ECONOMIC ANALYSIS OF ORGANIC CARROT CULTIVATION IN PROTECTED AREAS: ESTIMATES FOR 2025

Rozi Liliana BEREVOIANU[1], Diana Maria ILIE [1]

e-mail: necula.diana@iceadr.ro

Abstract

The paper aims to evaluate the economic viability of organic carrot cultivation in protected areas, based on the estimation of the revenue and expenditure budget for 2025. The methodology applied focused on the analysis of key financial indicators: production value, the structure of variable and fixed costs, taxable income and net income, profitability rate, production cost, and domestic market price. The results show that the high share of variable costs reflects the dependence of the crop on ecological inputs and labor resources, while subsidies play a decisive role in strengthening revenues and reducing economic risks. The break-even analysis confirms the capacity of this crop to generate profit and to maintain financial stability under the specific conditions of organic farming. The study demonstrates that organic carrot cultivation in greenhouses constitutes a sustainable and competitive option for Romanian farmers, with favorable prospects for integration into the certified products market. Moreover, the research highlights the contribution of this production system to enhancing resilience and supporting the long-term sustainability of organic agriculture.

Keywords: organic carrots; protected areas; economic analysis; profitability

Organic farming has strengthened over the past two decades as a viable alternative to conventional systems, being promoted both for its contribution to environmental protection and for its potential to meet the growing demand for safe and certified food products. Within the European Union, the "Farm to Fork" strategy sets as a target the achievement of 25% of agricultural land managed under organic farming by 2030, which provides a clear development trajectory for the sector and creates economic opportunities for farmers (European Court of Auditors, 2024). In this context, the economic viability analysis of organic crops becomes essential for understanding both the sustainability of production and the capacity of farms to remain competitive on the European market.

Carrot (*Daucus carota L.*) is one of the most important root vegetables cultivated worldwide, valued both for its nutritional properties and for the stability of demand on the fresh vegetable market. At the EU level, the largest cultivated area of carrots in 2023 was recorded in France, with 15.11 thousand hectares, representing an increase of 15.5% compared to 2010 (13.08 thousand hectares) and 0.73% compared to the previous year. In Romania, the carrot cultivation area in 2023 (6.91 thousand hectares) shows a decline of 25.46% compared to 2010 (9.27 thousand hectares) and an increase of 0.88% compared to 2022 (Eurostat, 2024). Within organic farming systems, carrot holds a particular role due to its ability to capitalize on fertile soils and diversified crop rotations, while the price premiums granted for certified organic products contribute to strengthening farmers' revenues (Bender *et al.,* 2020). At the same time, being a labor-intensive crop, organic carrot production is highly sensitive to labor costs and to the availability of certified inputs, which justifies detailed economic assessments of the profitability of this crop (Milić *et al.,* 2023; Adhikari, 2009).

Vegetable production in protected areas, such as greenhouses and high tunnels, plays a central role in ensuring the continuity of market supply and in obtaining higher-quality yields. In the case of organic carrots, cultivation in such systems can contribute to reducing climatic risks and extending the harvest period, but it also entails substantial initial investments and recurrent costs for structural maintenance and energy consumption (Paris *et al.,* 2022). Studies indicate that the main cost components in greenhouse systems are energy and labor, which makes energy efficiency and the use of renewable resources key determinants of profitability (Hopwood *et al.,* 2024). Furthermore, research conducted in Denmark has demonstrated

[1] *Research Institute for Agricultural Economy and Rural Development, Bucharest*

that tunnel production can significantly improve the quality of organic carrot seeds, providing advantages for the reproduction of biological material and for the economic success of specialized farms (Deleuran *et al.,* 2009).

An essential aspect of the economic analysis of organic carrot cultivation is the loss of value caused by cosmetic market standards. Recent studies indicate that up to 30% of marketable production may be downgraded or rejected due to visual defects, although the roots remain nutritionally adequate (Pietrangeli *et al.,* 2024). In parallel, research conducted on commercial organic farms has highlighted a high spatio-temporal variability of yields and root quality, which directly affects the proportion of production classified in higher quality grades and amplifies the economic risk (Catton *et al.,* 2025).

With regard to resource use, comparative analyzes between conventional and organic systems have demonstrated that organic carrot production requires higher labor input and more mechanical operations, particularly for weed control, which generates significant variable costs (Souza e Souza *et al.,* 2023). Moreover, studies on the water footprint of carrot crops highlight differences between organic and conventional systems, with implications for irrigation costs and for overall economic sustainability (Kowalczyk *et al.,* 2022).

Another major determinant of viability is the framework of public support. The European Court of Auditors (2024) emphasizes that CAP subsidies for conversion and maintenance in organic farming have been essential for sustaining farmers' incomes and reducing economic risk. Consequently, the integration of economic analysis tools—such as revenue and expenditure budgets, unit production cost, break-even point, and profitability rate—becomes indispensable for realistically assessing the capacity of organic carrot cultivation in protected areas to generate profit and to support the financial stability of farms in 2025.

Against the background of these technological and economic particularities, an integrated assessment of organic carrot cultivation in protected areas is required, one that quantifies both the associated costs and revenues. Economic analysis methodologies applied in horticulture—such as revenue and expenditure budgets, unit production cost analysis, break-even analysis, and profitability rate assessment—are commonly employed to support farm-level management decisions (Galinato and Miles, 2013; Hopwood *et al.,* 2024). In this context, the objective of the present study is to estimate the economic viability of organic carrot cultivation in protected areas in Romania for the year 2025, by calculating key financial indicators and by integrating the role of subsidies in strengthening the economic stability of farms.

MATERIAL AND METHOD

The present paper stems from the growing interest in organic vegetable cultivation in Romania and from farmers' need to identify economically viable solutions under increasingly competitive market conditions. In this context, an applied analysis was conducted on organic carrot cultivation in protected areas, with the primary objective of estimating the level of profitability and the degree of economic return that this production system can ensure in 2025.

To achieve this objective, a revenue and expenditure budget was constructed for a reference area of 1 hectare, considered as the standard unit of analysis. The structure of the budget was developed based on the technological and economic data specific to organic carrot cultivation in high tunnels: estimated average yield, consumption of material resources, costs of technological operations, as well as labor and administrative expenses.

Revenues were determined according to the forecasted production and the market price on the domestic market, adjusted to reflect the specificity of organic products. The calculation also included the subsidies provided under the National Strategic Plan 2023–2027, namely basic direct payments and the support granted for maintaining organic certification, which play an important role in strengthening the economic outcome.

Expenditures were grouped into variable costs (seed, organic and foliar fertilizers, biological treatments, mechanized operations, irrigation, supply) and fixed costs (permanent labor, general and management expenses, depreciation of buildings and utilities). This classification allows for observing the high share of inputs and manual labor within the organic production system.

Based on these elements, the main economic indicators were calculated: unit production cost, gross and net profit, profitability rate, variable cost margin, and break-even point. The analysis was complemented by the determination of risk indicators (operating risk ratio and safety index), which reflect the crop's vulnerability to market fluctuations or climatic variations.

To assess the break-even point, scenario simulations were conducted: a 20% increase and decrease in production value, and a 10% reduction in fixed costs. These scenarios allowed for testing the financial flexibility of the farm and for

highlighting the safety margin provided by the analyzed crop.

RESULTS AND DISCUSSIONS

In Romania, carrot cultivation is predominantly carried out in open fields, where this crop holds a significant share in the structure of vegetable production. However, in organic farms, cultivation in high tunnels is also practiced, as a strategy for diversifying production and for obtaining constant and early yields. The use of protected areas provides the possibility of better controlling environmental factors, thereby reducing risks generated by climatic variations and by disease or pest pressure—issues particularly relevant in the absence of synthetic chemical treatments.

Table 1

Revenue and Expenditure Budget for Organic Carrot Cultivation – Estimates for 2025

Indicators	U.M	Value
A. Production value, of which:	lei	135,400
B (+) Grants*	lei	3,469
C (=) Gross product	lei	138,869
D (-) Total expenses	lei	107,559
I. Variable expenses	lei	71,204
II. Fixed expenses	lei	36,355
E (=) Taxable income	lei	27,841
E.1(-) Taxes and fees	lei	4,455
F (=) Net income + subsidies	lei	26,856
F.1 (=) Net income	lei	23,386
G. Rate of taxable income	%	25.9
H. Net income rate + subsidies	%	25.0
H.1 Net income rate	%	21.7
Production cost	lei/to	5,378
Predictable domestic market price	lei/to	6,770

Notes: Planned subsidies:

- Planned APIA subsidy for 2025 under the National Strategic Plan of Romania (266.32 EUR/ha): BISS – Basic Income Support for Sustainability (99.27 EUR/ha), CRISS – Complementary Redistributive Income Support for Sustainability (52.08 EUR/ha), PD-04 – Environmentally beneficial practices applicable to arable land (56.28 EUR/ha), Payment for young farmers (48.00 EUR/ha), ANT-1 – Transitional national aid (10.69 EUR/ha).
- Planned APIA subsidy for organic farming in 2025 – maintenance of certification, DR 05–02: Package 2 – vegetables (including potatoes) certified in organic farming (431.00 EUR/ha/year).

** Euro exchange rate: 4.9753 lei

Source: authors' own calculations

The analysis of the revenue and expenditure budget for organic carrot cultivation in protected areas indicates a favorable economic outlook under the 2025 estimates. At an estimated yield of 20,000 kg/ha, the production value amounts to 135,400 lei/ha. By adding the planned subsidies for 2025, totaling 3,469 lei/ha, the gross product reaches 138,869 lei/ha, highlighting the positive impact of financial support on the economic sustainability of the crop (*table 1)*.

The cost structure confirms the characteristics of intensive organic crops. Variable expenses account for the largest share, approximately two-thirds of the total, while fixed expenses represent about one-third. This distribution highlights the strong dependence on inputs and manual operations, with a direct impact on the unit production cost (*figura 1*).

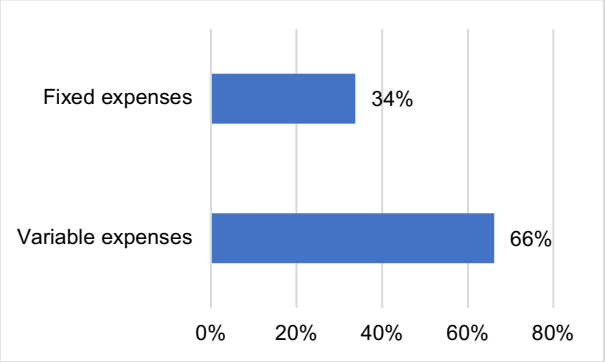

Figure 1 **Total production costs for organic carrot cultivation in high tunnels, estimated yield of 20 t/ha**

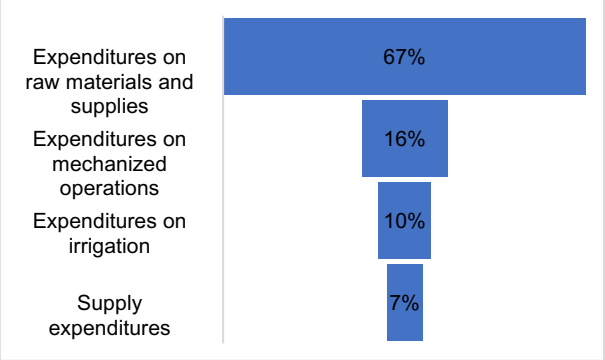

Figure 2 **Variable production costs for organic carrot cultivation in high tunnels, estimated yield of 20 t/ha**

Variable costs represent approximately 66% of the total production costs, amounting to 71,204 lei/ha. The main component is raw materials and supplies, valued at 48,014 lei/ha, which accounts for nearly 67% of variable expenses. Other variable costs include mechanized operations (16%), irrigation (10%), and supply (7%), all of which are essential elements for supporting the technological process. This structure reflects both the high share of inputs in organic technology and the importance of efficient management of material resources and technological operations in maintaining the profitability of organic carrot cultivation in protected areas (*figure 2*).

Fixed costs are dominated by expenditures on permanent labor, which reflects the high dependence of the organic system on human resources. General and management expenses, along with the depreciation of buildings and

utilities, complete the structure of this category (*figure 3*).

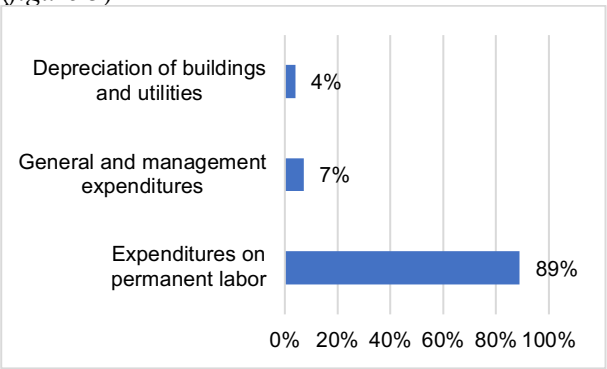

Figure 3 **Fixed production costs for organic carrot cultivation in high tunnels, estimated yield of 20 t/ha**

Subsidies represent an important factor in ensuring the economic sustainability of organic carrot cultivation, directly contributing to strengthening farm income and reducing economic risks. The total estimated value of financial support for 2025 is 3,469 lei/ha, equivalent to about 2.5% of the gross product. This amount results from the cumulation of direct payments under the National Strategic Plan (BISS – 99.27 EUR/ha, CRISS – 52.08 EUR/ha, PD-04 – 56.28 EUR/ha, payment for young farmers – 48 euro/ha, and ANT-1 – 10.69 EUR/ha), totaling 266.32 EUR/ha (approximately 1,325 lei/ha), to which is added the support for maintaining organic farming certification, amounting to 431 EUR/ha (about 2,144 lei/ha).

Taxable income amounts to 27,841 lei/ha, representing almost 20% of the gross product of 138,869 lei/ha. After deducting taxes and fees, totaling 4,455 lei/ha, the net income is 23,386 lei/ha, which reflects the actual profitability of the farm after fulfilling fiscal obligations. By including the estimated subsidies for 2025, the net income increases to 26,856 lei/ha, confirming the role of financial support in enhancing economic stability and supporting farmers who apply organic technologies.

At the unit product level, the production cost is 5,378 lei/ton, while the predictable average market price was estimated at 6,770 lei/ton. The difference of 1,392 lei/ton between price and cost highlights the profit margin of the crop, demonstrating the economic potential of organic carrots in protected areas and justifying their integration into the structure of sustainable vegetable crops.

The predictable selling price for carrot cultivation was calculated based on INS 2024 data on average prices for conventional production, adjusted with a 15% increase to reflect the specificity of organic production in protected areas. This percentage falls within the 10–40% range reported in the specialized literature and provides a realistic marketing strategy for the domestic market.

Table 2 summarizes the economic performance of organic carrot cultivation by highlighting the main indicators of profitability and risk. Profit per production unit amounts to 27,841 lei/ha, while profit per product unit reaches 1,392 lei/ton, confirming that the activity generates a financial surplus sufficient to cover fixed costs and to maintain the economic viability of the farm.

Table 2

Profitability and risk indicators

Indicators	U.M.	Value lei
Profit or loss per production unit	lei/ha	27,841
Profit or loss per product unit	lei/to	1,392
Profitability rate	%	25.9
Margin on variable costs (MCV)	lei	64,196
Contribution margin	%	47.4
Break-even point in value terms	lei	76,679
Break-even point in physical units	to	11.3
Operating risk rate	%	56.6
Safety index (Is)		0.4

Source: authors' own calculations

The profitability rate of 25.9% confirms that investment in organic carrot cultivation provides an attractive and sustainable return. The contribution margin (CMV), amounting to 64,196 lei/ha or 47.4%, highlights the extent to which production contributes to covering fixed costs and generating farm profit.

The break-even point, estimated at 76,679 lei/ha or 11.3 tons/ha, represents the minimum production level required to avoid losses, providing the farmer with a clear benchmark for managing operating risk. This correlates with the operating risk rate of 56.6%, which indicates significant exposure to market fluctuations, climatic conditions, or disease and pest pressure. The safety index (Is), calculated at 0.4, shows that the achieved production exceeds the minimum break-even level by approximately 40%, offering a moderate reserve of economic security.

Overall, these indicators confirm that organically grown carrots in high tunnels can be profitable and relatively stable, with a satisfactory profitability rate and a sufficient margin to manage risks, offering farms prospects of continuity and long-term sustainability.

In addition to determining profitability indicators, a break-even analysis contributes to highlighting the crop's resilience to potential economic changes. The simulation of scenarios

such as an increase or decrease in production value or a reduction in fixed costs provides a concrete picture of the farm's financial flexibility and balance (*table 3*).

Table 3

Break-even analysis – possible scenario simulations

Explanations	Values	%	Break-even point RE=0	Result obtained with a 20% increase in production value	Result obtained with a 20% decrease in production value	Maintaining the initial result when fixed costs are reduced by 10%
Turnover (CA)	135,400	100	76,679	162,480	108,320	127,732
Variable costs (VC)	71,204	53	40,324	85,445	56,963	67,172
Contribution margin (CMV)	64,196	47	36,355	77,035	51,357	60,561
Fixed costs (FC)	36,355		36,355	36,355	36,355	32,720
Gross result	27,841		0	40,680	15,002	27,841

Source: authors' own calculations

The results highlight that the current turnover level of 135,400 lei/ha significantly exceeds the break-even point, set at 76,679 lei/ha, which provides the crop with a substantial reserve of economic security.

In the scenario of a 20% increase in production value, the gross result rises to 40,680 lei/ha, which highlights the high profitability potential of the crop under favorable market conditions. Conversely, a 20% decrease in production value would reduce the gross result to 15,002 lei/ha, while still keeping the farm profitable, which reflects good resilience to market fluctuations.

At the same time, a 10% reduction in fixed costs allows the gross result to be maintained at the initial level of 27,841 lei/ha, confirming the importance of controlling structural costs for the farm's financial stability. These scenarios show that the farm has a significant margin of economic flexibility, but long-term success depends both on maintaining the level of production and on the rigorous management of fixed costs.

CONCLUSIONS

The analysis shows that organic carrot cultivation in protected areas represents a viable economic activity for Romanian farmers, capable of generating profit and ensuring a satisfactory level of profitability. The results obtained highlight that the success of this crop relies both on the growing demand for organic products and on farmers' ability to capitalize on market advantages. Financial support complements this picture, contributing to stability and to the reduction of risks, but without being the sole factor of sustainability.

The analysis of the cost structure highlighted the dependence on high-priced organic inputs and on manual labor, aspects that may limit the large-scale expansion of these technologies. At the same time, the relatively low break-even point provides a safety margin that can motivate investments in this segment. Scenario simulations show that organic carrot farms are sensitive to price fluctuations and production levels, yet they possess a certain financial elasticity that allows them to withstand moderate variations. Thus, the analyzed crop proves to be viable, albeit with a clear exposure to market risks.

To consolidate economic results and reduce vulnerability to market fluctuations, farmers may benefit from measures such as optimizing fixed costs, diversifying marketing channels, and integrating into cooperatives or local partnerships. Such solutions can transform organic carrot cultivation from a profitable individual option into an element of stability and development for the entire organic vegetable sector in Romania.

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REFERENCES

Adhikari R.K., 2009 – *Economics of Organic vs Inorganic Carrot Production in Nepal***.** Agricultural Economics Research Review, 22: 273–278**,** DOI: https://doi.org/10.3126/aej.v10i0.2127

Bender I., Edesi L., Hiiesalu I., Ingver A., Kaart T., Kaldmae H., Talve T., Tamm I., Luik A., 2020. *Organic Carrot (Daucus carota L.) Production Has an Advantage over Conventional in Terms of Root Shape and Yield Stability*. Agronomy 10(9), 1420, available on-line: https://doi.org/10.3390/agronomy10091420.

Catton, H.A., Larney, F.J., Forge, T.A. *et all, 2025* - *Within-farm spatiotemporal variability impacts*

carrot yield and quality more than preceding cover crop on a Canadian organic farm. Org. Agr. **15**, 375 – 398. https://doi.org/10.1007/s13165-025-00503-x

Deleuran, L. C., & Boelt, B., 2009 - Tunnel production enhances quality in organic carrot seed production. *Acta Agriculturae Scandinavica, Section B — Soil & Plant Science*, *59*(6), 559–566. https://doi.org/10.1080/09064710802482446

Eurostat, 2024 – *Agricultural production – crop production in EU standard humidity*. Available on-line: https://ec.europa.eu/eurostat/databrowser/view/apro_cpsh1__custom_18059759/default/table

European Court of Auditors, 2024 - *Special Report 19/2024: Organic farming in the EU - Gaps and inconsistencies hamper the success of the policy*, Luxembourg: Publication Office of the European Union, available on-line at: https://www.eca.europa.eu/ECAPublications/SR-2024-19/SR-2024-19_EN.pdf .

Galinato S.P., Miles C.A., 2013 – *Economic profitability of growing lettuce and tomato in high tunnel organic systems.* HortTechnology 23 (4): 453-461, DOI:10.21273/HORTTECH.23.4.453 .

Kowalczyk, Zbigniew & Kubon, Maciej. 2022 - *Assessing the impact of water use in conventional and organic carrot production in Poland.* Scientific Reports, available on-line: file:///C:/Users/PC14/Downloads/Assessing_the_impact_of_water_use_in_conventional_.pdf .

Milić D., Brčić S., Cvijanović D., 2023 – *Economics of Organic Carrot Production through Case Study*. Journal of Agronomy, Technology, Engineering and Management, 6(1): 873–884, DOI:10.55817/UQRF7578

Paris B., Vandorou F., Balafoutis T. A., Vaiopoulos K., Kyriakarakos G., Manolakos D., Papadakis G., 2022 - *Energy use and efficiency in European greenhouses: a review*, *Appl. Sci.* **2022**, *12*(10), 5150; https://doi.org/10.3390/app12105150

R. Pietrangeli, C. Cicatiello, 2024 - *Lost vegetables, lost value: Assessment of carrot downgrading and losses at a large producer organisation*, Journal of Cleaner Production, Volume 478, https://doi.org/10.1016/j.jclepro.2024.143873.

Souza e Souza L.G.S., Ferreira R.L.F., de Araújo Neto S.E., Uchôa T.L., da Silva N.M., Francisco W.M., 2023 – *Profitability of organic carrot cultivation under weed interference and sowing methods.* Pesquisa Agropecuária Tropical, 53, https://doi.org/10.1590/1983-40632023v5374735.

W. Hopwood, Z. Lopez-Reyes, A. Bantan, C. Vietti, D. Al-Shahrani, A. Al-Harbi, M. Qaryouti, P. Davies, M. Tester, R. Wing, R. Waller, 2024 - *Benchmarking techno-economic performance of greenhouses with different technology levels in a hot humid climate*, Biosystems Engineering, Volume 244, Pages 177-199, https://doi.org/10.1016/j.biosystemseng.2024.06.005.