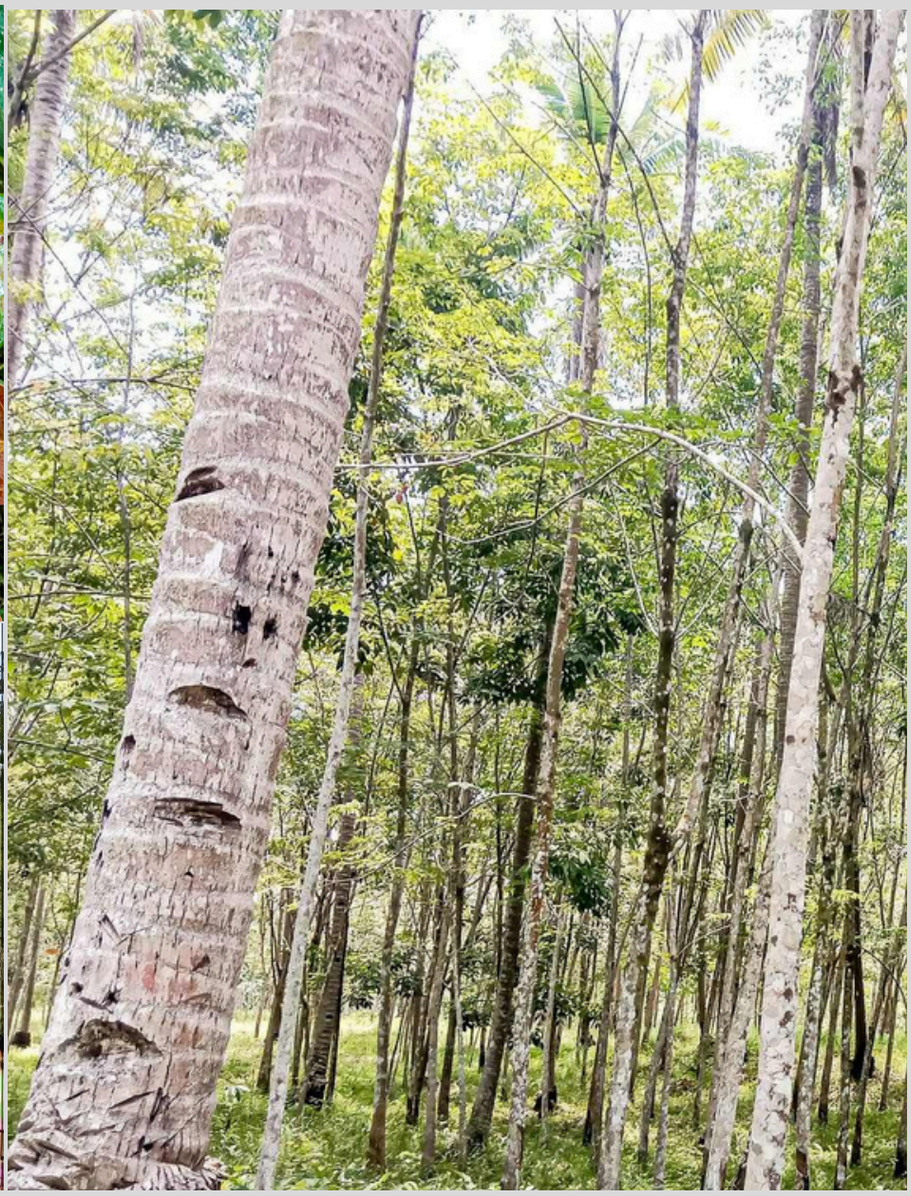
Graduate School

Doctor of Philosophy in Agricultural Sciences Major in Crop Protection

Impact Assessment Report

Etiology, Detection, and Management Strategies Against Pestalotiopsis Disease of Rubber



Impact Assessment Report

Etiology, Detection, and Management Strategies Against Pestalotiopsis Disease of Rubber

This is to certify that the impact assessment study titled "***Etiology, Detection, and Management Strategies Against Pestalotiopsis Disease of Rubber"*** was conducted and duly certified by the Western Mindanao State University (WMSU) Satellite Socio-Economic Research and Data Analytics Center (SERDAC).

The assessment was carried out using scientific methodologies, including household surveys, data analysis, and to evaluate the project's effects on food security economic well-being, and livelihood sustainability among the beneficiary households. the study adheres to rigorous research standards and provides an evidence-based evaluation of the project's impact

This certification is issued to confirm the validity and integrity of the assessment findings and to acknowledge the commitment of WMSU-SERDAC to supporting socioeconomic research for community development.

Certified and conducted by:

ANABEL GAMOREZ, PhD
Center Head
WMSU Satellite SERDAC

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Executive Summary

The project, “Etiology, Detection, and Management Strategies Against *Pestalotiopsis* Disease of Rubber”, was designed to mitigate the dissemination of the disease to the nearby rubber farms and to normalize the latex yield of the rubber trees. This impact assessment evaluates the project's effectiveness in preventing the spread of the disease, normalizing the rubber tree latex production, its impact on the economy of the local rubber farmers, and its acceptance by the community.

The intervention improved rubber yield by controlling rubber leaf fall disease and adjusting fertilizer rates. Farmers accepted the control management for improved income in rubber latex production. Those who switched to other crops opted for the cultural and control method to revive normal latex flow within one production cycle.

Despite the success, several challenges still exist. Some rubber farmers have found it difficult to implement the intervention due to the unstable pricing of fungicides and fertilizers in the area and their financial capacity. To guarantee long-term output, ongoing training in sustainable agricultural methods is also required.

Notwithstanding these difficulties, the project has had fruitful results, encouraging community involvement in sustainable agriculture and a culture of independence. This evaluation emphasizes the necessity of more assistance in crucial areas to improve the initiative's long-term effects.

Part I

Narrative Report

This section outlines the background, methods of implementation, and actual accomplishments and outputs of the management against Pestaliotopsis disease.

Introduction

Background of the Study

Rubber is the main crop producing latex or Natural Rubber, an important commodity in the development of various commercial, industrial, household, tire, and footwear products. However, major prevailing rubber diseases with worldwide importance infecting rubber plantations such as Corynespora leaf fall, Colletotrichum leaf spot, Oidium powdery mildew, and leaf fall, stem bleeding and white root rot disease. Lately, an emerging foliar pathogen Pestalotiopsis microspora causing leaf fall disease of rubber has been reported as the most recent disease threat infecting hundreds of hectares of rubber plantation in different rubber-producing countries in Asia like Thailand, Indonesia, Vietnam, Sri Lanka, and most recently India, Cameroon and Papua New Guinea (CRTA, 2019). This pathogen infects rubber trees associated with other pathogens (IRCO 2019) and attacks all life stages of rubber including plant nursery, budwood garden, immature and mature plantation.

The disease symptom begins with brown to greyish spots on the leaves. These spots converge into one or several necrotic patches with around 0.5-2.0 cm. The attacked leaves show yellowing of leaf edges at a later stage, not changing, and defoliate. The disease resulted into quick defoliation of up to 75%, plant canopy become thin and leafless. Based on field observation, the disease symptoms and leaves defoliation were mostly found on the mature leaves compared to young leaves.

The fungal spores of Pestalotiopsis have four spore septum, straight or curved, spores spread by wind, water, and insects. To date, the spraying of synthetic fungicides at the early stages of the development of the disease is the most suggested control measure. However, the treatment protocol is still being developed and trials are being done with drones spraying, fogging and mist blowing of fungicides 5 m above the canopy (CRTA, 2019).

The Pestalotiopsis was first reported in Malaysia in 1975, the disease begins to spread not just to neighboring plantations but also to neighboring countries like Indonesia. In 2016-2017, the incidence of Pestalotiopsis disease was reported in North Sumatra and South Sumatera, Indonesia (Damiri et al, 2022). In 2018,103,000 ha of rubber plantation was infected and 382,000 ha, almost triple in July 2019. The disease significantly decreased the natural rubber production in Indonesia >25% from 2017-2018 and is expected to drop by 15% in 2019 (IRCO, 2019). In the same year, CRTA reported Pestalotiopsis devastation in the 4, 000 ha rubber plantation in Sri Lanka. Disease diagnosis is generally based on conventional methods such as microscopy, biochemical tests, and culture method which are laborious and time-consuming.

Introduction

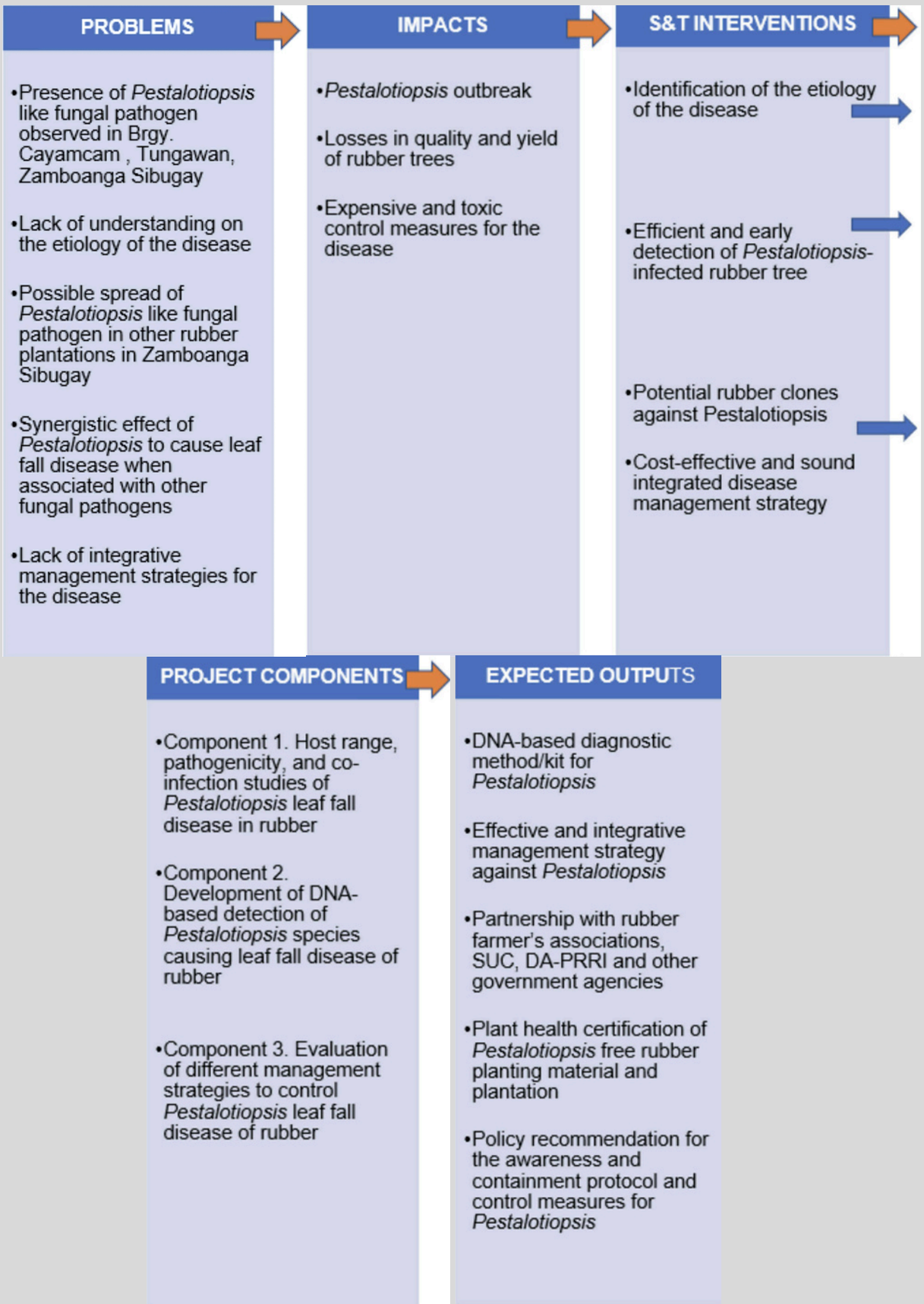
Nowadays, the use of molecular techniques such as nucleic acid amplification tests and the utilization of specific nucleic acid probes are employed in the detection of pathogenic microbes. End-point PCR w various modifications has got much attention as the molecular identification tool (Magdama et al, 2019). The advanced molecular platforms such as quantitative real-time PCR (qPCR) and digital PCR (dPCR) are alternatives to the conventional endpoint PCR, and other gel-based detection for reliable, safe, and automated pathogen identification and detection (Zhao et al, 2016). However, we need to develop an on-site diagnosis, simpler and faster method that has higher specificity than qPCR. Thus, there's a pressing need to develop a simple, rapid, accurate with high specificity diagnostic technologies to circumvent this current problem through the development of advanced molecular platform.

Also, the fast, reliable, highly sensitive PCR-based molecular detection of the causal pathogen of a plant disease is very important for an efficient management strategy. By so far, techniques include the traditional visual examination based on the taxonomic key of Stamps et al. (1990) and isolation in selective media, but these are relatively time-consuming, labor-intensive, and very often require extensive knowledge of fungal taxonomy (Silvar et al., 2005). Also, serological techniques have been developed but the lack of specificity of some antibodies and the necessity of obtaining monoclonal antibodies complicates the technique. Molecular methods and in particular the polymerase chain reaction (PCR) have been successful in identifying and detecting different fungal plant pathogens (Silvar et al., 2005). Therefore, it is of dire need in the management program of the disease.

On the side of management measures done, Pestalotiopsis infected countries suggested the use of systemic fungicide through fogging and spraying for the management of the diseases. However, the use of synthetic fungicide is expensive and could increase pesticide residues to the environment. One of the best options is the use of resistant clones which is considered as the most economical method of controlling plant diseases. Resistant clones can be use further for breeding programs in the future. Moreover, the use of endophytic fungi as potential biological control agents can be explored to control leaf diseases of rubber. Endophytes are organisms that are found in almost plant parts and act as chemical synthesizers inside the host plant and promote 11 the growth of host plants by directly producing secondary metabolites, which enhances the plant's resistance to biotic and abiotic stresses (Wen et al, 2022).

Therefore, this proposal aims to determine the biology and preliminary information on the epidemiology of Pestalotiopsis, to develop a simple and easy to perform method through molecular platform and evaluate an integrative management strategy to effectively manage the Pestalotiopsis causing leaf fall disease of rubber.

Scientific Basis/Conceptual Framework



Discussion of Results and Findings

Evaluation of Crop Protection Management Against Pestalotiopsis Leaf Disease (Farmers Field Intervention)

The evaluation of potential treatment against Pestalotiopsis Leaf Disease of rubber was done in the field set-up. Site selection or identification was done to determine the most suitable areas for the treatment plan. Two sites from North Cotabato specifically in Barangay Alimodian, Matalam were selected as the experimental site for the management of Pestalotiopsis Leaf Disease. The first set-up was treated with different fungicides and organic-based products and the other set-up is for the screening of potential endophytic fungi. Tagging and layouting of the experimental trees were also done in the selected area. The treatment application of organic formulations started last October 25, 2023 up to December 7, 2023. The application of biocontrol formulation (Probio) was done with different concentrations having 15 trees per treatment and used a power spray upon application.

Outputs of the Project (6Ps)

6 Ps	Expected Output	Actual Accomplishment
Publication	▪ At least 1 paper presented at the conference	
People and Services	▪ Mentored 1 MS student	
Product	▪ Potential host crops of *Pestalotiopsis*	▪ Documented and identified one (1) potential host range of *Pestalotiopsis*
	▪ Epidemiology of *Pestalotiopsis*	▪ Surveyed and assessed the incidence, severity and distribution of *Pestalotiopsis* in seven (7) major rubber producing provinces namely: Agusan Del Sur (10 farms), Basilan (7 farms), Bukidnon (2 farms), Davao De Oro (2 farms), North Cotabato (13 farms), Sultan Kudarat (1 farm) and Zamboanga Sibugay (9 farms) rubber plantations.
	▪ DNA-based detection kit for *Pestalotiopsis*	▪ Maintained and molecularly characterized pure cultures of *Pestalotiopsis*
	▪ Management strategies against *Pestalotiopsis*	▪ Assessed and evaluated biological and chemical based treatments
Patent		
Places and Partnership	▪ MOA between USM and PRRI	▪ Approved MOA between USM and PRRI
	▪ Partnership with rubber farmer's associations, SUC, DA-PRRI and other government agencies	▪ Partnered with the Provincial Agriculturist's Office and LGU's in Agusan Del Sur, Basilan, Bukidnon, Davao De Oro, North Cotabato, Sultan Kudarat, and Zamboanga Sibugay for the identification of rubber plantations for surveillance together with (44) rubber plantation owners/farmers in the utilization of their farms as location sites for disease surveillance, collection of leaf samples and field trial application of different treatments.
Policies	▪ Policy support for the conduct of the research	

Outcomes

- Increased quality of natural rubber
- Increased latex yield
- Increased income of rubber farmers
- Easy to use, effective and integrative management strategies

Potential Impacts (21s)

Social Impact

- Minimize yield loss and disease outbreak due to efficient surveillance, diagnosis and management of Pestalotiopsis disease of rubber.
- Enhanced knowledge of rubber farmers.
- Developed and promote effective biological and chemical based management strategies Economic Impact.

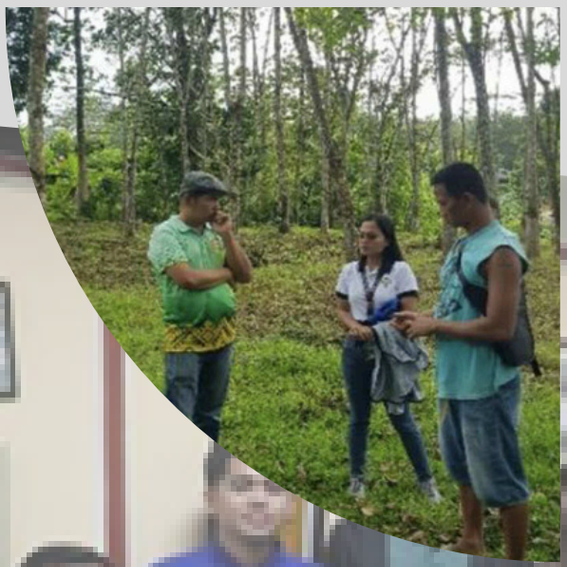
Economic Impact

- Increased quality of rubber trees/plantation and the increased rubber production and income of rubber farmers.
- Minimize additional cost for disease management.

Part II

Impact Assessment

This section provides information on the impact of the Etiology, Detection, and Management Strategies Against Pestalotiopsis Disease of Rubber. The impact assessed are, economic and social impact while capturing beneficiaries experiences and recommendations



Introduction

Background of the Study

The project, “Etiology, Detection, and Management Strategies Against Pestalotiopsis Disease of Rubber” is the response of the government in collaboration with the Department of Agriculture (DA), DA-Philippine Rubber Research Institute (DA-PRRI), Philippine Council for Agriculture, Aquatic, and Natural Resources and Development (PCAARRD), Local Government Units (LGUs), and University of Southern Mindanao, to control the outbreaks of the disease.

Pestalotiopsis Leaf Fall Disease (PLFD) has emerged as one of the most serious threats to rubber plantations, causing significant yield losses and economic setbacks for farmers. The disease, caused by the fungal pathogen Pestalotiopsis spp., leads to premature leaf fall, reduced latex production, and weakened tree vigor. In recent years, outbreaks have been reported with increasing frequency and severity, particularly in SOCCSKSARGEN region, where rubber is a vital livelihood crop. Farmers often struggle to control the disease due to limited knowledge, inadequate access to management technologies, and high input costs. Effective interventions are therefore critical to safeguard both farm productivity and the stability of rubber-dependent communities.

Introduction

Management strategies such as improved cultural practices, and timely fungicide applications, have shown potential in reducing the spread of the disease. However, their success depends largely on farmer awareness, adoption levels, and the sustainability of these practices under field conditions. Research-based guidance is urgently needed to identify and recommend the most practical and cost-effective approaches for smallholder farmers.

This study aims to explore and evaluate management interventions that can help farmers mitigate *Pestalotiopsis* Leaf Fall outbreaks more effectively. By addressing this challenge, the research contributes not only to improving farm resilience but also to ensuring the long-term sustainability of the rubber industry.

Introduction

Purpose of the Study

The purpose of this study is to evaluate the real effects after completion, rather than just predicting them. It helps determine whether the project delivered its intended benefits, what actual impacts it caused, and what lessons can be learned. The impact assessment of the project ensures the extension is not only completed but also useful, sustainable, and aligned with expectations, while minimizing harm and maximizing long-term benefits. The assessment specifically seeks to respond to the following:

a. Does the extension achieve its intended purpose?

b. Assess environmental, social, and economic impacts

c. Spot issues that weren't predicted during the planning stage.

d. Provide lessons learned to improve planning, design, and management of similar projects.

e. Support mitigation and improvement.

f. Suggest corrective actions (if needed) to reduce negative effects or enhance benefits.

Objectives

General Objective

To measure the actual social and economic impacts of the extension program.

Specific Objective

a.To assess whether the intervention in the farmer’s practice improves the effectiveness in controlling the rubber leaf fall disease.

b.To evaluate if the farmer's practice modification in the rubber production management enhances the rubber trees' latex yield.

c.To evaluate the farmers' social and economic acceptance of the implemented management intervention.

Review Literature

Rubber leaf fall is a serious foliar disease complex in Hevea brasiliensis that causes necrotic lesions, premature defoliation, canopy loss, and yield decline (Lopez, et al., 2018). More recently, Southeast Asia has seen the re-emergence of *Pestalotiopsis/Neopestalotiopsis* leaf fall, spreading across Indonesia, Malaysia, Thailand, Sri Lanka, and Vietnam, and cutting latex yields by up to ~50% in badly affected areas (PCAF, 2022). This has prompted the Philippines to propose the formation of a Technical Working Group (TWG) involving PRRI, DA, DOST-PCAARRD, USM, and other stakeholders to oversee research and prevention (PCAF, 2022).

The disease rose to national attention when Basilan Province declared a state of calamity on January 23, 2023, due to widespread infection of rubber plantations (Philippine News Agency, 2023a). Rubber leaf fall disease —primarily caused by Pestalotiopsis species has emerged as a serious threat to natural rubber production, particularly in Mindanao and Caraga regions (Philippine News Agency, 2023b).

A Food and Agriculture Organization (FAO) emergency mission was deployed in April–May 2023 to assist the Philippine government, providing technical support and recommendations to develop integrated pest management strategies and community-based surveillance systems (FAO, 2023).

Review Literature

In early 2023, the Department of Agriculture (DA), through the Philippine Rubber Research Institute (PRRI), began treating affected plantations using methods such as mist fogging, drone aerial spraying of fungicides, fertilization, and weed management (DA, 2023).

Simultaneously, PRRI conducted extensive surveillance in Zamboanga Sibugay, Zamboanga del Sur, and Zamboanga del Norte during April and May 2023 to assess the severity and monitor spread of *Pestalotiopsis* Leaf Fall Disease (PLFD) (Philippine Rubber Research Institute, 2023).

In the Caraga region, an earlier outbreak was detected in April 2023 affecting 1,765 hectares and impacting 1,120 farmers, prompting DA-Caraga and PRRI to conduct technical briefings and promote measures including fungicide application and biocontrol using *Trichoderma harzianum* (Philippine Information Agency, 2024). By mid-2023, awareness campaigns intensified throughout Caraga, emphasizing early detection and prompt treatment to curb the airborne disease's spread and mitigate losses of up to 70–90% in yield (Philippine News Agency, 2023c).

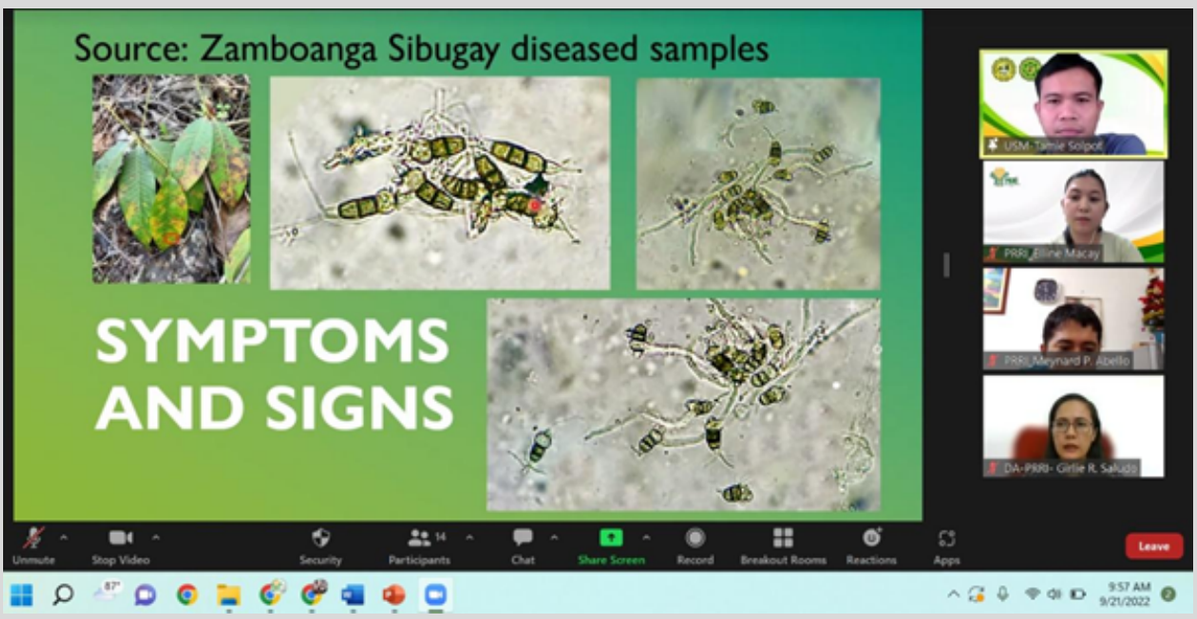
Meanwhile, positive developments from research in North Cotabato showed promise: a study by USM identified 18 endophytic fungi that demonstrated significant antagonistic activity against major and emerging leaf pathogens, including *Pestalotiopsis* species. (DOST-PCAARRD, 2024).

Review Literature

Some *endophytes* reduced disease severity nearly as effectively as conventional fungicides and *Trichoderma*, offering environmentally friendly alternatives for disease management (DOST-PCAARRD, 2024).

The combination of emergency response, surveillance, research into biocontrol agents, and institutional coordination reflects a multi-pronged effort to safeguard the rubber industry from recurring leaf-fall crises (Philippine Rubber Research Institute, 2023).

The Philippine experience with rubber leaf fall disease underscores the importance of early detection, robust response measures, and long-term R&D investments to protect farmers' livelihoods and national production (DA, 2023).



Methodology

A. Impact Pathway Analysis and Theory of Change

For the impact assessment of the extension project "Helping Rubber Farmers Combat Pestalotiopsis Leaf Fall: Effective Management Interventions to Mitigate Outbreaks," qualitative approaches were employed to ensure a comprehensive examination of the findings. The Most Significant Change (MSC) technique, which provided deeper insights into the project's influence on beneficiaries' lives than could be ascertained by quantifiable measurements, was used to document their life-changing stories.

Instead of using a control-group strategy, a before-and-after comparison approach was chosen to evaluate the project's impact. This method compared the pre- and post-intervention circumstances of participating homes to assess increases in social and economic benefits.

To learn how various project elements—such as community involvement, fertilizer access, and disease management training—contributed to the results that were seen, impact paths were also followed.

The Theory of Change (ToC) framework, which guides the impact assessment, looks at how inputs (training, fungicide, and fertilizer support) resulted in long-term impacts (higher household income and strengthened community cooperation) as well as immediate outputs (adoption of control and cultural management practices).

Methodology

Inputs

- Information dissemination
- Fertilizer
- Pesticide

Activities

- Conducted farmers' trainings and meetings.
- Provide fertilizer and pesticides to the farmer recipients.

Outcomes

- Conducted farmers' trainings and meetings.
- Provide fertilizer and pesticides to the farmer recipients.

Impacts

- Skilled rubber farmer.
- Institutionalization of the government intervention in helping the rubber farmers.

Methodology

B. Evaluation Designs Used

Qualitative Approach

The Most Significant Change (MSC) technique was used in the evaluation to gain insight into the beneficiaries' lived experiences. One rubber farmer who followed the instructions and observed an increase in crop productivity and income is the subject of a documented success story.

C. Data Collection Method

Structured Questionaire

Project beneficiaries were personally interviewed with the aid of structured questionnaires to gather information on economic advantages and sustainability practices. Fifty household recipients in all were polled.

Most Significant Change (MSC) Stories

A compilation of participant testimonies highlighting the most significant transformations the initiative brought about.

Methodology

D. Key Indicators Measured

Economic Indicators
Household income generation

Social and Community Impact Indicators
Strengthening of community networks through shared rubber production practices

Sustainability Indicators
Adoption of organic farming and sustainable gardening practices continued implementation of cultural and control management beyond the project duration

Results and Discussion

Key Indicator :1 Economic Impact

The program's intervention in the rubber latex production process results in an average increase of 35.30% in income from latex production compared to the harvest without intervention. The program gives a big help to the rubber farmers to boost their income. The result implies that the program effectively improves the yield of the rubber latex and translates to an increase in the income of the individual small-scale rubber farmers.

Before the intervention, latex yields were very low, and some of the rubber trees were not productive. The situation worsened when the incidence of the rubber leaf fall disease infected most of the rubber plantations in the locality. Some of them planned to change the rubber trees to other profitable crops.

Timely, the collaboration of USM, LGU-Matalam, and PRRI intervened to mitigate the impact of the rubber leaf fall disease; they distributed fertilizers and improved the cultural practices employed by the rubber small-scale farmer beneficiaries. After one cycle of production the latex yields improved because the rubber leaf fall disease was controlled this is the result of proper fertilization and application of the appropriate control measures in preventing the disease development.

Results and Discussion

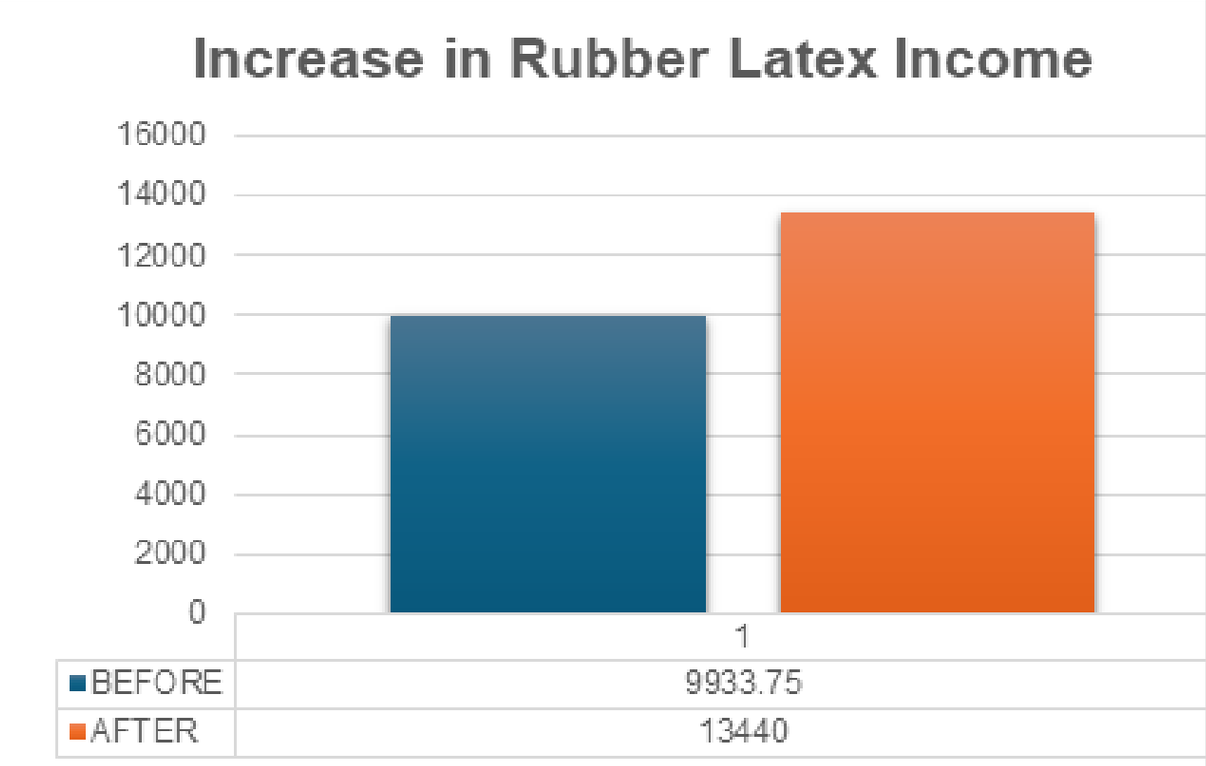


Figure 1. Comparative income of the farmer before and after the intervention.

Results and Discussion

Key Indicator 2: Social and Community Impact Indicators

The interviewed rubber farmer beneficiaries profess that their neighboring rubber farmers were encouraged to adopt the methods in controlling the rubber leaf fall disease. Results revealed that 63% of the respondents indicated adopting fertilization and application of the fungicides to the infected rubber trees to induce resistance of the rubber trees and suppress the development of the rubber leaf fall disease. The overwhelming acceptance of the project was the result of the increase in their rubber latex yield and monetary income. The implication of the result suggests that the project was socially acceptable to the rubber small-scale farmers because it can improve their livelihood. The positive result of the intervention strongly speaks for itself to become socially acceptable.

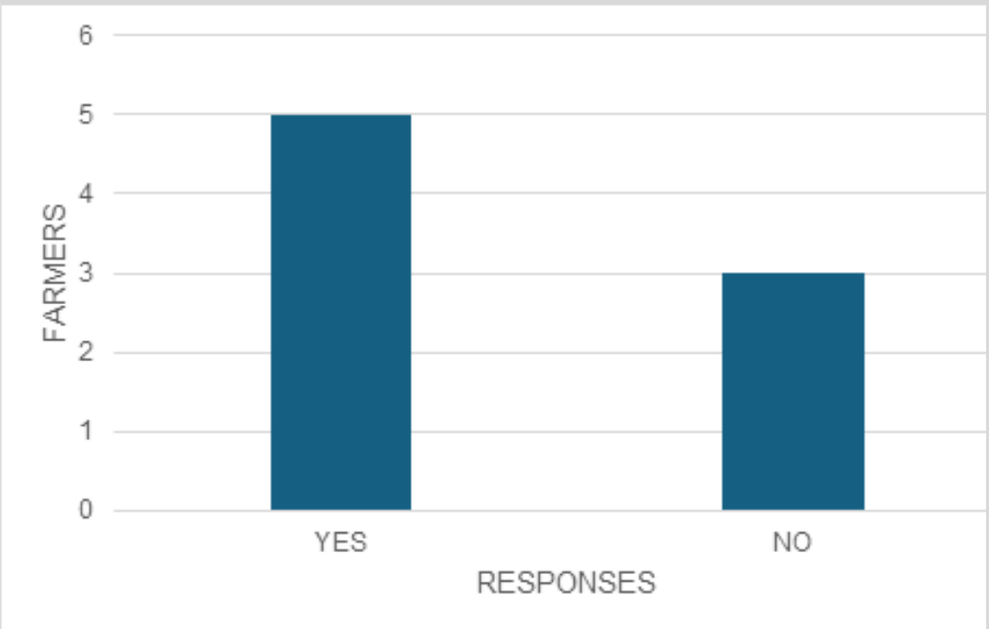


Figure 2. The project encourages collaboration with neighboring rubber farmers.

Results and Discussion

Key Indicator 3: Sustainability Indicators

Based on the positive and promising results of the intervention, 88% of the trained rubber farmer beneficiaries became the model of their locality and influenced other farmers to adopt the knowledge and skills they acquired. This result implies that the neighboring farm found out the significance of the application of the fertilizer in improving the latex production and preventing the development of the rubber leaf fall disease. This percentage is a good indicator of the sustainability of the intervention, where the neighboring farms appreciated the improvement of their rubber latex production and monetary income. The observation of the farmers on the positive results drove them to accept and adopt the cultural and control management introduced to the community. The pilot farmer beneficiaries' better income and standard of living, which allowed them to purchase items they had previously desired, was the primary reason why the farmers accepted and continued the new production management.

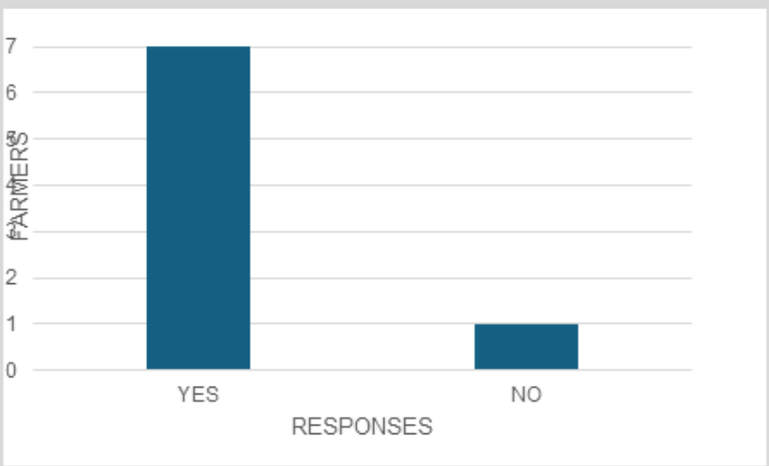


Figure 3. The trained rubber farmer beneficiaries influenced other farmers to adopt the knowledge and skills they acquired from the project.

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Conclusion

The evaluation of the project demonstrates its positive impact on the small-scale rubber farmers in addressing the economic impact of the rubber leaf fall disease, where it successfully suppresses the economic damage caused by the pandemic infection of the disease. The project successfully addressed its objectives to suppress the development of the rubber leaf fall disease and increase the rubber latex of the infected trees, and it was overwhelmingly accepted economically and socially by the rubber farmers.

Recommendations

1.Institutionalized the subsidy for the rubber small-scale farmers to help them cope with the losses incurred from the emerging insect pests and diseases.

2.Established a mobile clinic for the diagnosis of rubber disease symptoms and identification of the insect pest infesting rubber trees.

3.Before and after the program, monitor the farmers' progress. To determine who gains the most, gather data from various categories, such as different age groups, women, and young people.

Success Study

Fertilization & Disease Awareness Help Rubber Farmer Boost Latex Yield

Resilient Farming in the Face of Challenges

For years, Manang Tina, a rubber farmer from Barangay Sta Maria, Matalam, Cotabato, has faced two major hurdles on his hectare plantation: declining latex yield and the recurring problem of abnormal leaf fall disease. During the monsoon, when leaf fall disease spread rapidly, his yield dropped even further.

“Natingala mi nga bulan pa lang ang pagbalik sa dahon nangahulog napud ang among makuha nga cuplump nag kagamay ubos pa ang presyo ubos pa gyud ang harvest”

A Turning Point Through the Intervention of the Project

In 2022, Manang Tina, a farmer leader, was identified as one of the project's recipients. With the intervention, he learned two key lessons: first, balanced fertilization matters – Overuse of nitrogen was weakening his trees, while phosphorus and magnesium deficiencies were limiting latex production. Second, disease awareness is crucial – leaf fall disease, if left unmanaged, reduces the tree’s ability to photosynthesize, directly lowering yield. Timely fungicidal sprays and good plantation hygiene were essential.

Success Study

Steps She Took

Manang Tina carried out soil and leaf nutrition analyses to direct fertilizer applications following the training led by the project facilitators. Adopted a balanced fertilizer schedule (NPK + magnesium + organic manure) in split doses across the year. Implemented preventive fungicidal sprays at the onset of the rainy season. Removed diseased leaves from the plantation floor to reduce spore buildup.

The Results

After one full season of following these practices, Manang Tina saw a transformation: Latex yield increased by 30%, providing him with additional household income. Trees looked healthier, with lush green leaves and reduced tapping panel dryness. The incidence of leaf fall disease dropped significantly, allowing uninterrupted tapping. Production costs were reduced due to precise fertilizer use, avoiding wastage.

Success Study

“Dako ang natabang sa amoa nga farmers ang project kay makumapara sa una hapit na namo putulon ang rubber kay hinay ang duga sa latex, naa man diay ang sayon nga pama-agi ang pag-abono ug pag apply sa fungicide mibalik na ang pag duga mi taas pa gyud ang amo ma harvest nga latex.”

Inspiring the Community

Today, Manong Budoy shares his experience with his cooperative's fellow farmers. Plantations around the community are becoming healthier because of the widespread adoption of integrated nutrition management and disease awareness methods.

“Sa una ang pag-abot sa sakit sa rubber usa ra sa kapalaran sa amo nga mag-uuma kay ang among ginabuhat sa una human matanum ang rubber maghulat lang mi hangtod pwede na masangutan , Karon nakasabot nako nga ang kahibalo mao ang tinuod nga hinagiban. Karon tungod nadugangan ang ako kahibalo mas mitaas ang ako kumpyansa sap ag-uma sa rubber”

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