Comparative Analysis of Banana Cultivation Costs in Latin America: The Economic Benefits of Collective Action

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Article

Comparative Analysis of Banana Cultivation Costs in Latin America: The Economic Benefits of Collective Action

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Abstract: This study examines the economic impact of Farmer Producer Companies (FPCs) on banana cultivation costs in Ecuador. Comparative analysis of data from 150 FPC members and 150 non-members reveals that collective action through FPCs significantly reduces cultivation costs across multiple input categories. FPC members experienced statistically significant reductions in human labour (-10.53%), machine labour (-36.84%), fertilisers (-19.19%), and plant protection chemicals (-19.13%), resulting in an overall cost reduction of 13.87%. Concurrently, FPC members achieved 18.28% higher yields (11 tonnes/acre versus 9.3 tonnes/acre), which translated to 26.73% higher gross returns and 77.36% higher net returns compared to non-members. These benefits stem from bulk procurement advantages, resource-sharing mechanisms, and technical advisory services facilitated through the FPC structure. The findings demonstrate that FPCs effectively address the structural challenges faced by smallholders through economies of scale and enhanced bargaining power, presenting a viable pathway for improving profitability and sustainability in Latin American banana cultivation. This research contributes quantifiable evidence to support the promotion of farmer collectives as an effective intervention for rural economic development and agricultural policy reform.

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Introduction

Banana cultivation represents one of the most economically consequential horticultural enterprises in Latin America, making substantial contributions to both regional economic development and nutritional security. This crop serves a dual purpose: functioning as an essential dietary staple for millions of inhabitants whilst simultaneously operating as a vital cash crop for agricultural producers, particularly in Ecuador, Brazil, Guatemala, Costa Rica, Colombia, and Panama.

The banana's agricultural prominence stems from several key characteristics: its capacity to yield returns within a relatively abbreviated timeframe, persistent market demand irrespective of seasonal fluctuations, and remarkable adaptability to diverse agro-ecological conditions. These attributes collectively position banana cultivation as a cornerstone of livelihood sustainability for smallholder farmers throughout the region. The economic implications extend beyond individual producers to national economies, with banana exports constituting a significant proportion of agricultural foreign exchange earnings in several Latin American nations. Moreover, the banana production chain creates substantial employment opportunities in rural areas, from cultivation to post-harvest processing and transportation. Nutritionally, bananas provide an accessible source of carbohydrates, potassium, and various micronutrients, contributing significantly to food security across socioeconomic strata. This nutritional dimension further reinforces the crop's importance beyond its purely commercial value.

In some areas, farmers have come together making to empower themselves by forming companies which by functioning as registered legal entities, combine the cooperative approach with

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the operational efficiency of private businesses, enabling farmers to procure inputs collectively, access modern agricultural practices and negotiate better market prices. Smallholder farmers face persistent challenges that limit their profitability, including fragmented land holdings, high input costs and poor access to markets and infrastructure. Traditional agricultural practices often lead to higher costs of cultivation, as individual farmers are unable to procure inputs in bulk or adopt advanced farming techniques. Furthermore, fragmented market access and limited bargaining power make smallholder farmers vulnerable to price volatility and exploitation by intermediaries. In response, Farmer Producer Companies have emerged as a transformative solution to address these challenges. By providing a platform for collective action, these compnies empower farmers to access better resources, improve production efficiency and establish stronger market linkages.

The companies facilitate the bulk procurement of essential inputs such as seeds, fertilizers and plant protection chemicals at discounted rates, thereby reducing overall input costs for its member farmers. By promoting sustainable farming practices and modern techniques, they help members increase productivity while reducing dependency on costly external resources. They also offer technical guidance on soil health management, water conservation and the efficient use of fertilizers and pesticides, which has a direct impact on cost efficiency and profitability in banana cultivation.

The primary focus of this study is to examine the cost of cultivation (COC) for banana farmers who are members of a company in comparison to non-member farmers. By analysing key cost components, this research aims to highlight the financial benefits of company membership.

The relationship between input costs and return on investment is essential for determining whether farming operations remain profitable in the long run. This study, through a comparative analysis of COC between company members and non-members, provides valuable insights into how Farmer Producer Companies (FPCs) can help smallholder farmers overcome cost-related challenges. The findings will be particularly beneficial for policymakers, agricultural extension workers and farmers, offering a comprehensive understanding of the economic advantages of collective farming practices and the role of FPC membership in improving cost efficiency and profitability.

This research addresses a critical question in agribusiness: Does membership in an FPC significantly lower the cost of cultivation and enhance profitability for smallholder farmers? By focusing on banana cultivation in Ecuador, this study contributes to the growing body of knowledge on the economic advantages of farmer collectives and highlights the transformative potential of FPCs in advancing smallholder agriculture.

Materials and Methods

The study was conducted in a prominent banana-growing area in Ecuador known for its production volume and farmer participation in FPCs. Data were collected from 300 banana farmers, comprising 150 members of company and 150 non-members. Structured interviews were used to gather data on input costs, yields and other cultivation practices. The interviews aimed to capture detailed data on variable and fixed costs, particularly focusing on key inputs such as labour (both human and machine), seed costs, fertilizers and plant protection chemicals (PPC). The data collection spanned multiple growing seasons to ensure a comprehensive analysis.

The cost of cultivation (COC) for banana cultivation was calculated following agricultural economics methodologies. Costs were divided into variable costs and fixed costs. Variable costs included expenses related to human labor, machine labor, seed, fertilizers, PPC and interest on working capital. Fixed costs considered in the analysis were related to depreciation of machinery, land rent and miscellaneous expenses, such as irrigation setup maintenance.

Variable costs included:

- Human Labor: Labor costs were calculated by multiplying the number of man-days required for tasks like planting, watering and harvesting with the prevailing wage rate in the region.
- Machine Labor: The cost of machine labor was calculated based on the number of hours of use for tasks such as tilling and plowing, along with the cost per hour for hiring the machinery.

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- Seed (Saplings): The cost of banana saplings was determined by the number of saplings used per acre and the cost per sapling.
- Fertilizers: The costs of organic and chemical fertilizers were considered, including Diammonium Phosphate (DAP), Urea, Muriate of Potash (MOP) and micronutrients like Boron, Zinc and Iron. These inputs were critical to the cultivation process and influenced the yield and quality of the banana crop.

Data Analysis

Descriptive statistics were used to summarize and compare the costs of cultivation between company members and non-members. In addition to calculating the total variable and fixed costs, the gross returns were estimated by multiplying the yield per acre by the market price. Net returns were then calculated by subtracting the total cost of cultivation from the gross returns.

A t-test was conducted to determine if there were statistically significant differences between the COC for company members and non-members. This analysis assessed whether membership in the FPC provided a cost advantage. The impact of the companies on cultivation cost reduction and profitability was calculated as a percentage difference between the two groups.

Impact of Membership (%)

The impact of company membership on reducing the cost of cultivation was calculated by comparing the average COC between members and non-members, using the following formula:

$$\text{Impact of membership (\%)} = \frac{\text{COC (Non} - \text{members)} - \text{COC (Members)}}{\text{COC(Non} - \text{members)}} \times 100$$

t-Statistic Calculation

The t-statistic was calculated to assess the statistical significance of the difference between the two groups (members and non-members) in terms of COC. The formula for the t-statistic is as follows:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left(\frac{S_1^2}{n_1}\right) + \left(\frac{S_2^2}{n_2}\right)}}$$

where:

- $\bar{X}_1$= Mean COC for members
- $\bar{X}_2$ = Mean COC for non-members
- S_1^2 = Variance in COC for members
- S_2^2= Variance in COC for non-members
- n_1 and n_2 = 150

The results from the t-test provide insights into whether the observed differences in costs between company members and non-members are statistically significant, helping to verify the economic benefits of FPC membership.

Results and Discussion

The analysis of the cost of cultivation (COC) for banana farmers highlights significant differences across various inputs between company members and non-members. Labor remains one of the most substantial expenses, yet it is notably reduced for company members. This reduction can be attributed to collective labor management and resource-sharing strategies facilitated through Farmer Producer Companies (FPCs), which enhance labor efficiency and affordability. Similarly, machine

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labor costs are lower for members due to the availability of shared machinery or favorable rental agreements negotiated through collective action, whereas non-members bear higher costs for individual machine usage.

Differences in fertilizer and plant protection chemical (PPC) costs further emphasize the benefits of FPC membership. Company members gain access to bulk procurement discounts and expert technical guidance, which significantly reduces input costs. For instance, the costs of organic fertilizers and chemical fertilizers, such as DAP, Urea and MOP, are consistently lower for members, comprising 15.61% of total costs compared to 17.23% for non-members. PPC expenses are reduced for company members due to efficient resource management and expert advisory support, further minimizing variable costs. These findings underscore the economic efficiency of FPCs in optimizing input costs through collective procurement, technical training and improved advisory services, ultimately enhancing profitability for member farmers compared to non-members.

Table 1. Cost Comparison Between Company Members and Non-Members.

Particulars	**Members (in USD)**	**Non-Members (in USD)**	**Impact of membership (%)**	**t-Statistic**
Human Labor	374.00	418.00	-10.53	7.61
Machine Labor	26.40	41.80	-36.84	2.66
Seeds (Saplings)	195.36	195.36	0.00	-
Organic Fertilizer	88.00	108.90	-19.19	3.62
Chemical Fertilizers - DAP	77.72	87.04	-10.71	1.61
Chemical Fertilizers - Urea	25.27	43.44	-41.82	3.14
Chemical Fertilizers - MOP	118.80	148.50	-20.00	5.14
Micronutrients - Boron	26.40	34.65	-23.81	1.43
Micronutrients - Zinc	44.28	50.16	-11.73	1.02
Micronutrients - Iron	61.60	69.30	-11.11	1.33
Plant Protection Chemicals	102.30	126.50	-19.13	4.19
Total Cost	1140.12	1323.65	-13.87	-16.3

A comparative analysis of key input costs Human Labor, Machine Labor, Organic Fertilizer, DAP, Urea, MOP and Plant Protection Chemicals (PPC) between company members and non-members. The findings reveal that company members consistently incur lower costs across all major

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input components due to the advantages of collective procurement, resource-sharing strategies and technical support provided by the Farmer Producer Company.

The analysis further highlights substantial cost savings for fertilizers and plant protection chemicals among company members. For instance, the costs of DAP, Urea, MOP and PPC are consistently lower for members as a result of bulk purchasing benefits and technical advisory services. These reductions collectively contribute to a significant decrease in the overall input costs for company members, underscoring the economic benefits of FPC membership. By optimizing input management through collective action, company enables member farmers to achieve greater cost-efficiency and profitability compared to their non-member counterparts.

Company members demonstrated a significantly higher yield of 11 tons per acre compared to 9.3 tons for non-members, which resulted in substantially greater gross and net profitability. The figures are in Table 2.

Table 2. Yield, Gross Returns and Net Returns Comparison.

Particulars	Members	Non-Members	Impact of membership (%)	t-Statistic
Yield (tons)	11.00	9.30	+18.28	7.93
Gross Returns (USD)	3630	2864	+26.73	26.3
Net Returns (USD)	2209	1246	+77.36	124

Significant differences exist in Gross Returns, Net Returns and Yield proportions between members and non-members. This considerable improvement can be attributed to reduced input costs, efficient resource management and access to technical guidance facilitated by the Farmer Producer Company (FPC), which enables farmers to optimize production and minimise expenses. The accompanying pie chart demonstrates the Yield Comparison, where company members contribute 54.2% of the total yield compared to 45.8% for non-members, indicating an 18.28% increase in productivity for FPC members. This productivity boost reflects the adoption of improved practices and better input utilization supported by the FPC. Overall, these results emphasize the economic and productivity benefits of FPC membership, showcasing the role of collective action, optimized resource management and technical support in enhancing farmer profitability and productivity.

Conclusions

Based on the analysis presented, the research conclusively demonstrates the substantial economic advantages of collective action through Farmer Producer Companies (FPCs) in banana cultivation in Ecuador. The empirical evidence reveals that FPC members consistently experience lower cultivation costs across multiple input categories, with statistically significant reductions in human labour (-10.53%), machine labour (-36.84%), organic fertilisers (-19.19%), and plant protection chemicals (-19.13%). These cost efficiencies stem from bulk procurement advantages, resource-sharing mechanisms, and technical advisory services facilitated through the cooperative structure.

The economic benefits extend beyond mere cost reduction. FPC members achieved notably higher yields (11 tonnes/acre versus 9.3 tonnes/acre for non-members), representing an 18.28% productivity increase. This yield enhancement, coupled with reduced input costs, translated to markedly improved financial outcomes: gross returns were 26.73% higher for members, whilst net

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returns demonstrated a remarkable 77.36% increase. The t-statistics uniformly confirm the statistical significance of these differentials.

The research findings carry significant implications for agricultural policy and smallholder farmer development. FPCs effectively address the persistent challenges faced by smallholders, including fragmented landholdings, high input costs, and limited market access. By facilitating collective action, these organisations enable farmers to overcome structural disadvantages through economies of scale and enhanced bargaining power.

This study contributes to the growing body of literature on cooperative farming models by providing quantifiable evidence of their economic efficacy. The data clearly indicate that FPC membership represents a viable pathway for improving smallholder profitability and sustainability in Latin American banana cultivation. The model successfully combines the solidarity principles of cooperatives with the operational efficiency of commercial entities.

For policymakers and agricultural extension services, these findings underscore the value of supporting and promoting farmer collectives as an effective intervention for rural economic development. Future research might explore the long-term sustainability of these economic advantages and examine their replicability across different crops and regions. Additionally, investigating the social and environmental dimensions of FPC membership would provide a more comprehensive understanding of their overall impact on agricultural communities in Latin America.

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