FORESTRY & DRY LAND
2025, Vol. 01, Issue. 01, No. 1, pp. 8-14

ISJUTL
INTERNATIONAL SCIENTIFIC JOURNAL OF UNPAZ TIMOR-LESTE
International Peer Reviewed Journal: Open Access
Publication: High Visibility: Rapid Publishing
ISSN: 3007-9195 (1) : 3007-9187 (e)

ORIGINAL RESEARCH ARTICLE OPEN ACCESS

Impact of Arabica Coffee Rehabilitation on Socioeconomic Factors in Manufahi, Timor-Leste

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ARTICLE INFO

Article History:
Received 6th Febrary, 2025
Received in revised form 7th July, 2025
Accepted 31st July, 2025
Published online 1st August, 2025

Key Words: Agricultural rehabilitation, Coffee production, Arabica coffee, Smallholder farmers, Farmer income, Socioeconomic impact, Coffee farming, Crop productivity, Land restoration, Coffee rehabilitation, Coffee yield, Sustainable agriculture, Rural, livelihoods

ABSTRACT

Agricultural rehabilitation programs are key global strategies for restoring degraded land, boosting crop productivity, and improving smallholder livelihoods, especially in areas where agricultural decline threatens food security and income stability. In coffee-producing regions, these programs aim not only to increase production but also to enhance quality and economic value. However, despite widespread implementation, the effectiveness across regions and demographics remains underexplored, particularly regarding how socioeconomic factors impact outcomes. This study aims to assess the impact of full stumping rehabilitation on coffee production and farmer income, and to determine how factors such as family size, age, and gender influence these outcomes in Timor-Leste. The research was conducted in Same, Manufahi municipality, chosen for its significance as an Arabica coffee production hub. It focuses on Arabica red cherry coffee farmers who completed full stumping in 2019, with coffee as their primary livelihood, and is limited to landowning farmers. The study specifically examines their income, considering the time and sources of income from Arabica coffee. The results show that the coffee rehabilitation program significantly increased farmers' production and income across various regions. Production increased by more than 100% in Babulo and Letefoho, and farmers' income increased by up to 200% in certain areas. However, the program's impact varied across socioeconomic groups and regions. Larger families were better able to benefit from the program due to more efficient labor allocation. Middle-aged farmers (35-50 years) achieved the highest increases in production and income. Some regions, like Carbulau and Tomonamo, saw only slight improvements, highlighting regional gaps in the program's effectiveness. Limited data on female farmers indicate that although both men and women experienced increases, men saw more variability and greater potential for improvement. The Wilcoxon Signed-Rank Test confirms that changes in production and income were statistically significant, demonstrating the program's effectiveness while also identifying areas for targeted intervention to improve outcomes in underperforming regions or groups.

Introduction

Agricultural rehabilitation programs are a key strategy used globally to restore degraded land, improve crop productivity, and enhance the livelihoods of smallholder farmers. These programs are especially critical in regions where agricultural decline has threatened food security and income stability. In coffee-growing regions, such programs aim not only to increase production but

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also to improve the quality and economic value of coffee. However, while rehabilitation programs have been widely implemented, their effectiveness across different regions and demographics remains underexplored, particularly in terms of how socioeconomic factors influence the outcomes (FAO, 2017).

Timor-Leste primarily cultivates two types of coffee: Arabica, which is the dominant variety, and Robusta. Coffee stands out among the thirteen primary commodities due to its wide cultivation regions and significant export potential. However, the coffee industry in Timor-Leste has not yet achieved its full long-term capacity due to insufficient and unpredictable production, varying quality, and inadequate sector management (Asian Development Bank, 2020; Feller, 2022).

To address these concerns, the implementation of full stumping has been viewed as a solution to improve productivity and coffee quality. Full stumping is a pruning procedure for Arabica coffee trees that involves cutting all of the tree's stems close to ground level, promoting the proliferation of fresh shoots and enhancing the development of more efficient root systems.

This research aims to evaluate the impact of the coffee rehabilitation program through full stumping on production and income, and to determine how socioeconomic factors, such as family size, age, and gender, influence these outcomes in Timor-Leste.

Methods

The research was conducted in the same administrative post located in the Manufahi municipality of Timor-Leste. The study focused on Arabica red cherry coffee farmers who completed full stumping in 2019, with coffee as their primary livelihood, and was limited to landowning farmers. Primary data were collected through interviews and observations, while secondary data were obtained from government sources and previous research.

A questionnaire is a list containing a series of questions that need to be answered or completed by the respondents.

Cameras and Recording Devices: These are used to record field observations and interviews.

GPS Devices: These are used to note down specific locations of coffee farms and map the research area.

Notebooks are used to record important notes, make lists, plan schedules, or store other vital information. Writing tools are essential in the process of writing, drawing, or taking notes.

A census was adopted as a method to collect data from all farmers.

The total number of farmers in this study, after proportional allocation, was 120.

The distribution of farmers consisted of 60 respondents from Holarua, 25 respondents from Letefoho, 20 respondents from Rotuto, 10 respondents from Tutuluro, and 5 respondents from Babulo.

Data management was conducted using MS Excel.

A boxplot was used to visualize and describe the data on income and production before and after rehabilitation for several variables: farmer size, age, and gender.

Descriptive analysis was adopted to calculate the mean, median, and standard deviation.

Results and Discussion

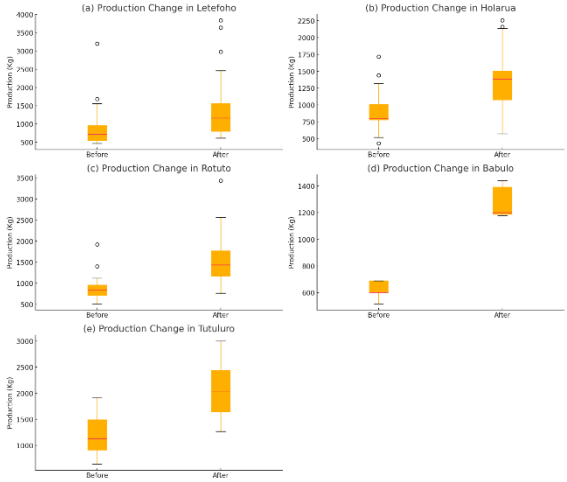

Figure 1: Comparison of Coffee Production Before and After Rehabilitation Based on Suco.

Overall, the box plots show that the rehabilitation program significantly and positively impacted production levels in all regions. However, the magnitude and variability of the improvements varied across the regions [Suco].

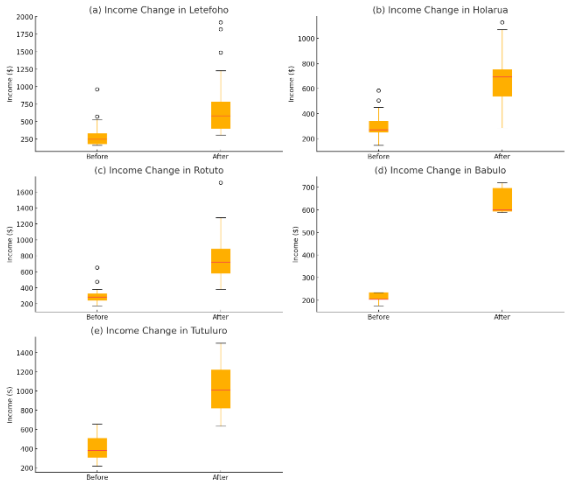

Figure 2: *Comparison of farmers' income before and after rehabilitation based on Suco.*

Across all regions [Suco], the median income increased significantly after rehabilitation, indicating that the program had a positive impact on income levels.

Regions such as Letefoho, Rotuto, and Tutuluro show the largest income gains, with broader ranges and more outliers, indicating that some individuals in these regions experienced particularly high improvements in income.

Babulo shows more consistent income gains across individuals, with fewer extreme values, suggesting that the program had a more uniform impact in this region.

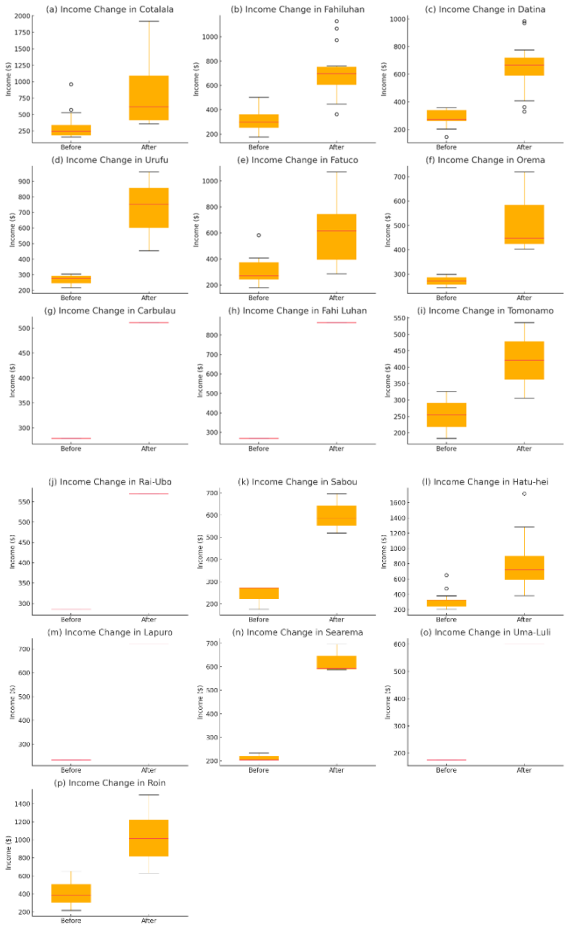

Figure 3: Farmer's income between before & after rehabilitation based on Aldeia

Changes in income across Aldeias reveal that the rehabilitation program had varying levels of impact depending on local conditions. For example, Cotalala experienced a significant median income increase from $250 to $1,000, reflecting the strong uptake of the rehabilitation program. In contrast, Carbulau saw minimal changes, indicating that the program may not have been as effective due to socioeconomic constraints or limited adoption of new practices.

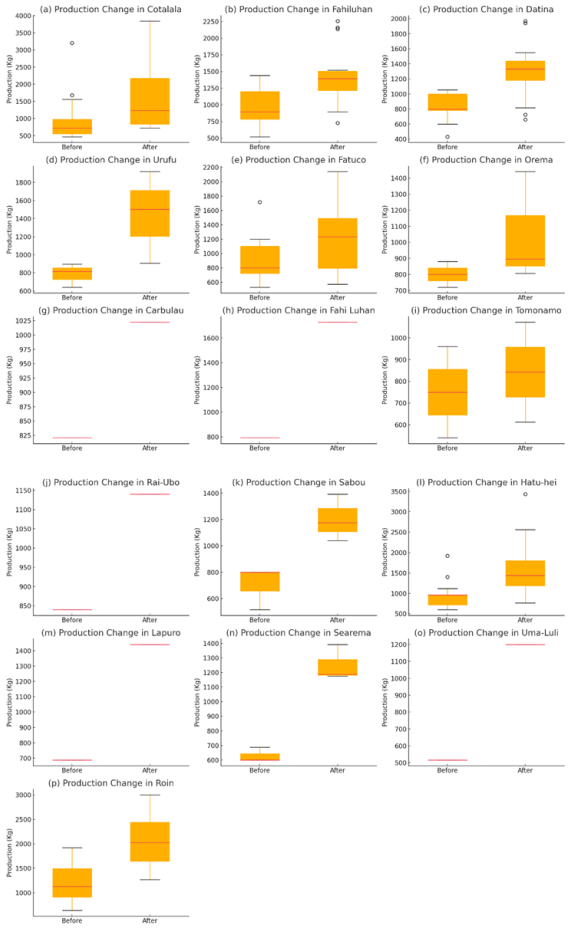

Figure 4: Coffee production between before and after rehabilitation based on Aldeia

Overall, the rehabilitation program had a positive impact on production in many aldeias, though the magnitude of the improvement varied. Some regions, such as Cotalala, Hatuhei, and Roin, saw significant production, while others, like Carbulau, Fahi Luhan, and Lapuro, experienced little change.

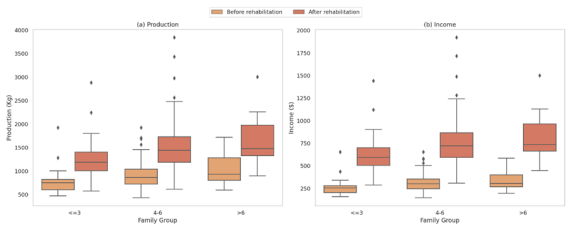

Figure 5: Comparison of coffee production [a] and farmer's income [b] between before and after rehabilitation based on family size group.

Overall, the data strongly suggest that the rehabilitation program was successful in increasing both agricultural output and income across all family size groups. The most significant improvements were observed in larger families, particularly those with 4 to 6 members and those with more than 6 members.

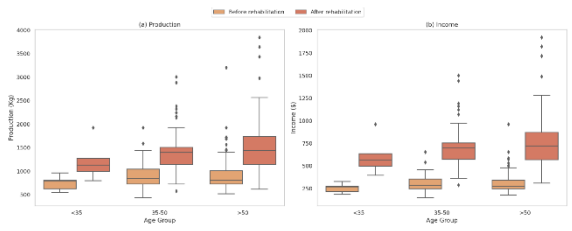

Figure 6: Comparison of coffee production [a] and farmer's income [b] between before and after rehabilitation based on Age group.

The analysis of production and income changes by age, as shown in the figure, indicates that middle-aged farmers (35-50 years) experienced the greatest improvements, with median production increasing from 1,250 kg to 1,750 kg and income rising from $400 to $750. This finding is consistent with previous studies showing that middle-aged farmers are more likely to adopt new technologies and practices compared to their older or younger counterparts.

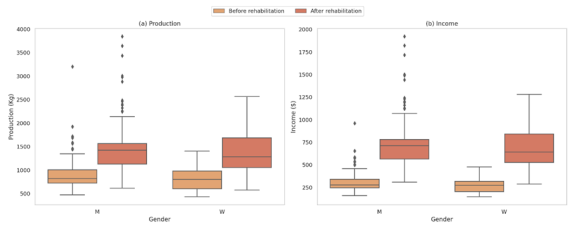

Figure 7: Comparison of coffee production [a] and farmer's income [b] between before and after rehabilitation based on gender.

The figure shows that male farmers experienced greater variability in both production and income changes, with median production increasing from 1,000 kg to 1,500 kg and income rising from $250 to $500. Female farmers also saw improvements; however, the gains were more consistent and less variable.

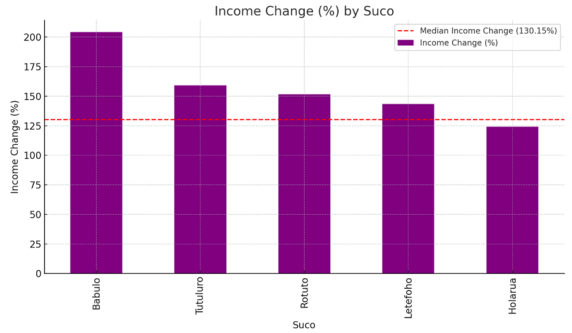

Figure 8: The percentage change and median income change of farmer between before and after rehabilitation for each Suco.

Overall, the chart highlights varying degrees of income improvement across the sucos. While Babulo experienced the most significant benefits, all regions saw positive growth, reflecting the generally favorable impact of the rehabilitation efforts, even though the gains were uneven across the sucos.

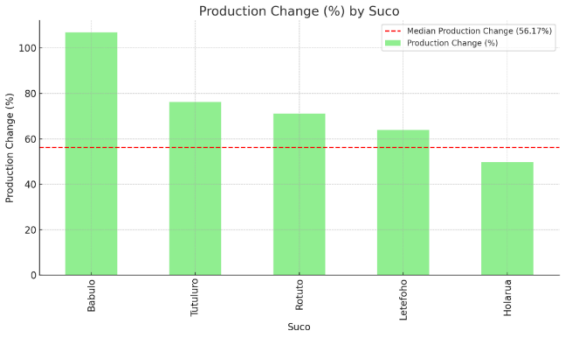

Figure 9: The percentage change and median of coffee production between before and after rehabilitation for each Suco.

The chart indicates that all sucos experienced positive production growth following the rehabilitation program, although the degree of improvement varied. Babulo experienced the most significant increase in production, while Holarua recorded more moderate gains. The median production change of 56.17% serves as a benchmark, with three sucos exceeding this value and two falling slightly below it. The overall trend suggests that the rehabilitation program had a predominantly positive impact on production across the regions.

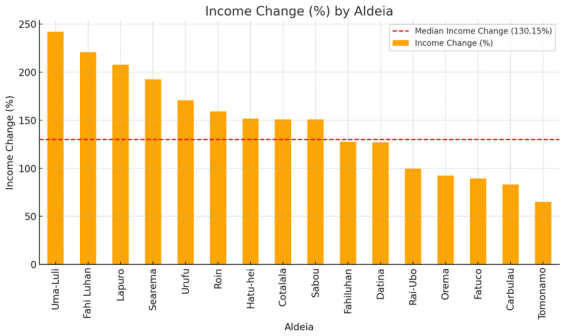

Figure 10: The percentage change and median of farmer's income between before and after rehabilitation for each aldeia.

The figure shows that Uma-Luli experienced the most significant income change, exceeding 250%, followed by Fahi Luhan and Lapuro. In contrast, aldeias such as Fatuco and Carbulau saw more modest gains.

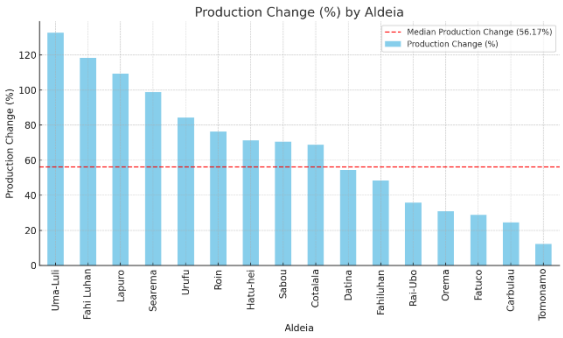

Figure 11: The percentage change and median of coffee production between before and after rehabilitation for each aldeia.

The data reveals significant variation in production changes across aldeias following rehabilitation. Uma-Luli, Fahi Luhan, and Lapuro saw the largest increases in production, while aldeias such as Tomonamo and Carbulau experienced the least improvement. The red dashed line, representing the median production change (56.17%), highlights that many aldeias performed above this level, suggesting an overall positive impact of the rehabilitation program, though the extent of the benefits varied across regions.

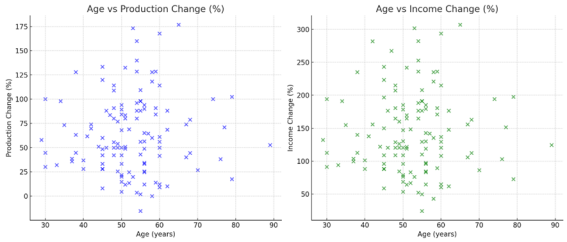

Figure 12: Scatter plots of age against production change and income change to visualize potential trends.

The correlation between age and changes in production was found to be weak, with r = 0.047 and a p-value of 0.610. This indicates that there is no statistically significant relationship between age and changes in production, which suggests that age does not play a meaningful role in influencing how much an individual's production levels improve following rehabilitation.

The correlation between age and changes in income was weaker, with r = 0.014 and a p-value of 0.884. This non-significant result implies that age has no noticeable effect on changes in income, further reinforcing the idea that income improvements following rehabilitation were not influenced by the age of the participants.

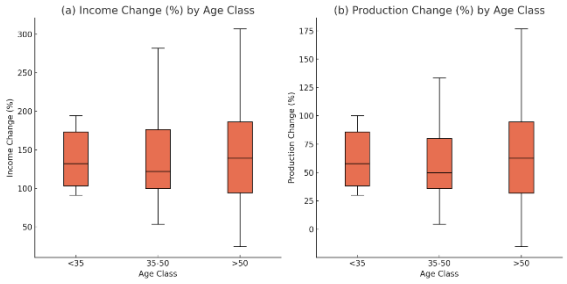

Figure 13: Box plots of farmer's income [a] and production changes [b] by age class

Younger participants (aged <35) and older participants (aged >50) exhibited more consistent but smaller changes. The Kruskal-Wallis test (p = 0.884 for income and p = 0.686 for production) shows no statistically significant differences across age groups.

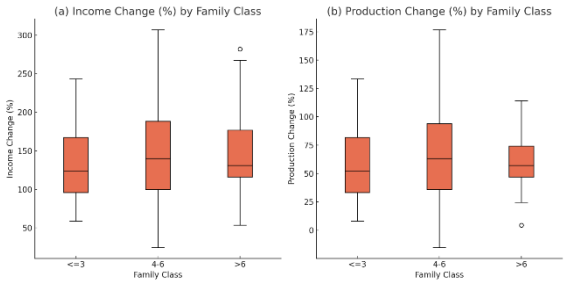

Figure 14: Boxplot of farmer's income [a] and Production changes [b] between three family classes.

The figure examines changes in income and production based on family size, revealing that families with 4 to 6 members experienced the greatest median increases in both income and production. However, the results of the Kruskal-Wallis test (p = 0.718 for income and p = 0.756 for production) show no statistically significant differences across family size categories.

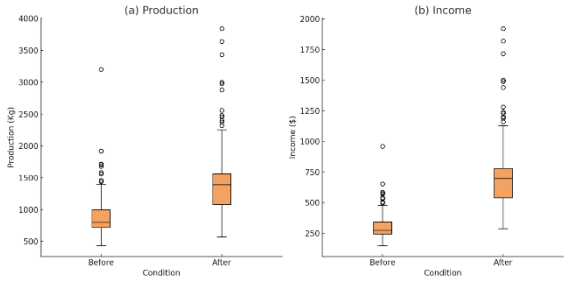

Figure 15: Comparison of coffee production [a] and farmer's income [b] between before and after rehabilitation.

Production increases were more variable, with the median production rising from 1,000 kg to over 1,500 kg. In contrast, income gains were more consistent, with the median rising from $250 to $500. The Wilcoxon Signed-Rank Test confirmed the significance of these changes, reinforcing the positive impact of the program ($p < 0.0001$).

Conclusion

The program effectively increased median production levels, with notable gains in regions such as Babulo and Letefoho, where production rose by over 100%. Similarly, farmers' incomes saw substantial improvements, with median income increases of up to 200% in certain regions.

Related to the variability of these changes across family size, age, and gender, larger families showed a greater capacity to benefit from the program due to their ability to allocate labor more effectively. Middle-aged farmers (ages 35-50) achieved the largest production and income gains. In addition, men experienced more variability and potentially larger improvements.

Not all regions benefited equally; some sucos and aldeias, such as Carbulau and Tomonamo, experienced more modest improvements in production and income, highlighting regional disparities in the program's effectiveness.

The relationship between family size and production/income changes indicates that larger families (4-6 members) experienced the greatest median increases in income and production.

Age does not significantly influence the extent of production or income changes following rehabilitation. Men saw significant improvements in both production and income after rehabilitation.

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