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Cocoa Productivity as a Moderating Variable in the Relationship between Maintenance Costs and Farmer Welfare

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Abstract

This study aims to analyze the effect of maintenance costs on the welfare of cocoa farmers in Manyamba Village, Tammerodo Sendana District, and to examine the role of cocoa productivity as a moderating variable in this relationship. The research method used a quantitative approach with a population of 60 cocoa farmers who also served as the research sample. Data were collected through observation, interviews, documentation, and questionnaires, then analyzed using the Partial Least Squares (SmartPLS) technique. The results showed that maintenance costs had a positive and significant effect on farmer welfare. Cocoa productivity was also shown to have a significant positive effect on improving welfare. However, the results of the moderation effect test showed that productivity did not play a significant role in strengthening or weakening the relationship between maintenance costs and farmer welfare. These findings confirm that efforts to improve farmer welfare depend not only on managing maintenance costs and productivity, but also require support from other external factors such as access to financing, agricultural technology, and government policies.

Introduction

Indonesia is known as one of the world's largest cocoa producers, with the cocoa plantation sector making a significant contribution to the local economy, particularly in rural areas. West Sulawesi, including Manyamba Village in Tammerodo Sendana District, is a significant cocoa production center. However, despite its significant production potential, the welfare of cocoa farmers in the region remains relatively low (Effendy et al. 2019). One of the main causes of this low welfare is the high costs of crop maintenance, such as expenses for fertilizers, pesticides, labor, and other routine maintenance. These substantial costs are not always commensurate with the yields obtained, creating an imbalance between income and expenses. This situation creates structural problems in the production cycle, where farmers often struggle to cover operational costs, even to generate a surplus that could improve their standard of living (Rianse, 2006).

In this context, cocoa productivity is a crucial factor, as it has the potential to either strengthen or weaken the influence of maintenance costs on farmer welfare. High productivity levels allow for increased yields despite high maintenance costs, thereby rebalancing the cost-to-income ratio. Conversely, if productivity is low, high costs will further depress farmer incomes (Greg, 1989). Previous research has shown that cocoa productivity in Indonesia still faces inefficiency issues. Effendy et al. (2019) found that the average technical efficiency was only 0.82 and allocative efficiency was 0.46, meaning there is potential for up to a 60% reduction in production costs if managed optimally. This confirms that increasing productivity is a crucial aspect in improving the welfare of cocoa farmers. Furthermore, various factors influence

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productivity levels, including the use of superior seeds, organic fertilizer application, participation in extension services, access to financing, and the use of modern agricultural technology. Furthermore, research in Southeast Sulawesi indicates that land area, production facilities, plant age, labor, socioeconomic conditions, farming patterns, and farmers' social capacity all play a role in determining cocoa productivity. Thus, maintenance costs are not only directly related to production costs but also closely linked to potential yields through productivity. Therefore, cocoa productivity can be positioned as a moderating variable that can strengthen or weaken the relationship between maintenance costs and farmer welfare.

Literature Review

Grand Theory

This research is based on the Resource-Based View (RBV) theory, Production Theory, and Welfare Theory. According to Barney (1991) in RBV, existing resources, including maintenance costs for fertilizers, pesticides, and labor, will provide added value if managed efficiently, thereby increasing cocoa productivity. Furthermore, based on Varian (2014) in Production Theory, maintenance costs are seen as inputs that directly influence output in the form of harvest yields, where increased productivity will improve farmer income. Meanwhile, as explained by Mas-Colell et al. (1995) through Welfare Theory, proper resource allocation will increase community utility and welfare, so that high cocoa productivity plays an important role in strengthening the positive impact of maintenance costs on improving farmer welfare.

Welfare

Welfare is the condition in which basic human needs, both material and non-material, are met, enabling individuals or groups to live decent, healthy, and happy lives. The concept of welfare encompasses economic, social, educational, and health dimensions, as well as overall quality of life. In the context of farmers, welfare is reflected in increased income, family economic stability, access to health and education services, and the ability to sustainably meet daily needs (Sen 1999).

Maintenance Costs

Maintenance costs are all expenses incurred to maintain, care for, and preserve the condition of assets, equipment, or plants so that they remain optimally functional and productive. In agriculture, maintenance costs include expenses for fertilization, pest control, watering, land improvement, and routine plant care. These expenses are crucial because they directly impact production quality and the sustainability of farming businesses (Giatman 2011).

Productivity

Productivity is a measure of the effectiveness of resource use (labor, capital, land, and technology) in producing output or results. A high level of productivity indicates the ability to produce more output with the same or fewer inputs. In agriculture, productivity is often calculated based on the amount of harvest per unit area of land and is an important indicator in assessing the efficiency and success of farming businesses (Tangen 2005).

Previous Research

Maintenance Costs (X1) versus Welfare (Y)

Findings from Calcante et al. (2013) showed that repair and maintenance costs significantly impact farmer welfare, accounting for 55.4% of the tractor's list price at 12,000 hours of service, emphasizing the need for accurate cost estimates to inform purchasing decisions and improve economic performance. Furthermore, research by Maridjo & Szulc (2023) shows that

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maintenance costs, as part of production costs, can reduce overall economic welfare, particularly in the context of upland and rice paddy fields.

Productivity (Z) versus Welfare (Y)

A study by Putri et al. (2024) shows that increased productivity through subsidies does not automatically translate into improved welfare, suggesting that policymakers need to adopt a multifaceted strategy that balances productivity gains with sustainable income growth for farmers. Furthermore, research by Suryalena et al. (2025) shows that agricultural productivity significantly affects farmer welfare. This suggests that both Community Capital and farmer characteristic development have a positive impact on welfare and productivity within farmer groups.

Productivity (Z) Moderates Maintenance Costs (X) on Welfare (Y)

Prokopov et al. (2023) showed that increasing machine-tractor unit productivity, achieved through effective maintenance strategies, directly moderates maintenance costs, benefiting farmer welfare. Furthermore, Simarmata et al. (2024) showed that increasing productivity through optimized maintenance planning reduces downtime and improves resource allocation, which can lead to lower maintenance costs. This, in turn, positively impacts farmer welfare by promoting sustainable agricultural practices and food security.

Method

Research Design

The type of investigation utilized in this case is a quantitative explanatory design. Its focus is not only the description of the observable trends but also the explanation of the causal relationships between the costs of maintenance, cocoa productivity, and welfare of farmers. The explanatory design enables one to explore how changes in maintenance costs affect the welfare outcomes and whether the productivity has a strengthening or weakening impact in that relationship. Therefore, the paper integrates the theoretical frameworks with the practical facts to reveal the hidden-working mechanisms that inform the economic state of farmers in the Village of Manyamba. In spite of the fact that descriptive statistics is used to describe respondent features and aggregate data distributions, the main analytical orientation is inferential. Based on this, the study is not merely an enumeration of statistical summaries but uses them to test hypotheses and as a source of discovering substantive relationships between variables. The explanatory quality of the study allows a rich interpretation that goes beyond the illustration of numbers, hence linking theory and field realities in a consistent analytical platform.

Population and Sample

The study population will include all cocoa farmers who live and grow cocoa in the Manyamba Village, Tammerodo Sendana District of sixty respondents. Considering the relatively small figure of the population, the study uses census approach of sampling, where all the members of the population are approached as respondents. This methodological choice is necessary to make sure that the results capture the entire range of conditions and experiences within the population and, therefore, this excludes the possibility of sampling bias. The fact that the investigation targets all the farmers is expected to capture the real picture of the actual socioeconomic makeup of cocoa production in Manyamba and ensure that all the current variations in behavior or outcome are reflected in the dataset points. Such an inclusion approach also enhances the explanatory value of the results. The interrelations of variables observed were attributed to the fact that all the farmers in the village were involved in the experiment so the

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results could be viewed as the real dynamics of the population instead of estimations based on a small sample. Therefore, this methodological option increases authenticity of the findings based on the analysis.

Data Collection Methods

The data collected through the multi-modal approach which included direct observation, structured interviews, documentary analysis, and survey tools. The functions of each modality were discrete and they were interrelated to produce a holistic empirical data. The actual agronomic situations in cocoa farms were observed to record the maintenance activities and resource-use activities that were carried out by farmers. More detailed data related to the perceptions of the farmers; the motivation factors and the decision-making process used in relation to the maintenance expenditure and productivity management were provided through structured interviews. Triangulation and checking of data collected during field observation and interviews were conducted by use of documentary literature such as farm logs and regional agricultural reports. The major tool used in the process of acquiring quantitative data was survey questionnaires. The questionnaires were designed based on the indicators which were derived using the existing theoretical frameworks and previous empirical studies then tuned to suit the local agricultural and socioeconomic environment. They measured three latent constructs, which comprise maintenance cost, cocoa productivity, and farmer welfare, and each of them was measured using several items on a five-point Likert scale. This design made the respondents be able to express their perceptions in a manner that is standardized and at the same time resonant to the context and therefore facilitated the reliability and interpretability of the data obtained.

Data Analysis Procedures

Partial Least Squares were used to analyze the data including Structural Equation Modeling (PLS-SEM) version 3 of Smart PLS. This methodological decision was based on its strength of testing complex models using a small sample size and its ability to estimate both direct and moderating effects at the same time. PLS-SEM is most appropriate when it comes to investigations that combine a theory-based model with an exploratory approach because it allows the measurement reliability to be evaluated and allows testing hypothesized causal relationships in a single process. The analysis was carried out in two major steps: the assessment of the measurement model (the outer model) and the assessment of the structural model (the inner model). These phases ensured measurement of the constructs were valid and that the statistical support of the hypothesized relationships between variables was obtained.

Result and Discussion

Outer Model Test

Convergent Validity Test

Table 1. Outer Loading Values of Each Variable

Construct	Item Code	Loading Factor	Information
Maintenance Cost (X)	X1	0.757	Valid
	X2	0.790	Valid
	X3	0.393	Invalid
	X4	0.716	Valid
	X5	0.703	Valid
Productivity (Z)	Z1	0.804	Valid
	Z2	0.726	Valid

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	Z3	0.743	Valid
	Z4	0.821	Valid
	Y1	0.853	Valid
	Y2	0.821	Valid
	Y3	0.852	Valid
Welfare (Y)	Y4	0.786	Valid
	Y5	0.796	Valid
	Y6	0.807	Valid
	Y7	0.742	Valid

Source: Data processed based on SmartPLS3 output results, 2025

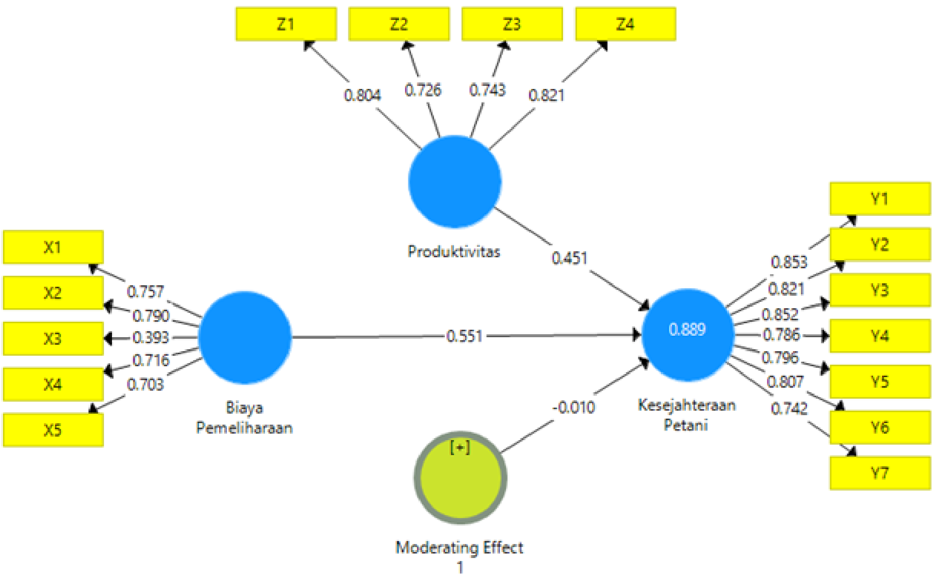

Figure 1. Results Calculate PLS Algorithm (Outer Model)

Source: Results exercise data, 2025

The results of the outer loadings analysis indicate that most indicators in the research variables meet the validity criteria with loading factor values above 0.7. The Maintenance Cost variable (X) is declared valid for four indicators (X1, X2, X4, and X5), while indicator X3 is invalid because it has a loading factor of 0.393 and therefore needs to be removed from the model. All indicators in the Productivity (Z) and Farmer Welfare (Y) variables are proven valid with loading factor values >0.7, which means that both constructs are measured consistently and representatively. Thus, the measurement model can be declared suitable for use in the next analysis stage.

Reliability Test

Table 2. Results Test Reliability

Variables	*Composite Reliability*	*Cronbach's Alpha*	Information
Maintenance Cost (X)	0.810	0.710	Reliable
Productivity (Z)	0.857	0.777	Reliable

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Farmer Welfare (Y)	0.930	0.912	Reliable

Source: Data processed based on SmartPLS3 output results, 2025

The reliability test results indicate that all constructs meet the generally accepted threshold of 0.7 for both Composite Reliability and Cronbach's Alpha, confirming that the instruments used are internally consistent and reliable. The Farmer Welfare (Y) variable exhibits the highest reliability (Composite Reliability = 0.930; Cronbach's Alpha = 0.912), suggesting that the items measuring welfare are highly correlated and consistently capture the underlying construct. This high reliability can be interpreted in two complementary ways. First, the welfare construct operationalized through indicators such as income stability, access to education, and living standards is conceptually straightforward and less prone to subjective interpretation by respondents. These dimensions tend to be more tangible and easily assessed compared to variables like maintenance cost or productivity, which involve technical or behavioral nuances. Second, the sample in this study consists of farmers from a relatively homogeneous community in terms of socioeconomic background and livelihood structure.

Such homogeneity likely reduces response variability and enhances internal consistency among welfare-related items. In contrast, the Maintenance Cost (X) and Productivity (Z) variables, although still reliable, exhibit slightly lower coefficients. This may stem from the inherent variability in how farmers perceive and manage input costs or evaluate their productivity levels, which are influenced by environmental conditions, crop cycles, and market fluctuations. These contextual factors introduce a degree of heterogeneity that can modestly reduce item consistency. While all values exceed the accepted reliability threshold, it is important to acknowledge what lower reliability would imply. If any construct such as Maintenance Cost or Productivity had a Composite Reliability or Cronbach's Alpha below 0.7, it would suggest inconsistency in the respondents' understanding of questionnaire items or in the instrument's ability to measure the intended construct accurately.

Such a situation would weaken confidence in the corresponding path coefficients and reduce the overall validity of the structural model. In applied research terms, low reliability would necessitate revisiting the measurement model by rephrasing ambiguous items, increasing the number of indicators, or re-examining construct dimensionality. Therefore, while the results here affirm measurement stability, future research should continue refining these instruments. In particular, ensuring that cost and productivity indicators are clearly operationalized and contextually adapted to the local agricultural practices of cocoa farmers could further enhance the precision and consistency of data collection.

Source: Results exercise data, 2025

R Square Test

Table 3. R Square Test

Variables	R Square
Farmer Welfare (Y)	0. 879

Source: Data processed based on SmartPLS3 output results, 2025

The goodness-of-fit test results show that the R-squared value for the Farmer Welfare (Y) variable is 0.879. This means that the independent variables in the model are able to explain 87.9% of the variation in farmer welfare, while the remaining 12.1% is influenced by factors outside the model. This value indicates that the model has very strong predictive power.

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Inner Model Test

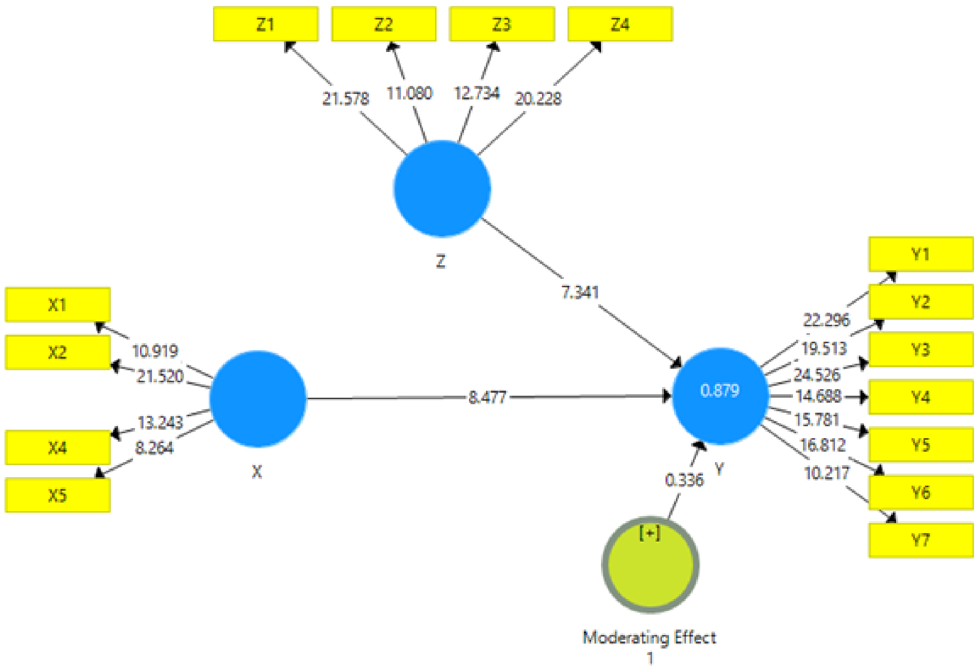

Figure 2. Results Calculate PLS Algorithm (Inner Model)

Hypothesis Testing

Table 4. Hypothesis Testing

	Original Sample (O)	**Sample Mean (M)**	**Standard Deviation (STDEV)**	**T Statistics (|O/STDEV|)**	**P Values**
Maintenance Costs (X) -> Farmer Welfare (Y)	0.533	0.545	0.063	8,477	0.000
Productivity (Z) -> Farmer Welfare (Y)	0.461	0.447	0.063	7,341	0.000
Moderating Effect 1 -> Farmer Welfare (Y)	-0.020	-0.011	0.060	0.336	0.738

Source: Data processed based on SmartPLS3 output results, 2025

Maintenance Costs (X) → Farmer Welfare (Y)

The test results show that maintenance costs have a positive influence on farmer welfare with a coefficient value of 0.533. The t-statistic value of 8.477, which is greater than 1.96, and the p-value of 0.000, which is less than 0.05, indicate that this relationship is significant.

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Productivity (Z) → Farmer Welfare (Y)

Hypothesis testing also shows that productivity has a positive effect on farmer welfare, with a coefficient value of 0.461. The t-statistic value of 7.341, which far exceeds the threshold of 1.96, and the significant p-value of 0.000, support a strong influence between the two variables.

Moderating Effect (X*Z) → Farmer Welfare (Y)

In contrast to the direct effect, the test results show that the moderating role of productivity in the relationship between maintenance costs and farmer welfare is not significant. The resulting coefficient value of -0.020 indicates a negative trend, while the t-statistic is only 0.336, well below 1.96, and the p-value of 0.738 is greater than 0.05.

Goodness of Fit Index

Table 5. Goodness of Fit Index Test

	Saturated Model	Estimated Model
SRMR	0.072	0.070

Source: Data processed based on SmartPLS3 output results, 2025

This value suggests a good level of fit of research model, since it is lower as compared to the generally accepted model acceptance level of 0.08. The results of the study indicate that the cocoa maintenance cost, productivity, and welfare of cocoa farmers in Manyamba represent a complex terrain of relationships. On the surface, the findings indicate that there is a rather direct relationship: more investment in maintenance also seems to increase the welfare of farmers, and, conversely, productivity is positively associated with well-being. But the fact is there, hidden under these obvious associations, the less obvious fact that productivity is not seen to mute the relationship between costs of maintenance and welfare. This means that the relationship between expenditure and better livelihoods is not straight or technical. Instead, it is immersed in a web of financial limitations, environmental uncertainty and social constructs that define the way farmers can use resources and receive the fruits of their toil.

To appreciate this complexity, it is necessary to move out of the limited perspective of input/output logic and see this issue in the context of time and institution in which farming decisions are being made. According to the farmer-centered cost benefit analysis of climate-smart agriculture, the actual payoffs of the agricultural investment are usually seen in the extended perspective. To them is a reminder that the cost of maintenance cannot be evaluated based on the returns it would generate in the short-term, but rather as an investment in the stability of farming systems. The farmers of Manyamba can then be at an intermediate stage, that spending on production and livelihoods at an intermediate stage, but have yet to transform into long term productivity payoffs. This temporal delay explains why the productivity has not increased the welfare implications of maintenance expenditure in the time period of the study.

This is further complicated by financial structures. The article by Boansi et al. (2024) about the cocoa farmers in Ghana illustrates that when access to credit is present, the expenditures of farmers become productive investment or they are treated as survival spending. When farmers can access credit at low rates, they use the funds to invest in inputs with high yield and long-term soil management, whereas when the farmers have to use their own savings or informal borrowed money, they tend to spend the money on defensive measures to keep up subsistence (Attipoe & Adams, 2024; Gneiting & Arhin, 2023; Waarts et al., 2021; Seidu, 2024; Osei, 2024). Low financial inclusion in Manyamba will most likely limit a productive use of maintenance funds, thus turning the possible capital formation into mere replacement of costs.

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Lack of moderating effect of productivity, though, could indicate more fundamental systemic constraint than defective behavior of the farmers themselves.

There is even more recent work opposing the fact that cost is just money. The study by Hayden et al. et al. (2022) demonstrates that the farmers see in the web of non-financial costs such as time pressure, managerial anxiety, and social expectations as the subtle factors that influence their participation in the sphere of farm management. Such non-quantifiable burdens consume resources of energy and focus, usually damping the effect of higher expenditure on output (Tambadou, 2024; Bakker et al., 2023; Liu & Madni, 2024; Guja & Bedeke, 2025). Within the Manyamba situation, it is a reasonable assumption that when maintenance spending rises then the stress or workload correspondingly increases and negates efficiency improvements. This view places the welfare impact of expenditure, not just in economic terms, but also on psychological and social well-being, which are usually concealed in quantitative data, although crucial to explain rural livelihoods (Idowu et al., 2023; Shahab et al., 2025).

The nature of spending per se is also a factor. Rashid & Shahzad (2021) illustrates that circular sustainability consumption that composts and recycles organic waste can also increase productivity without increasing the costs of operation. Her conclusions emphasize that effective investments cannot be distinguished by the sums of money spent only but the quality of spending and knowledge systems to lead the effective spending (Bremaghani, 2024; Manea et al., 2024; Ellacuriaga et al., 2021; Saqib & Sadef, 2025). There is a possibility that farmers in Manyamba are spending a significant amount of money on regular maintenance, pesticides, fertilizer, and general labor, but they are not using methods that encourage soil health or resource efficiency. This point can indicate that the welfare benefits can be obtained as a result of the stability of steady expenditure, even when this expenditure does not necessarily lead to transformative productivity effects (Bigdeloo et al., 2021; Le Pera et al., 2022).

There is a related series of inquiry that focuses on the role played by technological and institutional access in determining productivity. posit that the digital and precision agricultural tools reorganize the efficiency of production by enhancing the information response and resource distribution. Individually, concludes that long-term credit promotes long-term investment, e.g. replanting or infrastructure enhancement, which increases yields in the long run. In this perspective, the results of Manyamba can be referred to the lack of enabling conditions. The absence of affordable technology or formatted financing can ensure short-term operation, but the cost of maintenance will hardly open the compounding benefits that are often brought about by technology and credit. As a result, the mediating nature of productivity is limited by institutional scaffolding of farm management.

These effects are also mitigated by heterogeneity amongst the cultivators. According to Jie et al. (2023), the related economic returns of the sustainable practices demonstrate significant variance in ecological and socio-economic environments, which depend on the support of land quality, extent, and market connectivity. Similar variability is self-evident in Manyamba, where the producers vary significantly in the areas of plot size, agronomic prowess, and exposure to external aid. When those differences are absorbed together in a single aggregate model, the intra-sample variance may attenuate statistical correlations, and make moderation effects seemingly weaker than they would seem to be in a more homogenous subgroup. Another interpretative dimension is provided by structural context. According to the data provided by BPS (2023), and analytical research conducted by WRI Indonesia (2025), the cocoa sector of Indonesia is still largely a sector dominated by the smallholder, with the arboreal stock aging, as well as with the underuse of new varieties. In this environment, the intensified spending is often a maintenance purpose, the expenditure keeps trees alive other than leading to

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productivity breakthroughs. Therefore, the trend in Manyamba is conformable to a larger nationwide fact in which expenditure maintains livelihoods, but does not change them; the welfare gains which were found in this research are thus indicative of stability and maintenance as opposed to increase.

This interpretation is added with one more layer of texture when it is compared to the modern field reports. Both the Kongor et al. (2024) explain how despite high prices of cocoa, many farmers in Indonesia and West Africa have to cut the trees because of pests, diseases and changes in the weather. The stories elucidate the weaknesses of market incentives without structural resilience (Bryceson et al., 2023). The farmers might not have the security needed to invest in their farms confidently even when the prices are favorable in the globe. In this regard, productivity, despite its desirable nature, could also not serve as any reliable multiplier of welfare since output is always threatened by the volatility of the environment and the market. Policy studies outline the directions in order to reduce this vulnerability. The efficacy of price-stabilization mechanisms and target subsidies also provided to farmers in order to allow them to internalize initial risks of investment is highlighted. Such tools may also shift in Manyamba the maintenance expenditure on short term coping strategy to a long-term productivity booster. At the same time, demonstrates in his example of informal rural finance, a number of farmers turn to the services of input stores, often leading to high-debt cycles that wipe out any potential profits. The institutional reorganization to increase access to equitable credit and cooperative financing would therefore aid the conversion of maintenance cost to justifiable investment.

Social and human capital continue to play critical roles in this change. show that farmers being integrated into strong social networks and co-operations are better placed to transform inputs into shared productivity. Similarly, Nnahiwe (2023) disclose that knowledge, motivation, and agronomic practice discipline are factors that distinguish high-yielding producers with other producers. These reflections come to a pivotal moment, where only capital does not lead to productivity, it is mediated by learning, trust and organizational capability. To the producers of Manyamba, the strengthening of the farmer collectives and extension services is therefore likely to be equally important as increasing financial resources. The fluctuating environment of world cocoa markets creates an inevitability. demonstrate that world price volatility has a significant impact on the welfare outcome, which can be much higher than productivity/ expenditure impact. The farmers who are diversifying sources of income or adaptive ones have a more stable level of welfare as compared to those who depend on cocoa only as they are exposed to price shocks. Here, the results of Manyamba are echoed in an international trend where the welfare of producers is subject to less control by the efficiency of the producer, and more by the general forms of market and climatic uncertainty that characterize the current agricultural production.

Conclusion

This study concluded that cocoa maintenance costs and productivity have a significant positive effect on farmer welfare in Manyamba Village. However, productivity was not shown to moderate the relationship between maintenance costs and welfare. These findings confirm that improving farmer welfare depends not only on cost and productivity management but also requires support from external factors such as access to capital, technology, and government policies that support sustainable cocoa farming.

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