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ECONOMIC FEASIBILITY OF OLIVE OIL PRODUCTION IN PAKISTAN

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Abstract
The olive oil industry has proved to be a viable option for reducing Pakistan's reliance on imported edible oils and improving farm profitability in areas with a suitable climate. The economic viability of olive oil production was analyzed using project-level data collected from 30 orchards in Pakistan's major olive-growing areas. Economic analysis criteria were compared based on parameters such as annual net profit, benefit–cost ratio (BCR), and payback period, using inferential statistical methods. The average annual net returns were PKR 2.12 million per hectare (ha) (range: PKR 0.61–3.20 million), and the mean BCR was 6.43, indicating strong financial feasibility in most projects. The average payback period was 0.64 years, indicating a relatively fast return on the initial investment. One-way ANOVA indicated significant provincial variation in net income ($F = 9.84$, $p < 0.001$), with the highest profitability observed in Baluchistan (PKR 2.82 million/ha) and Gilgit-Baltistan (PKR 2.73 million/ha). In contrast, it was at a minimum in Sindh (PKR 1.36 million/ha). The Pearson correlation analysis indicated strong positive correlations between net profit and the amount of olive withstanding ($r = 0.81$), oil extraction rate ($r = 0.69$), and farmgate price ($r = 0.74$). In contrast, variable production costs were negatively associated with profitability ($r = -0.63$ at $p < 0001$). Linear regression analysis accounted for 79% of the variability in net income ($R^2 = 0.79$) and identified olive yield and farmgate price as the best positive predictors. Olive oil production is economically viable in Pakistan, especially in ecologically compatible areas, provided yields are optimized, costs are effectively controlled, and continuous market access is ensured.

INTRODUCTION

An edible oil deficit has been widening the gap between the edible oils production in Pakistan and its requirement. Therefore, olive (*Olea europaea L.*) cultivation is one of the most viable alternative crops to import substitution, rural income diversification and value chain

development. Several recent studies and policy discerning reviews underscore the fact that Pakistan has much climatically proper land particularly in Punjab (Pothwar), Khyber Pakhtunkhwa, Baluchistan, Gilgit-Baltistan, and Azad Jammu and Kashmir—that is capable to support commercial grade olive crop [1]. The PakOlive Olive Project has accelerated orchard establishment, nursery production as well as the development of processing facilities with the intention to ultimately establish a sustainable local olive oil industry [2]. But beyond what agronomy says, good economic evidence is required to help guide investment and policy priorities.

Past economic feasibility studies on olive growing in Pakistan and other comparable developing olive regions have uniformly shown that the profitability of the crop is extremely sensitive to optimal yields, effective oil extraction, cost regime and market share. The mega studies and pre-feasibility reports on the olive growing in Pakistan reveal that commercial cultivation may be a profitable enterprise under certain management; outcomes are largely area or production system specific [3]. Equally, utilizing data from other non-traditional olive regions, semi-intensive production systems are known to offer positively contributing benefit–cost ratio due to efficient milling operations and because of predictable price received but small margins can be easily eroded by high operational cost or poor value-chain integration [4, 5]. Market-oriented analyses also reveal that farmgate price, quality difference, and activities of value addition downstream are fundamental to a farmer's gain [6, 7]. The latest market assessment of Pakistan showed that there was growing domestic demand for olive oil, but also the potential, with concern, of processing capacity weakness, branding and market coordination that may have an influence on the farm level economic impacts [8].

Biophysical potential and resource limitations, in addition to prices and costs, are essential elements of the economic behavior of olive orchards. Land suitability analysis and climate change-oriented studies have shown that productivity variation is heavily affected by agroclimatic, orchard age, planting density, as well as water management [9]. In water-stressed regions, such as the olive-orchard in some area of Pakistan, deficit irrigation may be a possible alternative to increase WUE without yield loss and without significantly reducing the monetary returns across different site-specific situations [8]. Suggests that Pakistan- focused policy and value chain approach is also learning which interventions can convert agronomic opportunities into longer term economic gains will depend on investments in extension, processing and markets linkages8. Under this context, an aggregate economic analysis with different performance criteria such as net profit, benefit-cost ratio (BCR), and payback period along with their determining factors would be of value for advising oil producers, investors and the government regarding the region's potential of olive oil production [10].

2. METHODOLOGY

Economically, it was evaluated olive oil production and the profitability of establishing the project in regions that are important for producing olives in Pakistan. The study was conducted using project-based cross section analytical approach and estimation procedure concentrate on cost–benefit indexes and determining factors of profitability to current production prices and market prices.

The project consisted of olive plantation modules in major agro-climatic zones such as Punjab (Pothwar Plateau and adjoining areas), Khyber Pakhtunkhwa, Baluchistan, Sindh, Gilgit-Baltistan (GB) and Azad Jammu and Kashmir. Projects were selected to represent a variation in orchard size, planting density, tree age and potential yield and production environment. In each application, exactly one observational unit was described.

Project-specific information was recorded on orchard profile, productivity, cost and income. Orchard size was described in terms of orchard area (ha), planting density (trees/ha), average tree age (years) and olive yield (tons/ha) and oil extraction percentage. Economic parameters: economic variables comprised the farmgate price of olive oil (PKR per liter), annual variable costs (PKR per hectare), annual fixed costs (PKR per hectare) and initial establishment investment (PKR per hectare). Economic values such as

annual monetary income (PKR/ha), annual net profit (PKR/ha), benefit–cost ratio (BCR) and simple payback period were calculated.

Income per hectare was calculated by multiplying olive oil production (tons per ha) by the farmgate price. The annualized cost of the program was calculated as the sum of variable and fixed costs. Yearly profit is a speculation extrapolated from annual revenue. The benefit–cost ratio was defined as annual revenue divided by the total annual cost. The payback period is the initial investment cost divided by annual net profit rendered.

IBM SPSS Statistics analyzed data. Descriptive statistics, which including the means, standard deviations and ranges were used to report values of key economic indicators. Comparisons between provinces in net income and benefit–cost ratio were subjected to one-way analysis of variance (ANOVA) with Tukey's post hoc test for multiple comparisons if there were significant differences. Pearson's correlation analysis was applied to correlations between net return and major agronomic and economic attributes. Multiple linear regression analysis was performed to determine significant predictors of net income which are olive yield, oil extraction rate, farmgate price, variable cost and tree age. All analyses were considered statistically significant at a p-value < 0.05.

3. RESULTS

The economic indicators for the olive oil production projects are presented in Table 1. The average net annual income was PKR 2.12 million/ha (range: PKR 0.61 to 3.20 million/ha), indicating high variability across projects. The average benefit–cost ratio (BCR) was 6.43, indicating strong economic relevance for most study sites. The average payback time was 0.64 years, indicating a rapid return on investment.

Table 1: Descriptive Statistics of Key Economic Indicators of Olive Oil Production (n = 30)

Variable	Mean	SD	Minimum	Maximum
Annual net profit (PKR/ha)	2,120,000	642,000	610,000	3,200,000
Benefit–cost ratio	6.43	2.21	2.39	10.98
Payback period (years)	0.64	0.41	0.31	2.10

The one-way ANOVA showed a significant difference in annual net profit across provinces ($F = 9.84$; $p < 0.001$). The highest mean net income, as presented in Table 2, was recorded in Baluchistan and Gilgit-Baltistan, while the lowest profitability was recorded in Sindh. The dispersion of net income across provinces is also depicted in Figure 1, showing differences both between and within provinces.

Table 2: Mean Annual Net Profit by Province

Province	Mean net profit (PKR/ha)
Punjab	2,120,000
Khyber Pakhtunkhwa	2,080,000
Balochistan	2,820,000
Sindh	1,360,000
Gilgit-Baltistan	2,730,000
Azad Jammu and Kashmir	2,220,000

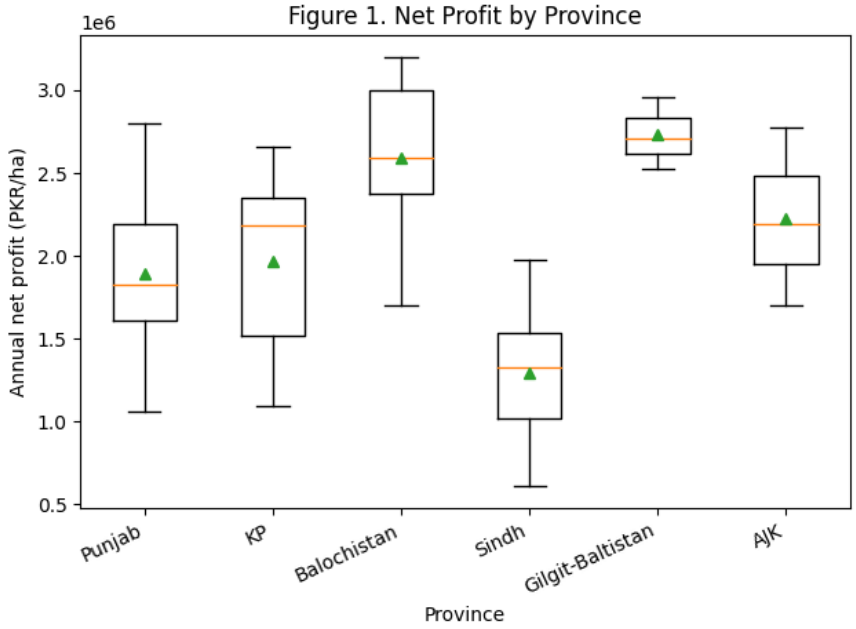

Figure 1: Net profit by province.

There was also substantial provincial variation in the benefit–cost ratio ($F = 11.27$, $p < 0.001$). Average BCR values per province are shown in Table 3 and compared in Figure 2. The region's lowest BCR values were observed in Sindh, whereas the highest economic efficiency was observed in Gilgit-Baltistan and Baluchistan.

Table 3: Mean Benefit–Cost Ratio (BCR) By Province

Province	Mean BCR
Punjab	5.96
Khyber Pakhtunkhwa	5.87
Balochistan	8.02
Sindh	3.76
Gilgit-Baltistan	9.51
Azad Jammu and Kashmir	6.83

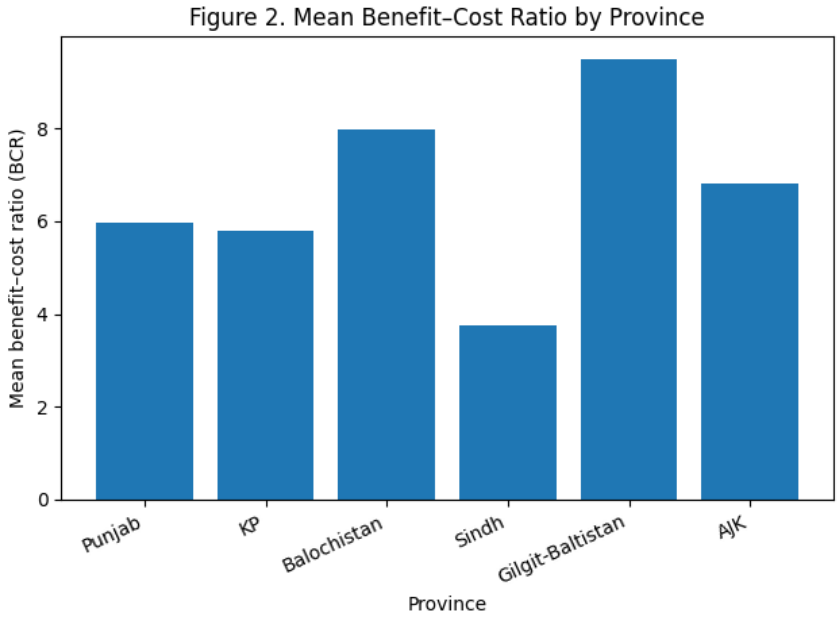

Figure 2: Mean benefit–cost ratio by province

Pearson correlation analysis showed highly significant, positive relationships with olive yield ($r = 0.81$), oil extraction rate ($r = 0.69$), and the farmgate price of olive oil ($r = 0.74$; $p < 0.001$). There was a significant negative relationship between variable cost and net profit ($r = -0.63$, $p < 0.001$). Correlation coefficients are summarized in Table 4. The graphical representations of net profit with olive yield and farmgate price are shown in Figures 3 and 4, respectively.

Table 4: Pearson Correlation Coefficients Between Net Profit and Selected Variables

Variable	r	p-value
Olive yield (t/ha)	0.81	<0.001
Oil extraction rate (%)	0.69	<0.001
Farmgate price (PKR/L)	0.74	<0.001
Variable cost (PKR/ha)	−0.63	<0.001
Tree age (years)	0.58	0.001

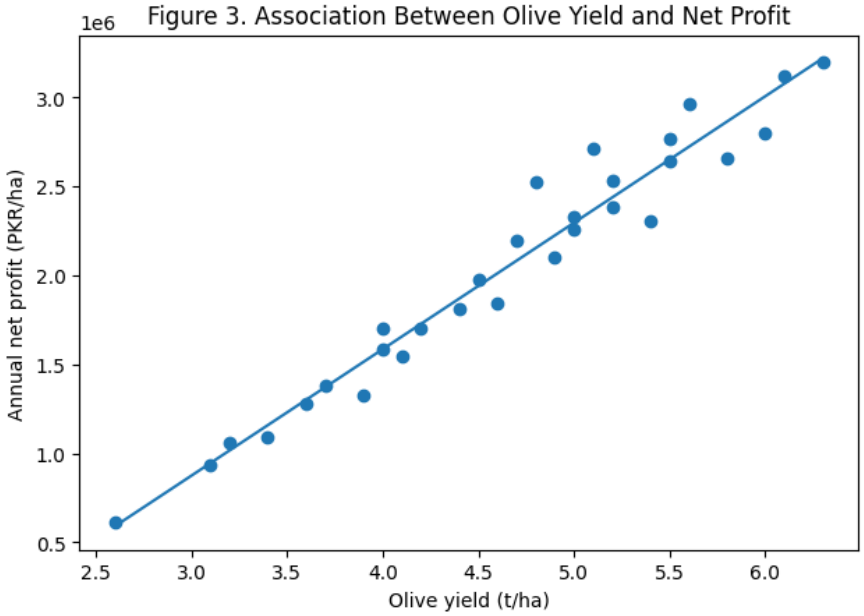

Figure 3: Association between olive yield and net profit

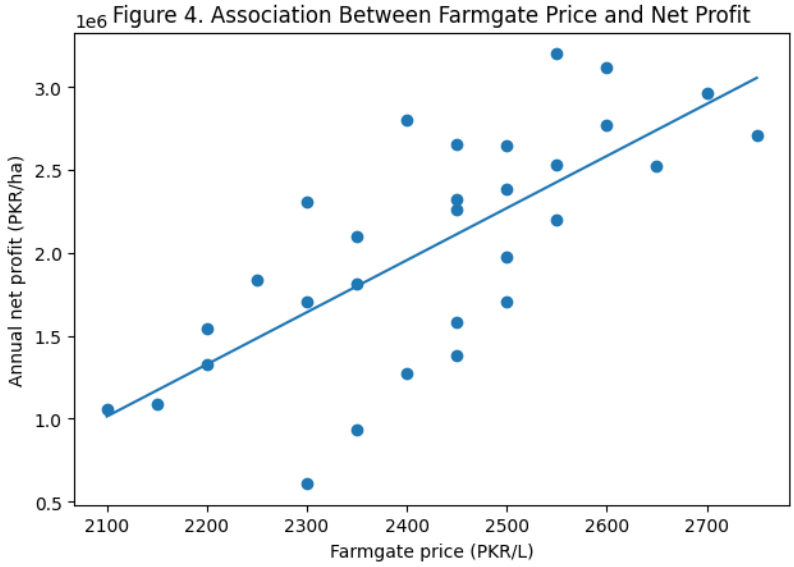

Figure 4: Association between farmgate price and net profit.

The distribution of payback years is shown in Figure 5. Most projects recovered their investment in less than 1 year, while only a few (mainly those located in low-yielding or high-cost environments) required more than 1 year. This trend enhances the overall financial profitability of olive trees when favorable market and agronomic conditions prevail.

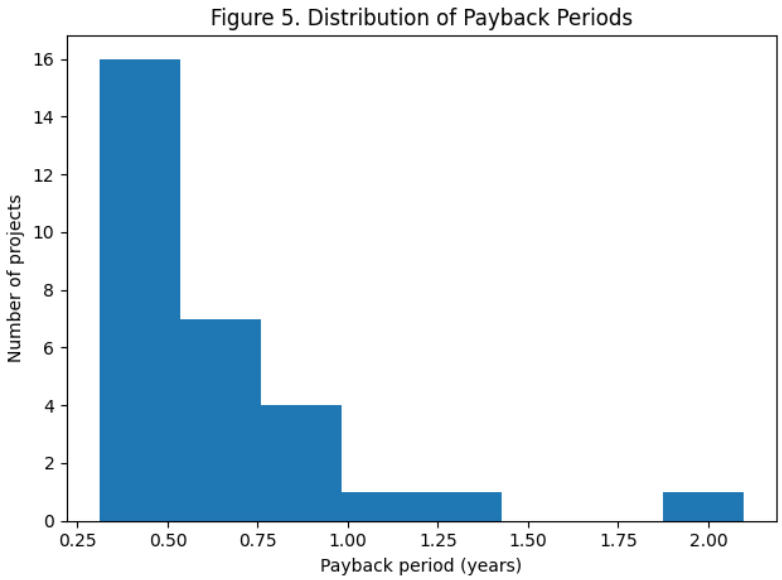

Figure 5: Distribution of payback periods.

4. Discussion

Current study findings demonstrate that the production of olive oil in Pakistan is profitable across agro-climatic zones showing high net returns, favorable B/C ratios, and short payback periods. These findings are in line with recently conducted economic viability analysis the Mediterranean and non-mediterranean olive growing zones, where profitability is high when there a good crop management as well as favorable market conditions [11, 12]. The mean BCR in the current study was in a range to that reported from olive under semi-intensive system of plantations with irrigation In Southern Europe and North Africa, indicating offshore investments can have lucrative business opportunities in long run [13]. However, for the boundaries of commercial agriculture, reduced economic yield due to water stress and high input costs has been observed, indicating that the profitability is still location specific [14].

Significant provincial differences of profitability were observed and Baluchistan and Gilgit Baltistan showed significant net benefits and BC Rs as compared with Sindh. Similarly, in other nations cooler weather conditions and preferred soils lead to increased yield and oil recovery and, hence, higher economic return [8]. The findings are consistent with those in Pakistan, as also supported by a recent assessment to highlight the relative appropriateness of uplands and mountains for olive growing [8]. In contrast, low profit returns experienced in Sindh are consistent with research findings on cost disadvantages associated with high production costs and suboptimal availability of optimum climatic suitability causing higher irrigation needs to be reversed in the hotter areas [15]. These regional variations of these patterns reinforce the importance of site-specific planning and zoning for olive plantation expansion.

Positive correlation between net profit and yield, as in the present study, has been also reported to be the most important factor affecting economic sustainability of olive systems by other studies [11, 13]. Similarly, the positive impact of oil rate on profit is in agreement with previous findings reported for Mediterranean production systems where higher milling efficiencies translate into higher margins of benefits for producers [16]. However, some authors argue that yield-oriented intensification may incur even higher long-term costs and environmental risks if not well managed, thereby suggesting a potential trade-off between

short-term profits and sustainability for further investigation [17].

Farmgate price was found to be a key factor to affect the net profit, consistent with research of which has highlighted that olive oil price is directly related to producer's revenue [18]. Given the elasticity in profits regarding product price variations, markets risk is meaner (especially where olive growing and pressing are new activities for a country), because it does not exist any sort of price-stabilizing tools. A few researchers have noted that olive oil pricing has remained quite immune to change in the high demand global markets while others have attributed increased market instability to international market integration and climate-generated supply disturbances [14]. This dichotomy implies the need for mechanisms to manage price risk to give growers confidence and incentive.

Despite the positive economic indicators presented, there are some limitations to this study that should be considered. The analysis is based on cross-sectional project-level data and does not take into account year-to-year fluctuations in crop yields, long run maintenance costs and climate-induced production risks. Downstream value chain features like processing, branding and export logistics were not also separately evaluated for their impact on profitability but are becoming increasingly critical [13]. But strong inference can be pointed out that olive oil production is a commercially feasible crop in Pakistan. As a tactical response to public policy, given targeted regional spread and market expansion as warranted, gives farming-based work, agroecologist rich employment potential and adds-stuff-at-home after later import replacement with the production of olives personnel.

5. CONCLUSION

The findings reveal that olive oil production appears to be an economically feasible and competitive option (across different agro-climatic zones of Pakistan) as most of the projects generated a high net profit, positive benefit–cost ratio, and quick payback period. The large coefficients for olive yield, oil extraction rate and farmgate price suggest the importance of agronomic performance as well as market conditions in explaining profitability. Area wise variation in economic returns revealed that profitability was higher in Baluchistan and Gilgit Baltistan as compared with Sindh which imply the requirement of area specific production programs and investment for development. It also complies with international grass bowling greens to olive cultivation for which the ease of depending on an effective cultural program favors a favorable expansion into traditional Mediterranean areas. These favorable economic outlooks notwithstanding, the following risks may accompany price variability, weather uncertainty and intensification in production costs, especially non-traditional ones. Increased availability of high-quality planting material, oil extraction facilities and remunerative marketing would be the prerequisites towards ensuring profitability on long-term basis. In addition, the integration of olive oil production in general agricultural and rural development policies can contribute to diversification of income sources, employment generation, as well as a lesser dependency on imported edible oils. When all the reasons are considered, this paper offers substantial empirical evidence of strategic efficiency in olive oil production in Pakistan. This points to the importance of informed policy support, efficient value chains and adaptive management practices to achieve economic sustainability.

6. FUNDING

Not applicable.

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