



Economic Sustainability of Extensive Olive Farms in Algeria: Cost and Profitability Analysis

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Abstract: Algerian olive production relies heavily on extensive, rain-fed systems that remain important for rural livelihoods, but their economic viability has yet to be thoroughly studied. This study evaluates the economic performance of extensive olive farms based on production costs, revenue, net margin, and the break-even point. A field survey was conducted among 38 farms located in the wilayas of Bejaia, Bouira, and Tizi Ouzou, with an average area of 3.78 ha. The results show overall positive profitability, with an average net margin of 466,611.5 DZD per farm, despite significant variability among farms. Production costs are primarily influenced by low productivity and high labor requirements, particularly for harvesting and pruning operations. The relatively low break-even point, estimated at $53,470.7 \pm 83,859.6$ DZD per farm, corresponding to approximately 0.53 metric tons of olives, indicates that most farms are able to cover their costs, but their performance remains sensitive to variations in yields, weather conditions, and labor costs. These results highlight the continued economic viability of extensive rain-fed olive cultivation, while emphasizing the need to improve local value addition, develop appropriate mechanization, and promote agroecological practices in order to strengthen its economic sustainability.

Key words: Economic sustainability, olive farming, profitability, production costs, economic analysis, extensive farming

Olive growing occupies a strategic place in the Mediterranean agricultural economy, both in terms of its social and environmental importance and its contribution to food security and rural job creation (De Luca *et al.*, 2023; Ben Abdallah *et al.*, 2022; Fraga *et al.*, 2021; Bernardi *et al.*, 2021; Florentino, 2018; Pinatel, 2015; Breton and Benvillé, 2012). In Algeria, this sector has a patrimonial and identity character, while also being an essential source of income for thousands of family farms (Amrouni Sais and Benziouche, 2026). The country has considerable olive-growing potential, estimated at nearly 450,000 hectares with more than 65 million olive trees, mainly located in the mountainous and semi-arid areas of the north and the High Plains (Amrouni Sais and Benziouche,

2024; MADRP, 2023). However, despite this quantitative growth, Algerian olive growing remains characterized by significant structural and technical heterogeneity (Amrouni Sais and Benziouche, 2024). The majority of farms adopt an extensive production method, characterized by low planting density, limited mechanization and significant dependence on climatic conditions (Jourdan *et al.*, 2022; Amrouni Sais *et al.*, 2021; Zaidi *et al.*, 2021).

In this context, the question of the economic sustainability of these farms is particularly acute. Indeed, the profitability of extensive olive growing depends on multiple factors, including the productivity of the orchards (Mokrani *et al.*, 2022; Ben Abdallah *et al.*, 2022; IOC, 2015; Mohamad *et al.*, 2013), the cost of labor (IOC, 2015; Amrouni Sais *et al.*, 2021; Sobreiro *et al.*, 2023), water availability (Sobreiro *et al.*, 2023) and the volatility of olive oil prices (Di vita *et al.*, 2013).

The economic analysis of these production systems therefore appears essential to identify the levers for improving profitability and to support the transition to more sustainable olive growing. In the context of climate change and increasing resource scarcity, economic sustainability is becoming a fundamental pillar of the resilience of the olive sector.

Thus, this article aims to assess the economic sustainability of extensive olive farms in Algeria, through the analysis of production costs, economic margins and profitability of the systems studied. The objective is to identify the main economic determinants of performance and to propose ways of improving to strengthen the long-term viability of this strategic sector.

Materials and Methods

Study area and sampling

The study was conducted in the wilayas of Béjaïa, Bouira and Tizi Ouzou, the main extensive olive-growing areas in northern Algeria. The sample consists of 38 extensive olive farms, selected according to several criteria: minimum area of one hectare, orchard in full production (over 15 years old), olive production intended for crushing and proven economic orientation (Fig. 1).

The breakdown across the three wilayas is as follows: [16] farms in Béjaïa, [11] in Bouira

and [11] in Tizi Ouzou, which reflects the relative importance of each area in terms of the region's total olive-growing area. The sampling was carried out using a reasoned sampling approach, in collaboration with the Directorates of Agricultural Services (DSA) of the relevant wilayas. The support of the DSAs facilitated the identification of willing and cooperative farmers, which contributed to the quality of the data collected. This approach aims to ensure geographical and structural representativeness of the diversity of extensive olive farms in the region, even though it does not allow for strict statistical generalization to the entire olive-growing population of the wilayas studied.

Extensive farming refers to farms classified as S1 and S3 according to the International Olive Council (IOC, 2015) classification. These systems correspond to traditional olive groves grown under rain-fed conditions, with low density (<180 trees ha^{-1}), planted on land with a pronounced slope $>$ to 20 % for S1 or moderate slope $<$ to 20% for S3, characteristic of traditional olive-growing areas.

It should be noted that the world's olive groves are classified by IOC into seven production systems (S1 to S7) according to planting density, topographical conditions and water regime (IOC, 2015). In this study, only systems S1 and S3 were included, in line with the objective of analyzing traditional extensive olive groves. The other systems (S2 to S7), corresponding to irrigated, intensive or super-intensive olive groves, were excluded due to their different structural and technical characteristics, which fall outside the scope of this research.

Indeed, extensive plantations account for 75% of olive-growing farms, 82 per cent of which are rain-fed and 18% irrigated (Vilar *et al.*, 2018)

Data collection and processing

Technical and economic data were collected between November and December 2024 using a structured questionnaire administered to olive growers. The information concerns structural characteristics (area, age, density, management methods), production costs (inputs, labor, energy, maintenance, crushing, depreciation) and income from the sale of olives or oil. The data was entered and analyzed using Microsoft



Fig. 1. Illustration of an extensive farm in the study area (Thmazi N'amar Barkouk, Ait Imghour, Mechtras, Tizi Ouzou, 2025).

Excel 2019, enabling the calculation of economic indicators.

Economic calculation methods: Several economic indicators were calculated

- Production cost of one kilogram of olives, obtained by dividing the total costs on the farm, comprising fixed costs (FC) and variable costs (VC), by the quantity produced, using the following formula: Production cost of olives = $(VC + FC) / Q_{t_o}$, where Q_{t_o} is the quantity of olives produced;

- Production cost of one liter of olive oil, calculated by dividing the total costs on the farm, comprising fixed costs (FC) and variable costs (VC) which in this case include the costs of transporting and pressing the olives, by the quantity of olive oil produced, using the following formula: Olive oil production cost = $(VC + FC) / Q_{t_h}$, where Q_{t_h} is the quantity of olive oil produced;

- Turnover (TO) represents the total value of sales of olives and olive oil. It is calculated by adding together the amounts from the sale of olives and olive oil. The selling prices are declared by the farmers.

Turnover (TO) = (Unit selling price of olives × quantity of olives sold) + (Unit selling price of oil × quantity of oil sold)

- Farm margins correspond to the difference between turnover (TO) and variable costs (VC) for the gross margin, and the difference between turnover and total costs (VC + FC) for the net margin, according to the following formulae: Gross margin = TO - VC

Net margin = TO - (VC + FC)

- Break-Even Revenue (BER), expressed in value, is the minimum turnover that a farm must achieve to cover all production costs, fixed and variable, resulting in a null net margin. It is calculated as follows:

- Break-even volume (BEV) is the minimum quantity of output (tons of olives or liters of olive oil) that a farm must produce and sell to cover all its costs, yielding a null net margin. It is obtained by dividing the break-even revenue by the unit selling price. It is calculated as:

$BEV = BER / P_u$. P_u is unit selling price of olive or olive oil.

These indicators enable an assessment of the economic sustainability and performance of the extensive olive-growing farms studied. They are essential tools for evaluating the economic viability of olive-growing systems (De Luca *et al.*, 2023; Di Vita *et al.*, 2013). For the calculations, the following was taken into account.

Fixed costs (FC) comprise depreciation, the rental value of the land and overheads; variable costs (VC) include seasonal labor, inputs, milling costs and marketing expenses.

For milling costs paid in cash or in kind, the latter range from 900 to 1,200 DZD per quintal in cash or as a levy of 1/8th, 1/9th or 1/10th of the oil produced in kind.

Turnover was calculated by valuing the entire production, whether sold or consumed on the farm, at the market prices reported during the survey.

Marketing costs are virtually zero, as sales are generally made using reused packaging provided either by the farmer or the buyer.

Table 1. Descriptive characteristics of the extensive olive farms studied

Indicators	Average value	Mini	maxi	Standard deviation	Median	Quartile 1	Quartile 3
Area (ha)	3.78	1	13	2.98	3	2	4.37
Total olive production (t)	8.47	0.6	45	10.74	4	2.07	10.27
Yield (t ha ⁻¹)	2.22	0.3	7.93	1.89	1.46	0.85	3
Number of olive trees ha ⁻¹	89.2	27	180	36.05	88.33	68.75	100
Total labor (days)	113.92	12.5	530.5	131.50	62	48	116
Total AWU	0.52	0.06	2.41	0.60	0.28	0.22	0.53
Labor (days) per ha	31.58	4.8	100	21.73	25.1	16.22	44
AWU per ha	0.14	0.02	0.45	0.1	0.11	0.07	0.2

Depreciation of fixed assets was calculated using the straight-line method, with a useful life set at 5 years for agricultural machinery, 20 years for buildings and 30 years for the olive grove. Interest on fixed capital was not considered due to the lack of reliable data to estimate the opportunity cost of agricultural assets.

The labor force comprises both family labor and seasonal labor. The former was valued at 1,500 DZD per day, which corresponds to the average wage for seasonal labor in the study region at the time of the survey. The latter was estimated based on the farmers' declarations. The inclusion of family labor in production costs makes it possible to compare results between farms with different labor structures and avoids an overestimation of the net margin in systems with high levels of family labor.

The annual rental value of the land has been set at 5,000 DZD ha⁻¹, in accordance with Law No. 21-16 of 30 December 2021. Shared costs (energy, fuel, equipment maintenance) have been allocated in proportion to the share of olive-growing income in the farm's total income. This rental value represents the opportunity cost of the land and is applied to all farms to ensure consistency within the analytical framework.

All economic indicators were calculated at the level of each individual farm, and the statistics presented (averages, minimums, maximums) were derived from these individual values, thereby avoiding aggregation bias. All monetary values are expressed in Algerian dinars (DZD).

Results and Discussion

The olive farms studied are extensive, mainly using traditional systems. They are

characterized by rain-fed cultivation, low planting density (an average of 89.2 ± 36.05 trees ha⁻¹) and often sloping topography, which severely limits mechanization. The labor force is mainly family-based, with low work intensity, reflected in an average of 31.58 working days per hectare, or approximately 0.14 Annual Work Unit (AWU) ha⁻¹.

These farms, with an average size of around 3.78 ± 2.98 hectares, produce an average of 8.47 ± 10.74 tons of olives, with a yield of 2.22 tons per hectare (Table 1), which remains modest but consistent with rainfall conditions and the low level of intensification observed. The most labor-intensive operations remain harvesting and pruning, which account for almost all annual interventions.

These results confirm that olive growing in the region studied remains above all a family activity playing a role in supplementing the income of rural households. A significant part of production is intended for self-consumption, which reflects the maintenance of a production model that is more social than economic (Amrouni Sais *et al.*, 2021; Zaidi *et al.*, 2021; IOC, 2015).

These findings are also part of a broader trend observed in Mediterranean olive-growing countries, where traditional extensive olive cultivation remains dominant (Fernandez Escobar *et al.*, 2013; Florentino, 2018; IOC, 2015; Russo *et al.*, 2016; Bernardi *et al.*, 2021; Iofrida *et al.*, 2020). Thus, the farms studied have structural and functional similarities with these Mediterranean models, reflecting a strong social and cultural resilience linked to the local olive-growing tradition.

The average cost of producing one kilogram of olives is estimated at 53.62 ± 10.39 DZD with significant variability from farm to farm,

Table 2. Average unit costs of production and cost price of olive oil in the farms (DZD)

Indicators	Average	Minimum	Maximum	Standard deviation
Unit production cost of one kg of olives	53.62	40.20	77.61	±10.39
Unit cost price of one liter of oil (excluding fixed costs)	357.99	200	563.64	±92.87
Unit cost of one liter of oil (excluding rental value)	362.90	201.25	565.91	±92.96
Unit cost of one liter of olive oil (all costs included)	383.75	232.5	573.48	±94.07

reflecting differences in yield and cultivation practices (Table 2). The total cost price of one liter of olive oil averages 383.75 ± 94.07 DZD, all charges included, which remains competitive overall in relation to the selling prices observed on the local market (a range of 700 to 1,100 DZD). The results show that the fixed costs represent a marginal part of the total cost, confirming the low capital but highly manual work-dependent nature of the extensive olive-growing model studied.

Traditional extensive farms have high production costs, mainly due to low productivity and high labor intensity, primarily for harvesting and pruning (Amrouni Sais *et al.*, 2021; Bernardi *et al.*, 2021; IOC, 2015, Di Vita, 2013; Elfkih and Karray, 2011). Indeed, Bernardi *et al.* (2021) showed that the only way to reduce production costs in olive groves was through mechanical harvesting, as opposed to manual harvesting.

Analysis of the extensive olive farms studied reveals a wide variety of economic situations, despite relatively homogeneous agroecological and technical conditions. Turnover, costs, and margins vary significantly from one farm to another, reflecting the diversity of practices, yields, cultivars, and agricultural management techniques (Di vita *et al.*, 2015).

The average turnover amounts to $950,001.3 \pm 1,031,179.6$ DZD, with extreme values between 100,800 DZD and 4,410,000 DZD (Table 3). This high amplitude is mainly explained by the size of the orchards and the yield of the olive trees (Table 1). Total variable costs averaged 460,333.4 DZD, or 48% of turnover, reflecting overall cost control, particularly in terms of labor, which

is the main item of expenditure. This finding is consistent with observations made in most olive farms around the Mediterranean, where mechanization remains limited and harvesting requires a large workforce (Karray *et al.*, 2000; IOC, 2015, Bernardi *et al.*, 2021; Amrouni Sais *et al.*, 2021).

The average net margin is $466,611.5 \pm 552,502.6$ DZD per farm, confirming overall positive profitability for all farms, although some producers have more modest margins due to low yields or high harvesting costs. These results attest to the economic viability of the extensive model in the region studied, even under a rain-fed regime. However, they also highlight a marked heterogeneity among farms (which is already reflected in the high standard deviation) and the fragility of some production units, whose performance remains highly sensitive to climatic conditions, yield variability and cost fluctuations (Gomez-Limon and Sanchez-Canizares, 2023).

Indeed, the net margin shows considerable variation, with a first quartile of 108,212.5 DZD and a third quartile of 531,121.9 DZD. Thus, 50 per cent of the farms fall within a range of 422,909.4 DZD, revealing significant heterogeneity in economic performance within the sample.

The break-even point is a key indicator of the economic sustainability of farms. It is estimated at $53,470.7 \pm 83,859.6$ DZD per farm, or $12,376.5 \pm 14,920.7$ DZD ha⁻¹ (Table 4). In terms of production, this threshold corresponds to approximately 0.53 tons of olives or 71.29 liters of olive oil. This relatively low level indicates that most of the farms studied are

Table 3. General economic indicators for extensive olive farms (DZD)

Indicators	Average	Minimum	Maximum
Turnover	950,001.3	100,800	4,410,000
Variable costs	460,333.4	39,500	2,133,667
Direct margin	489,667.9	42,100	2,276,333.3
Fixed costs	23,056.4	1,210	170,200
Net margin	466,611.5	32,100	2,204,333.3

Table 4. Break-even point for extensive olive farms (DZD)

Indicators	Average	Minimum	Maximum	Standard deviation
Break-even revenue	53,470.7	2,014.3	364,609.8	83,859.6
Break-even revenue per ha	12,376.5	1,517.9	91,152.4	14,920.7
Break-even volume olive (t)	0.53	0.02	3.65	0.84
Break-even volume oil (l)	71.29	2.68	486.15	111.81

able to cover their annual costs, but the safety margin remains limited given the volatility of oil prices and the irregularity of yields (Gomez-Limon and Sanchez-Canizares, 2023). The most efficient farms are those that value the oil directly from consumers, consisting of loyal customers, their acquaintances, and their extended family.

The results show that despite overall positive profitability, the economic sustainability of extensive olive farms remains fragile. Profit margins are highly dependent on climatic conditions and market price fluctuations (Gomez-Limon and Sanchez-Canizares, 2023). Nevertheless, the cost structure remains favorable thanks to low input intensity and local marketing of production.

These empirical results obtained corroborate those of several previous studies (De Luca *et al.*, 2023; Cardone *et al.*, 2021; Maesano *et al.*, 2021; Iofrida *et al.*, 2020; Di Vita, 2013; Elfkih and Karray, 2011; Mohamad *et al.*, 2013), which show that extensive models, although with a certain economic reliability, remain less efficient than intensive systems (Mohamad *et al.*, 2013; Iofrida *et al.*, 2020; Ben Abdallah *et al.*, 2022). Furthermore, some studies report negative economic results for traditional olive-growing systems, highlighting their limitations in terms of profitability and efficiency. Traditional management methods and low levels of innovation compromise the sustainability and longevity of these olive groves. In addition, the predominance of the family model, which is mainly justified on cultural grounds, may no longer be sufficient in the long term. (Mokrani *et al.*, 2022).

In order to improve the sustainability and economic performance of traditional olive farms, several courses of action can be considered. The rational modernization of agricultural practices is a priority lever, through the introduction of more efficient management techniques, the reduction of input costs and the optimization of workforce (Amrouni Sais and Benzouiche, 2025;

IOC, 2015). Crop diversification also appears to be a strategic axis for strengthening the economic viability of farms. When carried out in a thoughtful manner, it promotes a reduction in the use of inputs (pesticides, fertilisers, water) and associated environmental damage, while improving the overall profitability of agricultural systems (Thoyer *et al.*, 2014; INRAE, 2023, Amrouni Sais *et al.*, 2025; Vergara-Romero *et al.*, 2025; Amrouni Sais, 2026).

In this context, agroforestry offers a promising way to reconcile productivity, sustainability and profitability in olive growing systems. By combining olive trees with other crops or livestock, this model allows for better use of space and resources, stabilizes income and improves economic resilience in the face of climate hazards (Amassaghrou *et al.*, 2021; Barbault, 2023).

Furthermore, in a context of valorization of agricultural production, geographical indications appear to be a valuable development tool, meeting growing demands for quality, traceability, food safety and economic profitability (Allaire, 2009). Finally, organic farming is a particularly attractive alternative for promoting local resources, improving the economic performance of farms and strengthen social inclusion (Amrouni Sais and Fethallah, 2025). Comparative studies show that organic olive farms are more economically sustainable than conventional farms (Laajimi and Ben Nasr, 2009; Bouzaida and Doukali, 2019; Iofrida *et al.*, 2020).

Conclusions

The economic analysis of extensive olive farms shows generally positive indicators, demonstrating clear economic profitability despite a low level of intensification. However, this performance remains fragile and dependent on price and demand stability, labor availability and regular yields. These systems, which are mainly rain-fed and low-density, remain exposed to climatic hazards and structural

limitations linked to low mechanization and the age of the orchards.

Beyond their economic dimension, these farms play an essential role in preserving the landscape heritage and the traditional agricultural model, based on family management and the rational use of resources. To strengthen their sustainability, it appears necessary to promote support strategies that integrate the promotion of local olive oil, the adoption of agroecological practices, and technical and institutional support for producers. These levers would ensure long-term economic viability while preserving the social and environmental functions of extensive olive growing in Algeria.

Declarations

The authors have no competing interests.

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