The required investment was determined by taking into account the specific characteristics of the production process, the period during which funds are tied up, and the corresponding turnover ratios. The estimated permanent working capital requirement of 4,124.64 EUR represents an integral component of total investment expenditures, which, in addition to working capital, include direct investments in vineyard establishment on an area of 1 ha. Given the long vineyard exploitation period (40 years), it was assumed that the residual value of the vineyard at the end of its productive lifespan would be negligible and that the terminal value of the investment would be equal to the total amount of the initial investment in permanent working capital. Accordingly, in the final year of vineyard exploitation, the value of production is increased by the amount of invested permanent working capital, which is recorded in the investment calculation as the residual value of the investment.

Table 5. Investment Costs for Prokupac Vineyard Establishment by Year (EUR/ha)

Cost component	Year 0	Year 1	Year 2	Year 3	Total
Labour	2,000.00	800.00	2,250.00	900.00	5,950.00
Tractor and machinery operations	2,250.00	290.00	630.00	250.00	3,420.00
Vineyard Design	550.00	–	–	–	550.00
Grapevine Planting Material	5,810.00	–	–	–	5,810.00
Replacement vines	–	720.00	–	–	720.00
Vineyard Trellis Materials	–	–	7,100.00	–	7,100.00
Production Inputs	370.00	300.00	330.00	590.00	1,590.00
Total establishment costs	**10,980.00**	**2,110.00**	**10,310.00**	**1,740.00**	**25,140.00**

Source: Authors' calculations based on collected data.

Table 6. Net Fixed-Capital for Prokupac Vineyard Establishment (EUR/ha)

Year	Nominal outlay	Compound factor*	Capitalised outlay	Production offset	Net fixed capital
0	10,980.00	1.08479	11,910.99	–	11,910.99
1	2,110.00	1.05576	2,227.65	–	2,227.65
2	10,310.00	1.02750	10,593.53	–	10,593.53
3	1,740.00	1.00000	1,740.00	1,542.50	197.50
Total	**25,140.00**	**—**	**26,472.16**	**1,542.50**	**24,929.66**

Source: Authors' calculations based on collected data.

Note. I*nvestment costs were capitalised at an annual intercalary interest rate of 2.75% up to the end of Year 3.

Table 5 presents the annual costs incurred during vineyard establishment, covering the period before the vineyard reaches full production capacity. In the analysed case, this coincides with the vineyard reaching full production capacity in the fourth year from the beginning of the investment. Based on the data presented in this table, it can be concluded that establishing a vineyard with the Prokupac grapevine variety requires substantial financial resources, with the largest shares of investment costs attributable to vineyard trellis materials, grapevine planting material, and labour.

Table 6 presents the calculation of investment costs for vineyard establishment, including capitalised interest during the establishment period (intercalary interest). Interest was calculated at an annual rate of 2.75%, corresponding to the prevailing interest rate on savings deposits. The calculation was based on the opportunity cost of capital (foregone returns), which arises when the entire investment is financed from the producer's own financial resources. Furthermore, the production value generated in Year 3 was also taken into account, as the vineyard achieved a grape yield of approximately 2 t/ha, with the corresponding production value reduced by harvesting and transportation costs. Based on these calculations, the total investment required for establishing a vineyard with the Prokupac grapevine variety was determined as the sum of investment in fixed capital (Table 6), and permanent working capital (Table 4). Accordingly, the total investment required to establish 1 ha of vineyard with the Prokupac grapevine variety amounts to 29,054.30 EUR, of which 24,929.66 EUR represents investment in fixed capital and 4,124.64 EUR represents investment in permanent working capital.

Table 7. Projected Cash Flows for Prokupac Grape Production (EUR/ha)

Year(s)	Receipts	Investment outlays	Operating & tax outlays**	Net cash flow
0	–	11,910.99	–	-11,910.99
1	–	2,227.65	–	-2,227.65
2	–	10,593.53	–	-10,593.53
3	–	4,322.14****	–	-4,322.14
4–35*	8,198.46	–	4,818.39	3,380.07
36	7,788.54	–	4,577.47	3,211.07
37	7,624.57	–	4,441.12	3,183.45
38	7,378.62	–	4,336.55	3,042.07
39	7,214.65	–	4,200.20	3,014.45
40***	11,093.33	–	4,095.63	6,997.70
Total, years 0–40	**303,450.43**	**29,054.31**	**175,839.56**	**98,556.56**

Source: Authors' calculations based on collected data.

Note: * Identical annual amounts are presented for Years 4–35 of vineyard exploitation, with all 32 years included in the total calculations.

***Operating cash outflows also include an assumed corporate income tax at a rate of 10%.*

****Receipts in Year 40 also include the full recovery of invested permanent working capital.*

***** Year 3 includes net fixed-capital investment of 197.50 EUR/ha and permanent working capital of 4,124.64 EUR/ha.*

Table 8. Dynamic Cash Flows and Net Present Value of Prokupac Vineyard Investment (7% Discount Rate; EUR/ha)

Year(s)	PV receipts	PV outlays	Present value of net cash flow	Cumulative NPV
0	–	11,910.99	-11,910.99	-11,910.99
1–3	–	14,862.87	-14,862.87	-26,773.86
4–10	36,067.20	21,197.39	14,869.81	-11,904.05
11–18	24,886.47	14,626.26	10,260.21	-1,643.84
19	2,266.94	1,332.33	934.62	-709.22
20	2,118.64	1,245.16	873.47	164.25
21–35	19,296.37	11,340.85	7,955.52	8,119.78
36–40	3,126.02	1,669.21	1,456.81	9,576.59
Total, years 0–40	**87,761.64**	**78,185.05**	**9,576.59**	**9,576.59**

Source: Authors' calculations based on collected data.

Table 9. Calculation of the Internal Rate of Return (IRR) for Prokupac Vineyard Investment (40-Year Period)

Discount rate (%)	NPV (EUR/ha)
9.50	144.90
9.60	-142.72
10.00	-1,239.52
9.55 (IRR)	–

Source: Authors' calculations based on collected data.

Table 8 shows a positive Net Present Value (NPV) of 9,576.59 EUR/ha at a discount rate of 7%. This is the higher of the two rates recommended by the Ministry of Finance of the Republic of Serbia for 2026 (5% for financial analysis and 7% for social analysis; Ministry of Finance of the Republic of Serbia, 2026) and was selected to apply more stringent investment appraisal criteria. The positive NPV indicates the economic feasibility of establishing a Prokupac vineyard under the assumed conditions. This conclusion is further supported by the Internal Rate of Return (IRR) of 9.55%, which exceeds the applied discount rate. These findings indicate that the expected return on investment exceeds the assumed cost of capital, thereby confirming the economic justification of investing in Prokupac grape production over the analysed vineyard exploitation period.

In order to provide an additional assessment of the economic feasibility of the analysed investment, the present values of cash inflows and outflows presented in Table 8 were converted into equivalent annual benefits and costs over the 40-year vineyard exploitation period. The calculation was performed using the Capital Recovery Factor (CRF), which converts present values into equivalent uniform annual amounts, according to the following formulas:

$$AE = PV \times CRF$$

$$CRF = r / [1 - (1 + r)^{-n}]$$

where AE represents the equivalent annual value, PV is the present value, r is the annual discount rate, and n is the vineyard exploitation period (years). At an applied discount rate of 7% and an investment appraisal period of 40 years, the calculated CRF amounts to 0.07500914. The results of these calculations are presented in Table 10.

Table 10. Present Values and Equivalent Annual Benefits and Costs (7% Discount Rate)

Indicator	Present value (EUR/ha)	Annualisation calculation	Equivalent annual value (EUR/ha/year)
Benefits	87,761.64	87,761.64 × 0.07500914	6,582.93
Costs	78,185.05	78,185.05 × 0.07500914	5,864.59
Net benefits (NPV)	**9,576.59**	**9,576.59 × 0.07500914**	**718.33**

Source: Authors' calculations based on collected data.

The results presented in Table 10 indicate that the present value of total benefits amounts to 87,761.64 EUR/ha, while the present value of total costs is 78,185.05 EUR/ha. By applying the Capital Recovery Factor, the equivalent annual benefits and costs were calculated at 6,582.93 EUR/ha/year and 5,864.59 EUR/ha/year, respectively. Consequently, the equivalent annual net benefit amounts to 718.33 EUR/ha/year, indicating a positive annual economic return over the analysed investment period. Furthermore, the calculated benefit–cost ratio of 1.1225 indicates that each 1 EUR of discounted costs corresponds to approximately 1.12 EUR of discounted benefits. These findings provide additional confirmation of the economic feasibility of investing in Prokupac vineyard establishment under the assumed production conditions and the applied discount rate of 7%, complementing the previously obtained NPV and IRR results.

Table 11. Dynamic Payback Period (DPP) of Prokupac Vineyard Investment

Measure	Cumulative PV (EUR/ha) / DPP	Interpretation
Year 19	-709.22	Last year with negative cumulative PV
Year 20	164.25	First year with positive cumulative PV
Dynamic payback	**19.81 years**	**Approximately 19 years and 10 months**

Source: Authors' calculations based on collected data.

Based on the results presented in Table 11, the Dynamic Payback Period (DPP) of the investment is estimated at 19 years and 10 months, representing approximately half of the total vineyard exploitation period (40 years). Considering that the total investment is recovered during the first half of the vineyard exploitation period, this indicator also confirms the economic feasibility of investing in the establishment of vineyards planted with the Prokupac grapevine variety.

Considering that the required investment expenditure and indicators of economic efficiency may vary significantly depending on production, organisational and economic factors, the results obtained in this research represent only one possible scenario. Differences in the obtained results are particularly noticeable when compared

with previous studies conducted in different geographical areas, involving different grapevine varieties and investment conditions, which reported different investment payback periods (Koprivlenski, 2016; Szabó et al., 2022; Elenov & Sredojević, 2025). Other studies dealing with similar topics have concluded that labour and mechanisation have a significant influence on total production costs, which in turn affect business performance. These studies also indicate that efficient management of production processes has a significant influence on business performance in grape production (Baptista et al., 2025; Rauhöft et al., 2026). These findings indicate the importance of considering all the specific characteristics of grape production, as well as the need to adapt investments in vineyard establishment to the actual production conditions.

Conclusions

Based on the results of the research and analyses conducted, it can be concluded that the indicators related to grape production of the autochthonous wine grapevine variety Prokupac are positive. Based on the technological and organisational production chart and the analytical cost calculation, a positive financial result of 2,727.52 EUR/ha was determined, confirming the economic profitability of grape production under the analysed conditions. In addition, the application of dynamic methods for assessing the economic feasibility of investments showed a positive Net Present Value (NPV) of 9,576.59 EUR/ha, an Internal Rate of Return (IRR) of 9.55%, and a Dynamic Payback Period (DPP) of 19.81 years, or approximately 19 years and 10 months. These indicators confirm the economic feasibility of investing in the establishment of vineyards planted with the Prokupac grapevine variety under the analysed production and economic conditions. It is particularly important to emphasise that the economic feasibility of investing in Prokupac vineyard establishment was confirmed even without government subsidies, assuming that the entire investment was financed from the producer's own funds. Based on this, it can be concluded that the economic indicators could be further improved if producers received certain subsidies. It should also be noted that the economic feasibility of investments in vineyard establishment may vary significantly. This primarily depends on achieved yields, grape selling prices, production costs, the level of mechanisation of production operations and the selected financing model. Therefore, the results of this research represent one possible scenario of the economic sustainability of Prokupac grape production, while also providing a relevant methodological basis for further organisational and economic analyses of grape production.

Accordingly, future research should focus on the development and comparative analysis of different organisational and economic models of grape production, with particular emphasis on autochthonous wine grapevine varieties. Special attention should be given to examining differences in the organisation of production processes, labour and machinery requirements, cost structures, achieved business performance and the economic feasibility of investments. In addition, the application of sensitivity analysis, scenario analysis and multi-criteria decision-making methods could contribute to

identifying the key factors influencing the economic performance of grape production, as well as developing models aimed at improving business performance in grape production. The scientific contribution of such an approach would be reflected in the systematic integration of organisational, production-technological and economic indicators, considering that comprehensive and directly comparable studies covering these aspects are still relatively limited, particularly in the viticulture sector of the Republic of Serbia. Finally, the results of this research, as well as future studies, could provide an important basis for investment decisions made by grape producers and for the development of more effective agricultural policy measures. In this context, particular attention should be paid to ensuring the long-term predictability and continuity of subsidy programmes for the establishment of new vineyards, as well as encouraging the use of new technologies that may contribute to increased productivity and reduced production costs. These measures could create more favourable conditions for the economically sustainable development of the grape production sector, improve the competitiveness of domestic producers and, in particular, support the preservation of grape production from autochthonous grapevine varieties in the Republic of Serbia.

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Conflict of interests

The authors declare no conflict of interest.

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