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Impact of labor and input costs on the competitiveness of apple farms: A case study from Korça region, Albania

Ilir Sosoli[1], Remzi Keco[2*], Ilir Tomorri[2]
[1]Department of Agribusiness, University "F.S.Noli" Korcë, Albania.
[2]Department of Agribusiness Management, Agricultural University of Tirana, Albania; rkeco@ubt.edu.al (R.K.).

Abstract: This study investigates the influence of labor and input costs on the profitability and competitiveness of apple farms in the Korça region of Albania. Drawing on primary data collected from 125 apple farms during the 2024 growing season and secondary data from national and regional sources, the study evaluates how cost variations impact farm-level economic outcomes. Findings reveal that labor and input costs jointly constitute over 90% of total production expenses, with labor averaging 40–45% and inputs 50–55% of total costs. Cost fluctuations, particularly during harvest and fertilizer procurement periods, have a substantial effect on unit production costs and market competitiveness, as measured by the cost-competitiveness ratio. This study highlights the crucial role of labor and input costs in determining the competitiveness of apple farms. Input costs represent a continuous and significant challenge for farmers in their activities. The study concludes that to sustain competitiveness, apple farmers in Korça must adopt cost-reduction strategies and benefit from targeted policy support such as labor subsidies and cooperative input purchasing.

Keywords: *Apple farming, Competitiveness, Cost-efficiency, Input costs, Labor costs, Policy support.*

1. Introduction

Agriculture remains a critical sector for the Albanian economy, contributing approximately 20% of GDP and employing a significant portion of the rural population [1]. Within this sector, apple production is of particular importance in the Korça region, which is recognized as the main apple-producing area in Albania [2]. Despite favorable climatic and soil conditions, the competitiveness of apple farms in the region faces high labor costs, rising input prices, a lack of modern agricultural technologies, and instability and lack of support in the sale of production.

These challenges are compounded by limited access to financial services, weak integration into value chains, and inadequate market infrastructure. Apple cultivation is an important economic activity for Albanian agriculture. Apple is the most cultivated and consumed fruit in Albania, and knowledge of the structure of income and expenses is of particular importance in making investment decisions. This activity constitutes an important source of income for farmers in this region.

1.1. Background on Apple Farming in Korça

Apple farming is a major agricultural activity in Korça, Albania, with optimal soil and climate conditions fostering extensive cultivation. The sector supports regional employment and contributes significantly to the local economy. Apple production has shown consistent growth, fulfilled a large portion of domestic demand, and boosted export potential. National statistics reveal that Korça accounts for approximately 27% of Albania's fruit tree production, underlining its agricultural prominence.

The region's pivot toward a market-oriented model emphasizes efficiency, profitability, and sustainability, with local buyers and wholesalers integrating farmers into broader markets. Data trends

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* Correspondence: rkeco@ubt.edu.al

show declining imports and rising exports, underscoring increased self-sufficiency and international engagement.

Table 1.
Data on apple production.

No.	Indicator	Unit	2018	2020	2022
1	Surface	Ha	4,294	4,420	4,294
2	Production	Ton	108,375	102,167	103,645
3	Export	Ton	4,647	5,597	8,516
4	Import	Ton	6,243	8,076	7,242
5	Consumption	Ton	109,972	104,646	102,370
6	Import / Consumption	%	5.6	7.7	7.1
8	Export / Production	%	4.2	5.3	10.3

Source: Food and Agriculture Organization of the United Nations (FAO) [3].

As indicated above, this shift towards self-sufficiency is reflected in small percentages in imports, while exports have slightly increased. Local buyers and wholesalers are the primary channels through which farmers sell their apples, further integrating into the sector into national and regional markets.

1.2. Economic context

Despite Korça's significance in apple production, farmers in the region face a range of economic challenges that jeopardize farm profitability. Rising labor costs, fluctuating prices of agricultural inputs, and limited access to affordable credit create financial pressures on producers. Labor costs are particularly influential, driven by the high demand for seasonal labor during critical activities such as pruning and harvesting, which are both time-sensitive and labor-intensive. Additionally, the seasonal migration of young people to neighboring Greece further exacerbates labor shortages.

Meanwhile, input costs such as fertilizers, pesticides, and fuels are highly volatile, and efforts to reduce these expenses often compromise both quality and production. These challenges are further compounded by inadequate infrastructure and limited market access, which increase production costs and reduce overall profitability for many farmers.

1.3. Research objectives

This study aims to assess how variations in labor and input costs impact the productivity and profitability of apple farms in the Korça region.

By quantifying the specific weight and effects of these cost components on the unit production cost of apples, the study seeks to understand the economic pressures on farmers and identify key areas where cost management could improve competitiveness. Our research provides insights into potential policy measures and management practices that could support apple producers in the Korça region, enhancing both the sustainability and resilience of this essential agricultural sub-sector.

2. Literature Review and Theoretical Framework

Today's agricultural sector and fruit production are characterized by continuous challenges, encompassing environmental and socio-economic concerns such as biodiversity loss, water pollution, low income for farmers, and rural abandonment [4]. In an agricultural country like Albania, apples are a major agricultural product, providing income for farmers at regional scales. Factor allocation refers to the allocation and combination of agricultural production factors such as capital, labor, land, technology, fertilizer, and machinery in the process of production by apple growers [5].

The competitiveness of agricultural production in Albania, particularly in the apple farming sector, is shaped by several structural and economic factors. The country's agricultural sector remains dominated by smallholder farms, which restrict scalability and investment in technology [6]. These

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limitations are particularly pronounced in the Korça region, where apple production is prevalent but faces increasing cost-related pressures.

Imami and Skreli [7] in their study, they identified the main obstacles in the apple value chain in Albania, including poor farm organization, limited access to storage and warehousing, and high input costs.

Labor costs are a significant constraint on productivity and efficiency. Studies show that labor accounts for 20–28% of orchard production costs globally, with variations based on farm size, mechanization levels, and workforce availability [8]. In Korça, seasonal labor shortages exacerbated by youth migration amplify wage pressures during critical periods such as pruning and harvest.

Labor constitutes a major component of total production costs in fruit farming, particularly for crops such as apples that require intensive seasonal labor for pruning, thinning, and harvesting [9].

Antal et al. [10] in their study, they observed that the integrated system consistently had higher apple fruit yield and quality than the organic system. Furthermore, the integrated management system performed better not only in yield and quality but also in surplus income.

In a comparative study, Clark [11] highlights how labor-intensive orchard systems remain vulnerable to fluctuations in labor availability and cost, particularly in transitioning economies. Galinato et al. [12] find that mechanization in pruning and harvesting can reduce reliance on seasonal labor, but adoption remains limited in regions like Korça due to financial constraints.

As Sheldon [13] argues, access to affordable and efficient input markets significantly shapes farm-level competitiveness. Input volatility, especially for imported items like fertilizers and pesticides, has been shown to impact profit margins across European and Balkan farming systems. Input costs represent an equally critical dimension. Badiu et al. [14] support this, noting that input price shocks have long-term implications on farm investment decisions, particularly in perennial systems like apple orchards. According to Osmani and Kambo [15], fragmented agricultural land is considered the major structural obstacle to faster and more efficient development of the agricultural sector.

Competitiveness in agricultural markets is increasingly assessed through dynamic metrics such as the cost-competitiveness ratio, which compares unit production costs to market prices. Pathiraja et al. [16] emphasize this ratio as a vital tool in benchmarking sectoral efficiency across different countries.

Applying such a metric in Korça provides a meaningful way to assess both short-term profitability and long-term economic resilience. While precision agriculture and digital technologies offer potential for cost optimization, their adoption remains limited among smallholder apple producers in Albania. Future studies may further investigate how scalable these innovations are within constrained financial and infrastructural contexts. The Korça region, although a major apple-growing region, faces challenges in adopting mechanized practices and accessing financial support schemes.

The development of this sector is accompanied by problems and challenges such as increasing the productivity of agricultural farms, efficiency of resource use, cooperation between small farmers, access to financing, modernization of the value chain, marketing and sale of agricultural products, as well as building administrative capacities to support these processes [17].

This study builds upon these insights by providing a localized, data-driven analysis of how labor and input costs affect the unit production cost and competitive standing of apple farms in Korça. It contributes to the literature by integrating farmer-level economic data with region-specific production dynamics and policy implications.

3. Materials and Methods

3.1. Data Collection

To evaluate the impact of labor and input costs on apple farm competitiveness in the Korça region, both primary and secondary data sources were utilized. Primary data were obtained through structured surveys conducted with 125 randomly selected apple farmers from intensive cultivation zones. The surveys included detailed questions regarding labor expenses, input usage and costs, and annual production volumes.

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To ensure comprehensive coverage and data triangulation, secondary data were gathered from official publications of the Albanian Ministry of Agriculture and regional agricultural departments. These sources provided information on prevailing input prices, average wages, yield benchmarks, and regional production trends. In addition, financial reports from agricultural cooperatives and local supply companies were analyzed to cross-validate self-reported farmer data, particularly regarding input expenditures for fertilizers and pesticides.

3.2. Variables and Metrics

The study focused on three main categories of variables:

a. Labor Costs: This includes wages for permanent workers, payments to seasonal laborers (especially during pruning and harvest), and any additional benefits such as meals or transportation. Labor costs were assessed per hectare and as a percentage of total farm expenses.
b. Input Costs: These included costs related to fertilizers, pesticides, irrigation, machinery fuel, and maintenance. Input costs were calculated both per hectare and as a proportion of total production costs.
c. Yield: Yield was measured as total apple output in kilograms per hectare. This metric was crucial for calculating unit production costs and for comparing cost-efficiency across farms.

3.3. Analytical Approach

To understand the relationship between input and labor costs and farm profitability, a multi-step analytical process was adopted:

Sensitivity Analysis: This technique tests how variations in labor and input costs (e.g., ±10%) affect the unit production cost and profitability margins.

a. Regression Analysis: A multiple regression model was employed, where farm profitability was the dependent variable and labor cost, input cost, and yield were independent variables. This allowed quantifying the size effect of each cost component on overall profitability.
b. Cost-Competitiveness Ratio: The competitiveness of apple production was assessed using the ratio of market price to unit production cost. A ratio above 1.0 indicates profitability, while a ratio below 1.0 suggests uncompetitive pricing.

This methodology enabled a robust evaluation of how cost structures influence the economic performance of apple farms in the Korça region and offered data-driven insights for improving cost efficiency and competitiveness.

4. Results

4.1. Labor Cost Findings

Survey results from the 125 apple farms in Korça reveal that labor costs account for approximately 40–45% of total production expenditures. These costs are particularly concentrated during labor-intensive phases such as pruning, thinning, and harvesting. Seasonal laborers make up the bulk of the workforce, and labor shortages exacerbated by youth migration to urban centers or abroad have led to rising daily wage rates. For example, wage premiums during the harvest season increased by an estimated 10–15% over the previous year. This aligns with findings from Clark [11], who highlights the sensitivity of labor-intensive orchard systems to fluctuations in labor market conditions.

4.2. Input Cost Findings

Input costs, encompassing fertilizers, pesticides, fuel, irrigation, and maintenance, represent 50–55% of total production costs. Fertilizer costs alone increased by over 15% from the previous year, a trend driven by global price volatility and reliance on imports. Pesticide applications remain a significant recurring expense due to heightened pest and disease pressures in the region. As Sheldon [13] notes,

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fluctuations in input prices are a major determinant of profitability in horticultural systems, particularly where input markets are externally influenced.

4.3. Impact on Unit Production Cost

When combined, labor and input costs represent roughly 90–95% of the total cost of producing one kilogram of apples. Assuming an average yield of 30,000 kg per hectare and total costs of approximately €12,000 per hectare, the estimated unit production cost is around €0.40 per kg. Labor contributes approximately €0.18 per kg, while inputs contribute €0.22 per kg. These figures highlight the sensitivity of profitability to fluctuations in either cost category.

4.4. Competitiveness Analysis

The cost-competitiveness ratio, calculated as the farm-gate market price divided by unit production cost, averaged 1.25 under stable price conditions (€0.50/kg market price vs. €0.40/kg cost). However, in scenarios where input or labor costs increased or market prices decreased, this ratio dropped below 1.15.

This decline signifies reduced profitability and highlights the financial vulnerability of farms to price and cost shocks.

Pathiraja et al. [16] identify this metric as critical for policy benchmarking in agri-food systems, and its application here underscores the need for targeted support mechanisms to stabilize costs.

These results collectively emphasize that managing labor and input costs is essential for maintaining competitiveness and economic resilience among apple producers in Korça. Innovations such as precision agriculture and cooperative input procurement could offer avenues for cost containment, though their uptake remains limited among smaller farms.

Table 2.
Data on the technological package for apple production in intensive orchards- area 1 ha (retail inputs)

No.	Cost items	Unit	Value in ALL	Production cost (ALL/kg)	Structure of expenses in %
1	Agricultural mechanics	Ha	133,000	2.7	9.6
2	Wing work	Working day	300,000	6.0	21.7
3	Inputs/materials	kg	654,000	13.1	47.2
4	Other expenses	n/a	149,200	3.0	10.8
*	Total Variable Costs		1,236,200	24.8	89.3
5	Total Fixed Costs	ALL	148,400	3.0	10.7
*	Total Costs	ALL	1,384,600	27.8	100
*	Total Income	ALL	2,150,000		
*	Net Profit	ALL	765,400		

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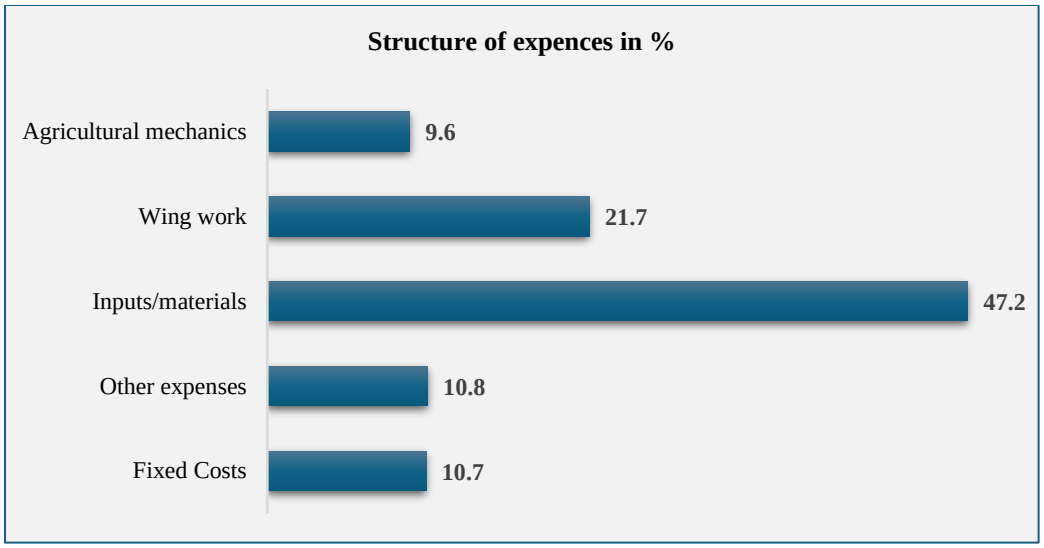

Figure 1.
Data on the structure of expenses for apple production per 1 ha.

Referring to the above data, the structure of costs to produce 1 ha of apples is as follows: for agricultural mechanics 9.6%; for wing work 21.7%; for inputs/materials 47.2%; for other expenses 10.8%; and for fixed costs 10.7%. Similarly, inputs such as fertilizers, pesticides, and irrigation account for a significant share of operational expenses. Cost inefficiencies may arise due to overreliance on manual labor, outdated technology, and fragmented land use.

5. Discussion

5.1. Data Analysis and Findings

5.1.1. Comparative Cost Impact

Input costs exert a slightly greater influence on profitability than labor costs, given their larger share of total expenses and persistent upward price trends. However, labor costs create acute financial stress during short, high-demand periods. Input costs, particularly for fertilizers and pesticides, fluctuate based on global supply chains and currency exchange rates, posing a continuous risk to farm budgets. In contrast, labor cost pressures are seasonal but can severely disrupt operations if shortages arise. Both cost types are critical, but input costs represent a more sustained threat to long-term competitiveness.

5.1.2. Economic Implications for Farmers

Fluctuating labor and input costs directly affect farmer income and decision-making. Rising labor costs may force farmers to delay harvests or reduce staff, which can compromise fruit quality and yield. Increased input costs may lead to reduced application rates, risking lower productivity. In response, some farmers delay purchases, seek alternative suppliers, or cut back on high-cost inputs, potentially harming long-term soil fertility and crop health. These cost pressures drive farmers to reevaluate their cropping strategies, investment decisions, and financial planning, increasing the risk of farm consolidation or exit from the sector.

5.1.3. Regional Considerations

Korça's reliance on seasonal labor and imported inputs amplifies exposure to external shocks. Migration trends reduce the local labor pool, inflating wages during peak seasons. Input supply chains are vulnerable to international disruptions, with limited regional buffering capacity. Local policies have

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not fully addressed these risks, leaving farmers to navigate cost fluctuations independently. Region-specific policy support, including subsidies for key inputs and labor programs targeting rural youth employment, could mitigate these vulnerabilities and enhance the resilience of apple farms.

6. Conclusions

This study highlights the crucial role of labor and input costs in determining the competitiveness of apple farms in the Korça region. Input costs present a more persistent and significant challenge to long-term profitability, while labor costs cause seasonal financial stress, especially during harvest. Both cost types require targeted interventions to stabilize farm operations.

To improve cost management, farmers should consider cooperative purchasing strategies, adopt efficient labor practices, and utilize precision farming techniques.

Labor and input costs are critical factors affecting farm-level competitiveness. Empirical findings from the Korça region indicate that labor and input costs constitute a significant portion of total production costs in apple cultivation. These costs directly influence farm activity and productivity, price competitiveness, and farmers' ability to sustain or expand operations.

Mechanization and efficiency levels remain low. Many farms still rely on manual labor for various stages of production, which increases dependence on seasonal labor, raises labor costs, and reduces productivity.

Price volatility and market access. Fluctuations in input prices (e.g., fertilizers, pesticides) and limited bargaining power in the value chain put additional pressure on farmers, reducing margins and investment capacity.

Limited access to financial support and a lack of technical and professional knowledge. Despite the availability of financial support schemes from public institutions and EU-supported programs for the rural sector, these funds are not sufficiently accessed by some farmers, missing out on opportunities to invest in technology to enable increased efficiency, reduced costs, and higher productivity on their farms.

Small farm sizes limit economies of scale. Fragmented land plots and small-scale production prevent farmers from benefiting from economies of scale, further increasing unit labor and input costs.

Policymakers should design strategies to support these efforts with tailored subsidies, rural employment programs, and incentives for sustainable farming.

Strengthening these areas will not only improve the competitiveness of apple farms but also enhance the sustainability and economic stability of Korça's agricultural sector overall.

7. Policy Recommendations

7.1. Supporting Labor Market Stability

To address labor shortages and seasonal wage surges, it is essential to establish structured regional seasonal labor programs. These initiatives would focus on attracting and training local workers, equipping them with the necessary skills for agricultural tasks such as pruning, thinning, and harvesting. This could be facilitated through local vocational centers or partnerships with agricultural institutions.

Moreover, to ease the payroll burden on farmers during labor-intensive periods, the government should consider providing wage subsidies. These subsidies would help stabilize labor costs and ensure adequate staffing levels during peak seasons. Additionally, creating mobile labor pools organized by agricultural cooperatives or local authorities could provide a flexible and readily available workforce that can be deployed to farms as needed. Such a system would reduce recruitment inefficiencies and help match labor supply with seasonal demand.

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7.2. Input Cost Management

Managing input costs requires collective strategies and policy backing. One effective measure is to promote the formation of cooperative purchasing groups. These groups allow farmers to pool their demand for fertilizers and pesticides, thus securing better prices through bulk buying. In parallel, offering targeted input subsidies to small and medium-sized farms would make essential materials more affordable and accessible.

Encouraging the adoption of precision agriculture technologies can also reduce unnecessary input use, cut costs while maintaining yield and quality. These technologies enable data-driven application of fertilizers and pesticides, reducing waste and environmental impact. Furthermore, investing in local production facilities for agricultural inputs would reduce the sector's reliance on imports and mitigate risks associated with global supply chain disruptions. Such investments would contribute to regional economic development while improving the predictability and affordability of inputs.

- *Promote investment in mechanization and input-efficiency technologies.*
- Policymakers and development agencies should prioritize support for the adoption of cost-reducing technologies, including mechanized harvesting, precision fertilization, and integrated pest management. Such interventions can substantially reduce labor dependency and optimize input use.
- Strengthen farmer cooperatives and associations. Organizing farmers into cooperatives can enable bulk purchasing of inputs at lower prices, shared use of machinery, and collective marketing strategies to improve competitiveness, enhance farmers' negotiating power, and reduce transaction costs.
- Increase access to training and extension services. Extension programs should focus on equipping farmers with the skills and knowledge required to manage costs more effectively, adopt sustainable production practices, and use inputs efficiently, especially for smallholders.
- Facilitate access to subsidies and agricultural support programs. Institutions and public agencies should improve and simplify application procedures, provide technical assistance for farmers to benefit from subsidies and support schemes, and offer guidance on how to apply effectively.
- Encourage diversification and value addition. Diversifying farm activities and promoting post-harvest processing (e.g., apple juice, dried apples) can improve income stability and can also help offset high production costs. Adding value to apples through branding or certification (e.g., organic, regional labels) can also enhance market competitiveness.
- Support further research and data-driven decision-making. Encourage regular cost-benefit analysis at the farm level and support research on best practices for apple production in Albania's specific agro-climatic conditions. Data-driven approaches should inform policy design and the development of regionally tailored interventions to enhance productivity and resilience.

7.3. Future Research

Future studies should investigate the potential of mechanization and digital technologies in reducing labor intensity and improving efficiency in apple cultivation. Understanding the cost-benefit dynamics of such investments would provide valuable guidance for farmers and policymakers.

In addition, exploring how climate change affects input requirements, pest dynamics, and irrigation needs could inform more adaptive and sustainable farm management practices. Comparative studies on the profitability and cost resilience of apple farming versus other fruit crops in Albania would also offer insights into optimal crop choices under changing economic and environmental conditions.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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