Internship Report

A Case Study on the Impact of RECP Adoption in Microenterprises (High-Value Crops-Pineapple) under the SMART Project of PKSF

Submitted by:

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Declaration

I, Mashiyat Faiza Jahan, declare that this report titled "A Case Study on the Impact of RECP Adoption in Microenterprises (High-Value Crops-Pineapple) under the SMART Project of PKSF" is an original work undertaken by me under the guidance and direct supervision of Abu Hayad Md. Rahat Hossain, Manager (Programme) as part of my internship program at PKSF.

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Acknowledgement

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I extend my deepest gratitude to my internship supervisor at PKSF, Abu Hayad Md. Rahat Hossain, Manager (Programme), for their consistent guidance, constructive feedback, and support throughout the duration of this work. I am equally grateful to the SMART Project team, for their cooperation and insights, which were essential in shaping the study and understanding the project's operational context.

I am thankful to the staff members of Society for Social Services (SSS) who arranged the field visit and facilitated access to respondents and provided logistical assistance during field operations. Their collaboration and coordination greatly streamlined the overall data collection process.

Finally, I express my sincere gratitude to the pineapple farmers who participated in the study. Their willingness to share their time, experiences, and perspectives made this research possible. The insights gained from their responses form the foundation of this report.

I remain grateful to all who contributed to the success of this internship and research. The knowledge and experience gained through the SMART Project will continue to inform and guide my future academic and professional endeavors.

Abstract

This study assesses the economic and environmental effects of Resource Efficient and Cleaner Production (RECP) practices adopted by pineapple micro-entrepreneurs under the SMART Project of PKSF. Using a mixed-methods approach, the research combines quantitative survey data from 25 farmers with qualitative insights from five in-depth interviews. Quantitative results show reductions in chemical fertilizer, pesticide, herbicide, and hormone use, accompanied by increases in organic fertilizer application, waste recycling, and managed waste. Water usage declined, chemical fertilizer use fell sharply, and the use of organic fertilizer increased after RECP adoption, which collectively contributed to lower production costs and a higher selling price for pineapples. Qualitative findings confirm strong farmer understanding of RECP, positive perceptions of environmental and health benefits,and active knowledge sharing within farming communities. Although changes in yield were mixed due to the adoption of multi cropping methods, overall outcomes indicate that RECP enhances resource efficiency, reduces environmental degradations, and strengthens economic resilience in small-scale pineapple cultivation. The study highlights the importance of continued training, additional financial support, and stronger market linkages to sustain and scale RECP adoption.

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1.0 Introduction:

Resource Efficient and Cleaner Production (RECP) offers microenterprises a practical way to lower input costs, improve productivity, and reduce the environmental footprint of their operations. The approach centers on using resources more efficiently, cutting unnecessary waste, and replacing harmful production habits with cleaner and safer alternatives. For small farmers, especially those producing high-value crops like pineapple, these improvements are not abstract goals. They directly affect profitability, day-to-day workload, and long-term viability in the face of changing weather patterns, rising agrochemical prices, and increasing pressure on natural resources.

Pineapple farmers in Bangladesh operate in a context where production efficiency and environmental vulnerability are closely linked. High chemical dependence, heavy water use, and unmanaged waste contribute to both higher production costs and higher health and environmental risks. As climate variability affects rainfall, soil condition, and pest dynamics, farmers face growing uncertainty in yield and income. RECP practices offer a pathway to address these challenges by promoting technologies and methods that use water, energy, and materials more efficiently while maintaining or improving yield.

The SMART Project of PKSF seeks to accelerate the adoption of these practices among micro-entrepreneurs. Through training, technical support, and targeted financial assistance, the project introduces interventions such as drip irrigation, Integrated Pest Management, composting, organic amendments, and improved waste handling. These practices aim to reduce chemical dependency, improve soil health, and build resilience in small-scale production systems. By integrating environmental and economic goals, the project positions RECP not only as a climate strategy but also as a way for farmers to strengthen their competitiveness.

This study examines how RECP adoption influences both economic performance and environmental outcomes in pineapple production. It also explores how farmers learn about these practices, how knowledge spreads within their communities, and what factors encourage or limit wider adoption. Through a mix of quantitative analysis and in-depth interviews, the research aims to generate evidence that can support PKSF and similar institutions in scaling RECP across microenterprise sectors.

1.1 Palli Karma-Sahayak Foundation (PKSF):

The Palli Karma-Sahayak Foundation (PKSF) is a national development institution established by the Government of Bangladesh in 1990 as a not-for-profit company. It serves as a semi-governmental apex body dedicated to reducing poverty and improving livelihoods through enterprise development, employment generation, and inclusive access to finance. PKSF works through a structured network of Partner Organizations (POs), which are selected through a rigorous institutional rating process. These POs deliver loans, training, capacity-building, technical support, and market linkages to poor and low-income households, small farmers, and micro-entrepreneurs across the country.

PKSF's mission goes beyond financing. It covers education, health, climate adaptation, social development, and enterprise growth. With more than 214 POs reaching millions of borrowers, PKSF operates both long-term programs funded internally and specialized development projects co-financed by international development partners. Its operational model combines loan-based interventions and grant-supported activities, supported by strong monitoring systems and field-level engagement. This institutional foundation enables PKSF to manage large-scale interventions like SMART and channel financial and technical support efficiently to microenterprises.

1.2 Sustainable Microenterprise and Resilient Transformation (SMART):

The "Sustainable Microenterprise and Resilient Transformation (SMART)", a five-year Government approved project, co-funded by the PKSF and the World Bank is going to support 80,000 microenterprises (MEs) in agribusiness, manufacturing, and service sectors. The project will have special focus on attaining environmental sustainability and energy efficiency without jeopardizing the growth of microenterprises. The SMART project will foster a green growth approach that abates environmental damage, secures sustainable growth engines through the adoption of green practices and technologies, creates new job opportunities, and achieves harmony between the economy and the environment. The Project will maximize the impact on the MEs in environmentally stressed and/or vulnerable to climate change and natural disasters. PKSF also intends to induce changes in the microfinance eco-system and support environmentally friendly businesses through the adoption of operational safety norms following different approaches including climate-resilient RECP practices and technologies, and a decent working environment in project-supported MEs. The Project Development Objective is 'to increase resource-efficient and resilient green growth of microenterprises.'

The Project aims to cover MEs from all over Bangladesh with a strategic focus on those areas more environmentally critical and vulnerable to climate risks, and economic sectors and sub-sectors with higher environmental improvement potential. The duration of the project is from August 2023 to December 2028. The total budget of SMART is US$ 300.0 million.

Components: Project consist of 3 components-

Component 1: Enabling capacity and systems for green growth of the MEs:

A) Enhancing MEs' environmental knowledge capacity

B) Enhancing common facilities and enabling environmental systems for MEs cluster

C) Enabling MEs to develop a green value chain and expand markets for green products

Component 2: Providing access to finance for MEs to enable green growth:

A) Line of credit for sustainable climate resilient RECP practices and technologies

B) Line of credit for revenue-generating common facilities

Component 3: Project Management, Communications, Monitoring & Evaluations, and Knowledge Management:

A) PKSF's project management and enhanced capacity

B) Communications, monitoring, and evaluations (M&E)

C) Knowledge management

1.3 RECP Adoption in Microenterprises (High-Value Crops-Pineapple):

Agriculture is one of SMART's core microenterprise sectors, and pineapple cultivation is a priority because of its strong market potential and suitability for cleaner production interventions. Pineapple farmers often face high production costs due to water-intensive irrigation, heavy chemical use, and labor demands, while traditional practices generate significant organic waste and expose farmers to chemical hazards. RECP practices help reduce these pressures by improving how farmers use water, energy, and materials. Relevant RECP practices in pineapple systems include:

- Drip and micro-sprinkler irrigation, which reduce water usage and improve yield stability.
- Integrated Pest Management (IPM), which lowers pesticide dependency and supports ecological balance.
- Use of organic fertilizers and compost, which improve soil health and reduce reliance on chemicals.
- Recycling and improved waste handling, turning plant residues and waste into usable inputs.

Through SMART, farmers receive training, technical support, and financial assistance to adopt these RECP practices. The project also encourages farmer-to-farmer knowledge sharing, which plays an important role in spreading these practices within local communities. This study assesses how these RECP measures affect economic performance, environmental indicators, and the diffusion of knowledge among pineapple micro-entrepreneurs.

1.4 Objective:

The objectives of this study are:

- To observe the economic effects of RECP adoption in microenterprises.
- To observe the environmental effects of RECP adoption in microenterprises.
- To examine behavioral changes in microenterprises after adopting RECP practices, focusing on production behavior, resource efficiency, and sustainability commitment.
- To examine the knowledge, practices & awareness of MEs.
- To provide insights for RECP practices across similar MEs.

2.0 Literature Review:

Resource Efficient and Cleaner Production (RECP) offers a way for small farmers to improve efficiency and reduce environmental harm by lowering the use of water, energy, and agrochemicals. In micro-enterprises, RECP practices such as drip irrigation, Integrated Pest Management (IPM), composting, mulching, renewable energy use, and improved waste reuse reduce production costs while strengthening resilience. This logic underpins the interventions promoted under the SMART Project.

RECP-focused studies show that efficiency gains extend across sectors, though most evidence comes from manufacturing and processing industries rather than agriculture. Ongechi and Mandala (2021), in an East African study on MSMEs, found that RECP financing improved energy efficiency, reduced material waste, and increased enterprise profitability, but noted that microenterprises often lack awareness and technical capacity to adopt cleaner practices without targeted support. Jawjit et al. (2024) showed that adopting RECP practices in the sawn rubberwood industry reduced fuelwood use, minimized waste volumes, and decreased pollutant emissions, demonstrating how cleaner production can transform resource-intensive operations. Similarly, Ma et al. (2022) documented how data-driven RECP strategies in energy-intensive factories in China reduced carbon emissions, cut energy consumption, and increased overall production efficiency. Together, these studies demonstrate that RECP consistently delivers strong material, energy, and waste-management gains, but they also highlight a common gap: most documented RECP benefits are drawn from industrial and processing sectors, with far fewer systematic studies focused on primary agriculture or smallholder crop systems. This gap underscores the need for agriculture-specific evidence such as the present study.

Economically, micro-irrigation technologies (MITs) show strong benefits for smallholders. Nyangarika et al. (2025) found that farmers using MITs had higher net present value and stronger benefit–cost ratios compared to non-adopters, even after accounting for the initial investment. Low-cost drip systems show similar advantages, with studies reporting higher water-use efficiency, reduced fertilizer runoff, and lower labor requirements in small-scale, high-value crops (ResearchFloor, 2024). These findings emphasize that irrigation efficiency is one of the fastest ways for farmers to reduce production costs while stabilizing yield.

Environmentally, IPM has one of the strongest evidence bases among cleaner production methods. A multi-year field experiment by Grab et al. (2021) showed that

IPM reduced insecticide applications by about 95 percent while maintaining yields and increasing wild pollinator activity. A broader review across 85 programs by Pretty and Bharucha (2015) found that IPM reduced pesticide use to roughly one-third of baseline levels while increasing mean yields by more than 40 percent. These results show that IPM reduces chemical dependence while strengthening ecological balance and long-term farm health.

In pineapple systems, resource-efficient practices also show promising results. Ines et al. (2022) reported that organic-based pineapple production supported by micro-sprinkler irrigation improved yield, return on investment, and water management in upland production areas. Additional studies in tropical fruit systems show that bio-pesticides, organic fertilizers, and mulch-based moisture management reduce soil degradation and chemical exposure. Waste-to-resource measures, such as composting pineapple residues or extracting fiber from leaves, also demonstrate how RECP practices can reduce waste while generating added value.

Taken together, existing research shows that RECP practices deliver clear economic and environmental benefits across sectors, but most rigorous evidence comes from manufacturing, forestry, and energy-intensive industries, not agriculture. Very few studies examine RECP as a combined package within smallholder crop systems, and even fewer explore how farmers learn and share these practices within their communities. This study addresses those gaps by combining before–after indicators with in-depth interviews to understand both performance changes and the pathways through which RECP knowledge spreads among pineapple micro-entrepreneurs.

3.0 Research Method:

This study uses a mixed-method design to capture both measurable changes and the lived experiences of pineapple farmers adopting Resource Efficient and Cleaner Production (RECP) practices. The quantitative component focuses on before–after comparisons using structured survey data, while the qualitative component explores farmer behavior, decision-making, and knowledge sharing through in-depth interviews (IDIs). Using both approaches allows the study to measure performance shifts and understand the mechanisms behind those shifts.

3.1 Study Area and Sampling:

The study is conducted in pineapple-producing areas of Tangail district under the SMART Project of PKSF. The quantitative sample includes 25 pineapple farmers. Farmers are selected through purposive convenient sampling, ensuring that participants have adopted at least two RECP practice.

For the qualitative component, 5 farmers are selected for in-depth interviews using purposive criteria. These farmers demonstrate clear engagement with RECP practices and have experience with project-provided training or technical support.

3.2 Data Collection Tools:

Two instruments guide data collection:

1. Structured Questionnaire (Quantitative): This tool measures RECP adoption, production practices, and environmental and economic indicators before and after adoption. Indicators include:

    - Yield (number of pineapples produced)
    - Production cost
    - Sale price
    - Fertilizer, pesticide, herbicide, and hormone use
    - Organic input use
    - Water use
    - Waste generated, managed, and recycled

2. In-Depth Interview Guide (Qualitative): IDIs capture behavioral change, sustainability commitment, training experiences, and farmer-to-farmer

knowledge diffusion. Questions explore comfort with RECP practices, perceived risks and benefits, and the social processes that influence adoption.

Before collecting data in the field, a dynamic data entry form was developed using Kobo Toolbox. Data is collected through face-to-face visits with farmers. Surveys and IDIs are conducted in Bangla, with field notes and audio recordings (where permitted) used for qualitative analysis.

3.3 Data Collection Matrix:

Area	*Variables*	*Unit of Measurement*	*Source of Data*
Economic Aspects	No of Pineapple Produced	Numbers	Primary (Survey Questionnaire)
	Price of Produced Pineapple	Per Piece	
	Production Cost	Per Season	
Environment Aspects	Amount of Chemical Fertilizer	kg/season	
	Amount of Chemical Pesticide	litre/season	
	Amount of Chemical Herbicide	litre/season	
	Amount of Chemical Hormone	litre/season	
	Amount of Organic Fertilizer	kg/season	
	Amount of Organic Pesticide	litre/season	
	Amount of Other Raw Materials	kg/season	
	Amount of Water Usage in Production	litre/season	
	Amount of Solid Waste Generated	kg	
	Amount of Managed Waste	kg	
	Amount of Recycled Waste	kg	

3.4 Ethical Considerations:

All participants provide informed consent. Privacy is ensured by removing identifying information from transcripts and datasets. Participation is voluntary, and farmers may decline or withdraw at any time without consequences.

4.0 Data Analysis:

After data collection through ODK collect, data was extracted and necessary measures such as data coding, cleaning and minor editing were accomplished in Microsoft Excel. Afterwards, data was analyzed by using Stata/SE 14.

4.1 Data Preparation:

The raw data is extracted in .xlsx file format from Kobo Toolbox and then cleaned and prepared for STATA in Microsoft Excel. Afterwards, the environmental indicators and the production cost data were transformed to per decimal of cultivated land for each respondent.

4.2 Descriptive Statistics:

Descriptive analysis provides us with a preliminary understanding of the datasets. We can summarize the data by finding the mean, minimum, maximum and standard deviation of the indicators. This would allow us to do a comparative analysis.

4.3 Graphical Comparison:

Graphical analysis was used to visually compare key indicators before and after the adoption of RECP practices. Bar graphs were generated for major economic variables such as yield, production cost, and selling price, as well as environmental variables including fertilizer use, pesticide application, organic input use, water consumption, and waste management. These visual comparisons help illustrate the direction and magnitude of changes in a way that complements the numerical summaries.

5.0 Results:

This section presents the main findings from both the quantitative survey of 25 pineapple farmers and the five in-depth interviews. The quantitative results summarize changes across key economic and environmental indicators before and after the adoption of RECP practices. These indicators include production outcomes such as yield, costs, and price, as well as changes in chemical use, organic inputs, water use, and waste management. Descriptive statistics are provided to show overall trends, while the qualitative findings complement these results by illustrating farmers' experiences, perceptions, and knowledge-sharing behaviors. Together, the findings offer a comprehensive picture of how RECP practices have influenced farm performance and production methods in the study area.

5.1 Section A: Demographic Information:

From this section, we find that the 92% of respondents are female. The average age is 39.4 years, with a maximum of 56 and a minimum of 27. Most respondents have primary-level education, while several completed secondary education and one reached higher secondary level.

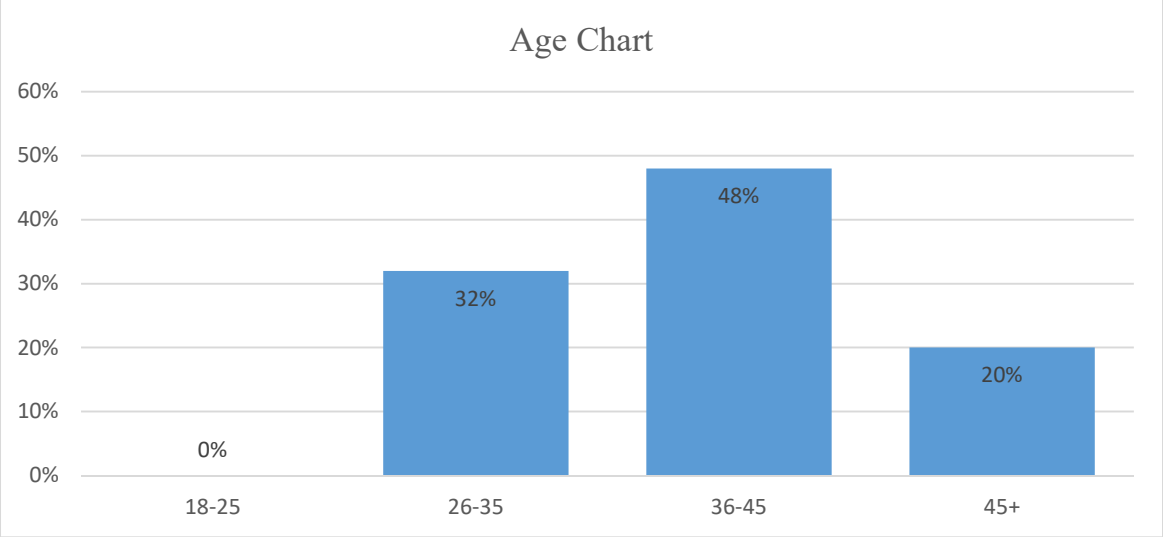

Figure 1: Age Chart of Respondents

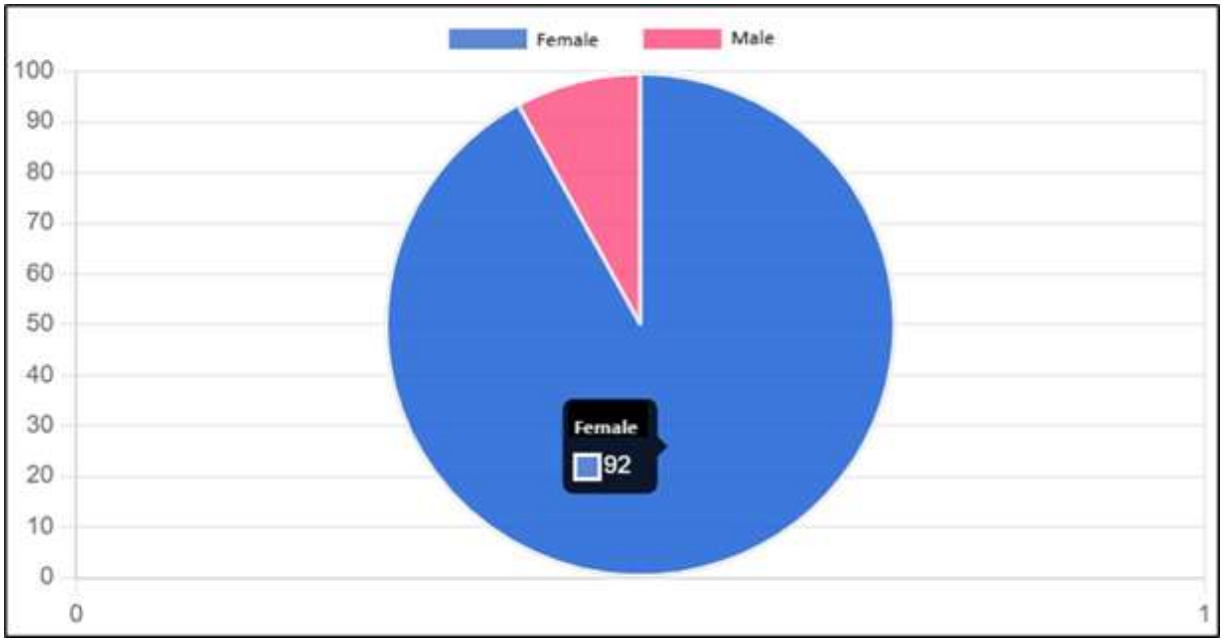

Figure 2: Gender Pie Chart of Respondents

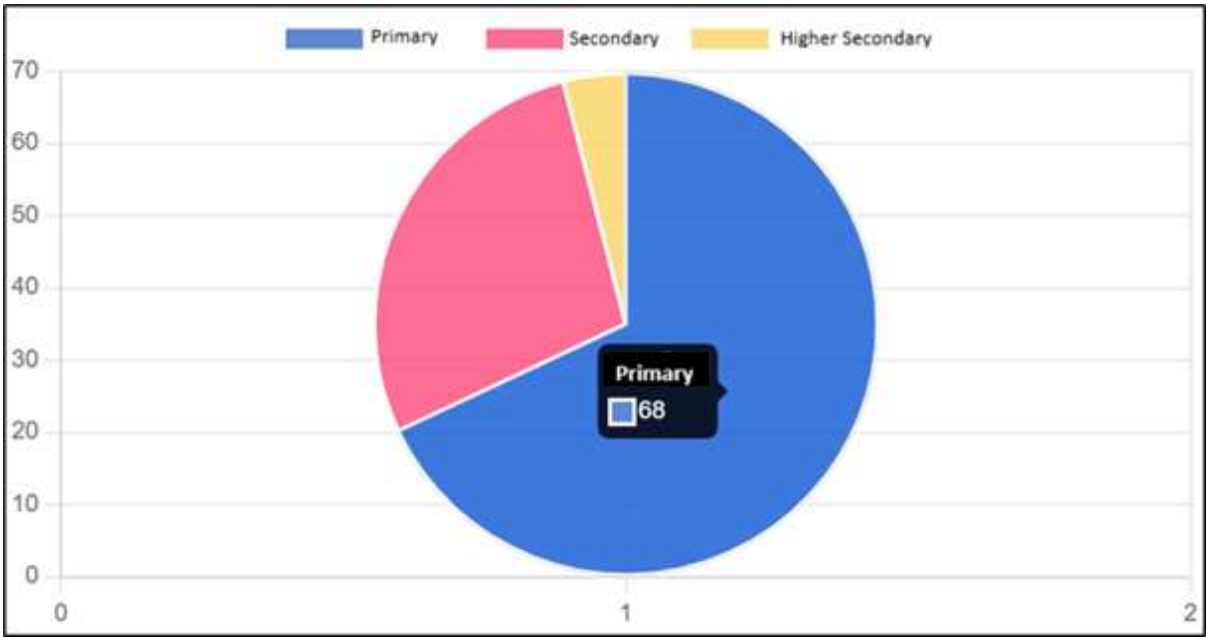

Figure 3: Education Level Pie Chart of Respondents

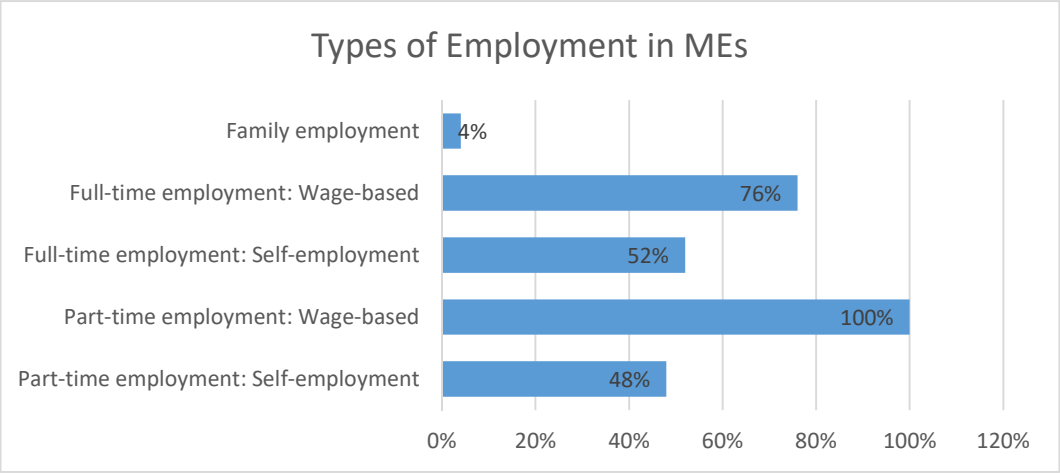

Figure 4: Types of Employment created in MEs

Regarding microenterprises, the mean duration of ownership is 15.6 years, ranging from a minimum of 5 years to a maximum of 36 years for farmers who have been involved in pineapple cultivation their entire lives. Most respondents cultivated the pineapple variety known as "Kalendar." In terms of employment structure, most microenterprises relied on a combination of part-time and full-time self-employment, supplemented by wage-based labor during cultivation seasons. Only one respondent reported relying primarily on family labor. The number of employees per category generally ranged from 1 to 5, with one case reporting 20 full-time wage employees.

5.2 Section B: RECP Adoption Details:

For this section, all respondents reported adopting RECP practices with support received under the project, including training, monetary assistance, and market linkages. Consequently, most respondents expressed satisfaction with the support provided and indicated a need for further training, more frequent workshops overall.

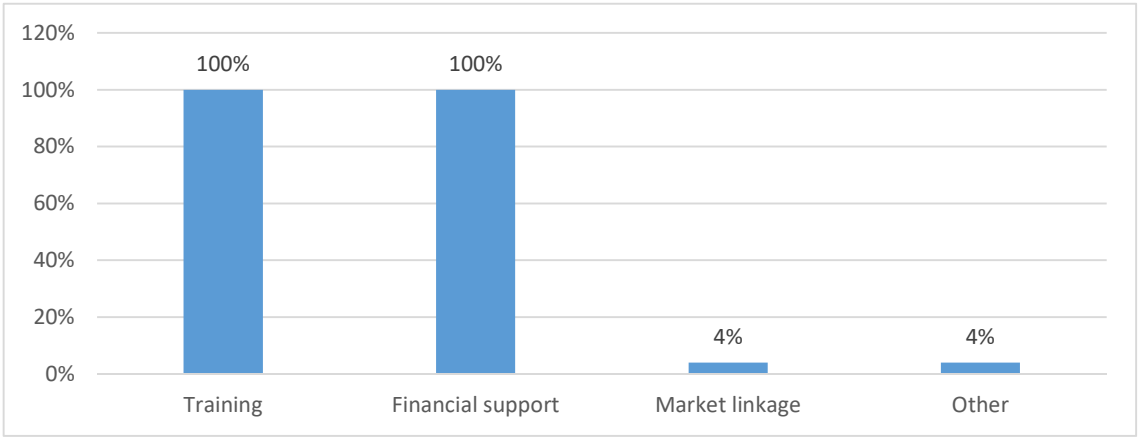

Figure 5: Types of Assistance provided to Respondents

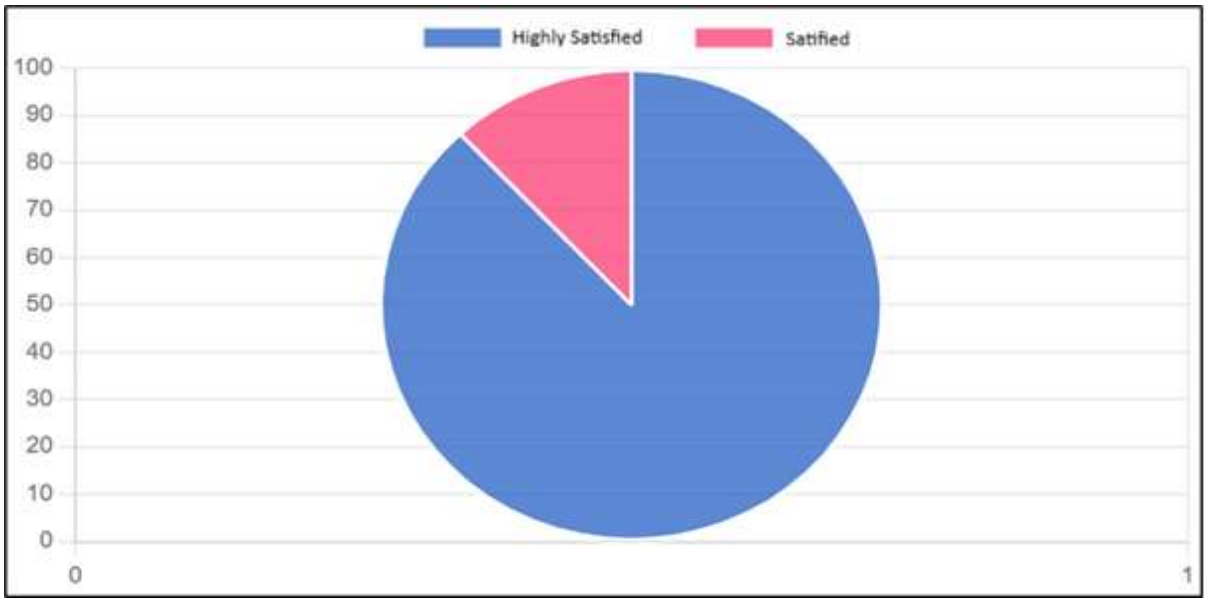

Figure 6: Respondents Satisfaction Level with the Assistance provided

In terms of practice selection, the nature of pineapple cultivation led most respondents to adopt RECP measures related to waste management and material management. Within material management, the most common practices were the use of organic fertilizer and color traps for pest control. For waste management, nearly all microenterprises adopted organic fertilizer production as their primary practice. In a few cases, respondents also reported using hose pipes and sprinkler system as part of their water management–related RECP practices.

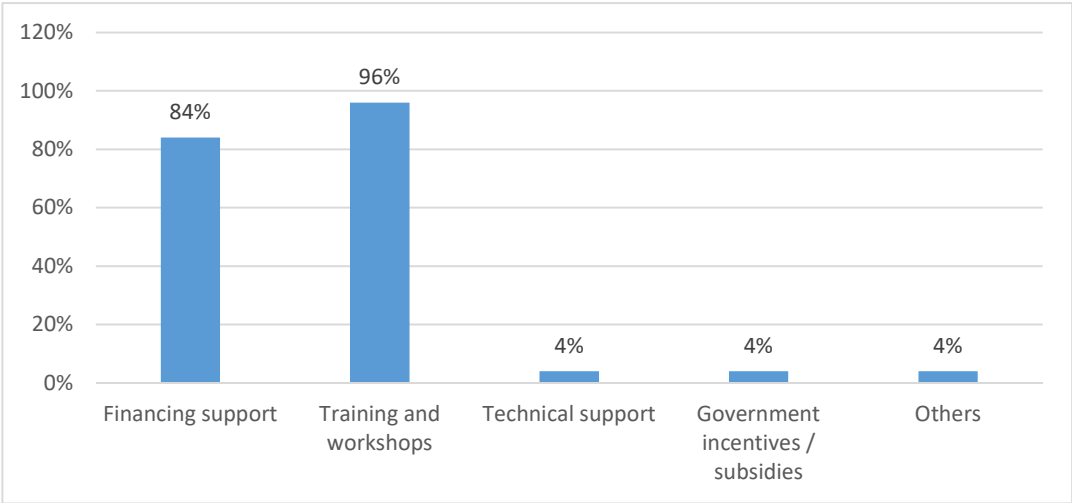

Figure 7: Types of Assistance Respondents want to have

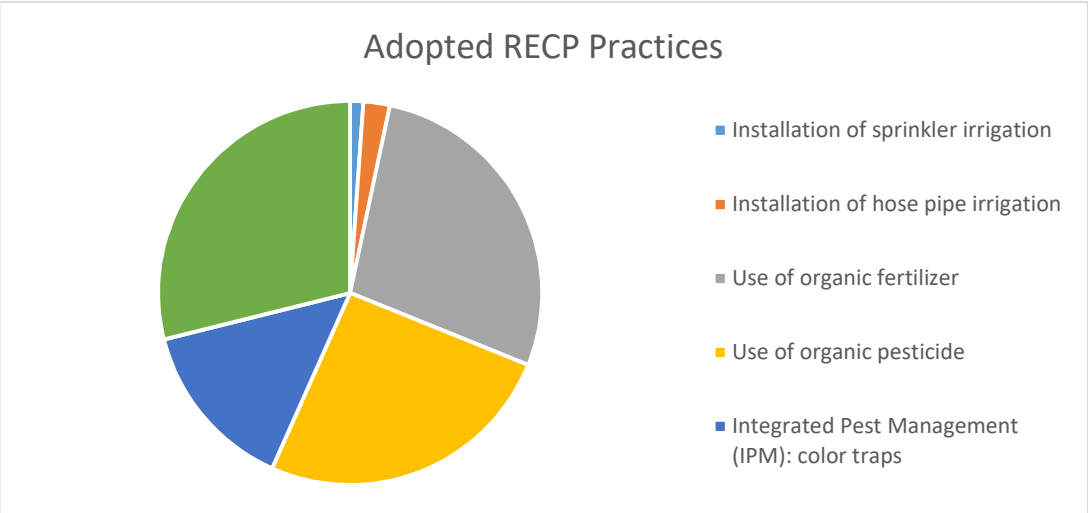

Figure 8: Pie Chart of RECP Practices adopted by Respondents

5.3 Section C: Economic and Environmental Impact Indicators:

Table 1: Descriptive Statistics of Economic and Environment Indicators

Indicators per decimal	***Observations***	***Mean***	***Standard Deviation***	***Minimum***	***Maximum***
Cultivation Land before RECP	25	134.16	195.2269	30	990
Cultivation Land after RECP	25	145.32	224.2554	30	1089
No of Pineapple Produced before RECP per Decimal	25	132.217	50.69332	0.288888	275.5906
No of Pineapple Produced after RECP per Decimal	25	126.221	39.83307	0.216667	200
Price of Produced Pineapple before RECP	25	30.28	3.878574	25	40
Price of Produced Pineapple after RECP	25	41.52	6.671582	30	50
Production Cost before RECP per Decimal	25	2006.03	978.9893	40.40404	4800
Production Cost after RECP per Decimal	25	1395.24	834.9808	33.05785	4133.333
Amount of Chemical Fertilizer before RECP per Decimal	25	36.4822	32.11476	7.142857	166.6667
Amount of Chemical Fertilizer after RECP per Decimal	25	14.3366	13.18579	2.232143	51.62963
Amount of Chemical Pesticide before RECP per Decimal	25	0.02561	0.020968	0	0.083333
Amount of Chemical Pesticide after RECP	25	0.00217	0.005398	0	0.022222
Amount of Chemical Herbicide before RECP per Decimal	25	0.00956	0.011847	0	0.033333
Amount of Chemical Herbicide after RECP per Decimal	25	0	0	0	0
Amount of Chemical Hormone before RECP per Decimal	25	0.14158	0.074156	0.033333	0.25

Indicators per decimal	*Observations*	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
Amount of Chemical Hormone after RECP per Decimal	25	0.04499	0.049008	0	0.12
Amount of Organic Fertilizer before RECP per Decimal	25	2.13196	2.209429	0	10.74074
Amount of Organic Fertilizer after RECP per Decimal	25	20.4209	49.07551	1	250
Amount of Organic Pesticide before RECP per Decimal	25	0.00733	0.011232	0	0.033333
Amount of Organic Pesticide after RECP per Decimal	25	0.02297	0.022345	0	0.083333
Amount of Other Raw Materials before RECP per Decimal	25	0.87389	3.99846	0	20
Amount of Other Raw Materials after RECP per Decimal	25	0.22226	0.995547	0	5
Amount of Water Usage in Production before RECP per Decimal	25	769.230	422.8574	100	1511.111
Amount of Water Usage in Production after RECP per Decimal	25	476.941	303.8709	8.333333	1000
Amount of Solid Waste Generated before RECP per Decimal	25	52.9579	96.79399	0	500
Amount of Solid Waste Generated after RECP per Decimal	25	53.5303	95.41186	15	500
Amount of Managed Waste before RECP per Decimal	25	0	0	0	0
Amount of Managed Waste after RECP per Decimal	25	45.7111	78.78078	12.5	416.6667
Amount of Recycled Waste before RECP per Decimal	25	0	0	0	0
Amount of Recycled Waste after RECP per Decimal	25	38.2881	79.26697	0	416.6667

From this table we can find the interpretations described below:

a) Cultivation Land: The results show a modest increase in cultivated land following RECP adoption. The average cultivated area increased from 134.16 decimals in the pre-RECP period to 145.32 decimals in the post-RECP period, while the minimum cultivated land remained unchanged at 30 decimals. The maximum cultivated area increased from 990 to 1,089 decimals, indicating that a small number of farmers expanded their cultivation scale after adopting RECP practices. However, the high standard deviations in both periods reflect substantial variation in farm sizes among respondents. Overall, the findings suggest limited but positive expansion in cultivated land, with most farmers maintaining similar landholding sizes while a few increased production area.

b) Pineapple Production: Mean pineapple production showed minimal variation, decreasing slightly from 132.22 to 126.22 units per decimal for one season. This stability, despite the introduction of new production practices, suggests that RECP did not negatively impact output. The slight decrease is linked to multi cropping systems (papaya, banana, chili), where land is shared between crops. Economically, maintaining production while reducing chemical inputs is a positive outcome. Environmentally, integrating diverse crops improves soil structure, biodiversity, and pest balance. The increase in maximum production further shows that some farmers benefitted significantly from RECP adoption.

c) Price per Pineapple: The average selling price rose from Tk 30.28 to Tk 41.52 after RECP adoption. This improvement indicates better fruit quality, likely due to reduced chemical use and enhanced soil conditions. Economically, this contributes to higher income even when production remains stable. Environmentally, cleaner production enhances consumer trust in low-chemical or chemical-free production. Additionally, cleaner production ensures better consumer health.

d) Production Cost: Mean production cost per decimal declined from Tk 2,006 to Tk 1,395 after RECP adoption. This reduction is primarily attributed to lower expenditure on chemical fertilizers, pesticides, herbicides, and hormones. Reduced recurring input costs directly improve profit margins and demonstrate the cost-efficiency of cleaner production practices.

e) Chemical Fertilizer Use: Chemical fertilizer application decreased sharply from an average of 36.48 kg to 14.34 kg per decimal for a season. This significant reduction indicates a clear shift away from synthetic inputs toward more sustainable soil fertility management. Lower chemical fertilizer use reduces input costs and mitigates risks of soil degradation and nutrient runoff.

f) Chemical Pesticide Use: Mean chemical pesticide use fell from 0.026 litres per decimal for 22 respondents to 0.002 litres per decimal for 5 respondents after RECP adoption for each cultivation season. This substantial decline reflects the effective uptake of alternative pest management practices such as IPM and organic pest control. Reduced pesticide use lowers production costs and minimizes environmental and health risks.

g) Chemical Herbicide Use: Chemical herbicide use was completely eliminated after RECP adoption, declining from 0.0096 litres on average for 13 respondents to zero respondents using chemical herbicide. The elimination of herbicides

reduces chemical exposure for farmers and supports soil biodiversity. Although this may increase labor requirements for manual weeding, the environmental and health benefits are considerable.

h) Chemical Hormone Use: The use of chemical hormones decreased from average 0.142 litres to 0.045 litres per decimal for each cultivation season. Reduced reliance on growth regulators and ripening agents lowers production costs and decreases the risk of harmful residues in produce, contributing to safer food production and improved environmental outcomes.

i) Organic Fertilizer Use: The average organic fertilizer use increased markedly from 2.13 kg to 20.42 kg per decimal after RECP adoption. This substantial rise demonstrates strong adoption of composting and bio-based nutrient management. Increased organic fertilizer application improves soil structure, moisture retention, and long-term soil fertility while reducing dependence on purchased inputs.

j) Organic Pesticide Use: The mean use of organic pesticides increased from 0.007 litres per decimal to 0.023 litres per decimal. This shift indicates a transition from synthetic chemicals to safer, bio-based pest control methods, supporting ecological balance and reducing health risks for farmers.

k) Use of Other Raw Materials: Use of other raw materials declined from 0.87 kg to 0.22 kg per decimal. This reduction suggests improved efficiency in input use, potentially linked to better production planning and reduced reliance on fuel- or material-intensive practices.

l) Water Usage: Average water use per decimal declined from 769 litres to 477 litres after RECP adoption. Improved irrigation practices, better soil moisture retention from organic inputs, and more controlled water application contributed to this reduction. Lower water use reduces irrigation costs and conserves local water resources.

m) Solid Waste Generation: Solid waste generation remained almost unchanged, increasing slightly from 52.96 kg to 53.53 kg per decimal. This minor increase is likely associated with increased biomass from intercropping rather than inefficiencies in production, and does not indicate negative environmental impact.

n) Managed Waste: Managed waste increased from zero to an average of 45.71 kg per decimal for all respondents after RECP adoption. This change reflects a significant improvement in waste handling practices, including sorting and

controlled disposal, reducing environmental pollution and improving on-farm hygiene.

o) Recycled Waste: Recycled waste increased from zero to 38.29 kg per decimal following RECP adoption. This demonstrates effective adoption of composting and waste reuse practices. Recycling farm waste reduces the need for external inputs, closes nutrient loops, and supports environmentally sustainable production systems. Among all the respondents 67% used their solid waste for making organic fertilizer, 30% used that as cow feed and 3% recycled that to use as fuel for cooking.

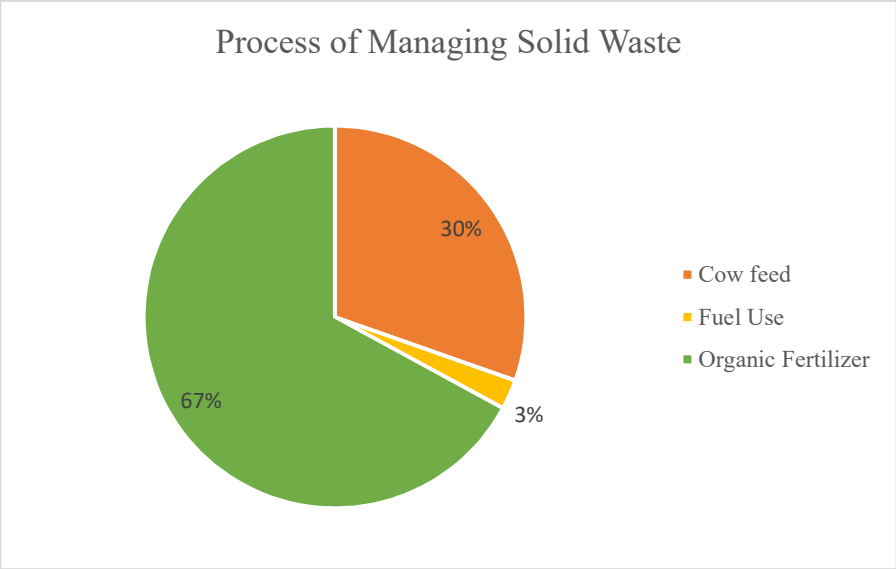

Figure 9: Pie Chart of Process of Solid Waste Management

5.4 IDI findings:

Five in-depth interviews were conducted with pineapple farmers who adopted RECP practices under the SMART Project. The findings below are organized according to the major sections of the qualitative questionnaire:

1. Understanding of RECP Practices: Across all interviews, farmers demonstrated a clear understanding of the RECP measures promoted through the SMART Project. Respondents commonly identified reduced chemical use, improved input efficiency, and safer production as central concepts of RECP. They understood that organic fertilizers, careful pesticide use, and alternative waste-handling methods were intended to replace more harmful traditional practices.

All five farmers expressed confidence in their understanding and attributed this awareness to the training provided by the project.

2. Comfort with Current RECP Practices: Farmers consistently reported being comfortable with the RECP practices they had adopted. They felt confident applying organic fertilizers, managing pesticides safely, using protective equipment, and managing crop waste in cleaner ways. Respondents noted that these practices were now routine and often easier to manage than previous chemical-intensive methods. No farmer expressed discomfort or reluctance regarding RECP, indicating strong acceptance at the field level.

3. Perceptions of Environmental and Health Effects: Environmental and health improvements were the most strongly emphasized outcomes. Farmers reported substantial reductions in chemical application, leading to better soil fertility, healthier crop growth, and reduced environmental contamination. They also noted fewer health risks for themselves and their families due to the safer handling of inputs, the use of personal protective equipment, and the elimination of harmful ripening hormones. Several farmers also observed improved conditions of cultivation lands after shifting toward RECP.

4. Sustainability and Intentions to Continue: All respondents stated that they intend to continue RECP practices beyond the duration of the project. They cited improved yield, reduced crop losses, higher product quality, and increased soil fertility as key reasons for long-term adoption. Farmers also noted that RECP practices have become integral to their production routines and are viewed as essential for sustaining both productivity and farm health. No respondent indicated any desire to return to previous methods.

5. Knowledge Sharing and Community Influence: Knowledge sharing emerged as a consistent behavior across all five farmers. Respondents actively shared RECP-related knowledge—such as fertilizer preparation, safer pesticide use, and improved waste handling—with neighboring farmers. They reported that other farmers showed interest after observing visible improvements in yield and fruit quality. In some cases, respondents noted widespread RECP adoption due to project involvement, while in others the spread was gradual but increasing. Peer influence and visible field results appeared to be strong drivers of community-level uptake.

6.0 Conclusion:

This study examined the economic and environmental impacts of RECP adoption among pineapple micro-entrepreneurs supported under the SMART Project. The quantitative findings shows that the reduction in chemical use, optimum water use, increase in organic fertilizer application, managing waste properly and recycling those wastes at the farm level is a significant positive environmental change in the cluster. These improvements indicate that RECP practices directly contribute to cleaner production and more efficient resource use. Although yield changes were mixed, farmers benefited from higher selling prices associated with improved fruit quality.

Qualitative results provide important context for these changes. Farmers reported strong understanding of RECP practices and confidence in their application. They observed noticeable improvements in soil health, personal well-being, and field conditions. Knowledge sharing within communities further strengthened adoption, showing that RECP benefits can extend beyond immediate project participants.

7.0 Limitations:

- The study uses a small sample size (25 survey respondents and 5 IDIs), limiting generalizability beyond the project area.
- Purposive convenient sampling may overrepresent farmers who are more active, engaged, or positive about RECP adoption.
- Recall bias affects before–after comparisons, as farmers relied on memory rather than recorded baseline data.
- Self-reported qualitative data may be influenced by social desirability, making it difficult to verify actual on-field practices.
- The assessment covers only RECP practices relevant to pineapple cultivation; other RECP components (energy use, wastewater, air pollution) could not be fully examined.

8.0 Recommendations:

Strengthening training and demonstration activities would greatly enhance the effectiveness of RECP adoption. Farmers consistently expressed the need for more frequent, hands-on, and practical learning opportunities. Additional field demonstrations, follow-up visits, and refresher sessions would help farmers understand the technical requirements of RECP practices and apply them more accurately throughout the production cycle.

Improving market linkages can further strengthen the economic benefits of RECP. Pineapples produced through cleaner and more sustainable methods often receive higher prices, but farmers need better connections with reliable buyers to fully capture this premium. Facilitating access to structured value chains, wholesalers, or retailers who value safer production methods would help farmers secure consistent demand and better price negotiations.

Promoting local RECP champions can accelerate peer-to-peer knowledge sharing. Farmers often learn best from observing successful adopters within their own communities. Identifying experienced farmers and empowering them as community trainers would help spread RECP practices more naturally and ensure that practical knowledge remains accessible even after project period ends.

Finally, strengthening monitoring systems is essential for maintaining consistent RECP practices and improving long-term outcomes. Regular follow-up visits, progress tracking, and structured performance reviews would help farmers identify challenges early and adjust their practices as needed. Enhanced monitoring also supports better data collection, making it easier for project teams to refine training content and evaluate overall project effectiveness.

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10.0 Appendix:

10.1 সম্মতি ফরম (Consent Form)

গবেষণার শিরোনাম: A Case Study on the Impact of RECP Adoption in Microenterprises (High-Value Crops- Pineapple) under the SMART Project of PKSF

গবেষকের নাম: মাশিয়াত ফাইজা জাহান

প্রতিষ্ঠান: পল্লী কর্ম-সহায়ক ফাউন্ডেশন (পিকেএসএফ)

গবেষণার উদ্দেশ্য:

এই গবেষণার উদ্দেশ্য হলো আনারস চাষে নিয়োজিত ক্ষুদ্র উদ্যোক্তাদের মধ্যে Resource Efficient and Cleaner Production (RECP) পদ্ধতির গ্রহণের ফলে উৎপাদন, সম্পদ ব্যবহারের দক্ষতা ও টেকসই ব্যবসায়িক আচরণের ওপর কী প্রভাব পড়েছে তা বোঝা। এই গবেষণার ফলাফল SMART প্রকল্পের আওতায় RECP চর্চার কার্যকারিতা মূল্যায়নে সহায়ক হবে।

আপনার অংশগ্রহণ:

আপনি যদি এই গবেষণায় অংশগ্রহণ করতে সম্মত হন, তাহলে আপনাকে একটি প্রশ্নাবলী পূরণ করতে হবে এবং প্রয়োজনে সংক্ষিপ্ত সাক্ষাৎকারে অংশ নিতে হতে পারে। এতে আপনার আনুমানিক ৩০-৪৫ মিনিট সময় লাগবে।

আপনার দেওয়া তথ্য শুধুমাত্র গবেষণার উদ্দেশ্যে ব্যবহার করা হবে এবং কোনোভাবেই বাণিজ্যিক বা অন্য কোনো কাজে ব্যবহার করা হবে না।

গোপনীয়তা ও নিরাপত্তা:

- আপনার দেওয়া সমস্ত তথ্য সম্পূর্ণ গোপন রাখা হবে।
- কোনো প্রতিবেদন বা প্রকাশনায় আপনার নাম বা ব্যক্তিগত তথ্য প্রকাশ করা হবে না।
- আপনি যেকোনো সময় গবেষণা থেকে সরে দাঁড়াতে পারবেন, এতে আপনার কোনো ক্ষতি বা অসুবিধা হবে না।

ঝুঁকি ও উপকারিতা:

এই গবেষণায় অংশগ্রহণের ফলে আপনার কোনো ঝুঁকি নেই। বরং আপনার মতামত ভবিষ্যতে ক্ষুদ্র উদ্যোক্তাদের জন্য টেকসই উৎপাদন চর্চা উন্নয়নে সহায়ক হবে।

স্বেচ্ছাসেবী অংশগ্রহণ:

আপনার অংশগ্রহণ সম্পূর্ণ স্বেচ্ছাসেবী। আপনি চাইলে কোনো প্রশ্নের উত্তর না দিয়েও অংশগ্রহণ চালিয়ে যেতে পারেন অথবা যে কোনো সময় অংশগ্রহণ বন্ধ করতে পারেন।

যোগাযোগ:

আপনার কোনো প্রশ্ন থাকলে বা আরও তথ্য জানতে চাইলে নিচের ঠিকানায় যোগাযোগ করতে পারেন-

গবেষকের নাম: মাশিয়াত ফাইজা জাহান

ফোন নম্বর: ০১৮৪৪৪৫৪১১২

অংশগ্রহণকারীর সম্মতি:

আমি উপরে বর্ণিত তথ্য ভালোভাবে পড়েছি/শুনেছি। আমি বুঝেছি যে আমার অংশগ্রহণ সম্পূর্ণ স্বেচ্ছাসেবী এবং আমি যে কোনো সময় অংশগ্রহণ বন্ধ করতে পারব। আমি গবেষণায় অংশগ্রহণে সম্মতি দিচ্ছি।

অংশগ্রহণকারীর নাম: _____

স্বাক্ষর (অথবা টিপসই): _____

তারিখ: _____

গবেষকের স্বাক্ষর: _____

10.2 Quantitative Questionnaire

Section A: Demographic Information

ক্রমিক নং	প্রশ্ন	উত্তর	কোড	স্কিপ লজিক
১	উদ্যোক্তার নাম			
২	বয়স			
৩	ফোন নং			
৪	লিঙ্গ			
৫	শাখার নাম			
৬	সদস্য কোড			
৭	জেলা			

ক্রমিক নং	প্রশ্ন	উত্তর	কোড	স্কিপ লজিক
৮	উপজেলা			
৯	ইউনিয়ন/ওয়ার্ড			
১০	গ্রাম/মহল্লা			
১১	চাষকৃত আনারসের জাতের নাম			
১২	শিক্ষাগত যোগ্যতা	স্বাক্ষর করতে পারেন না	1	
		প্রাথমিক	2	
		মাধ্যমিক	3	
		উচ্চ মাধ্যমিক	4	
		স্নাতক বা তার উপরে	5	
		মাদ্রাসা শিক্ষা (হাফেজি)/দাওয়া	6	
		কারিগরি ও বৃত্তিমূলক শিক্ষা	7	
১৩	উদ্যোগ মালিকানার বছর			
১৪	উদ্যোগে এক মৌসুমে কতজন কাজ করেন?	আংশিক কর্মসংস্থান : □ স্বকর্মসংস্থান: □ মজুরীভিত্তিক: পূর্ণকালীন কর্মসংস্থান: □ স্বকর্মসংস্থান: □ মজুরীভিত্তিক: পারিবারিক কর্মসংস্থান:		

Section B: RECP Adoption Details

ক্রমিক নং	প্রশ্ন	উত্তর	কোড	স্কিপ লজিক
১৫	কোনো RECP চর্চা গ্রহণ করেছেন কি না?	□ হ্যাঁ □ না		
১৬	RECP বাস্তবায়ন বিষয়ে কী ধরণের সহায়তা পেয়েছেন?	□ প্রশিক্ষণ □ আর্থিক সহায্তা □ প্রযুক্তিগত সহায্তা □ বাজার সংযোগ □ অন্যান্য (উল্লেখ করুন):		

১৭	প্রাপ্ত সহায়তায় আপনি কী সন্তুষ্ট?	□ খুবই অসন্তুষ্ট	1	
		□ অসন্তুষ্ট	2	
		□ নিরপেক্ষ / মোটামুটি সন্তুষ্ট	3	
		□ সন্তুষ্ট	4	
		□ খুবই সন্তুষ্ট	5	
১৮	বর্তমান সহায়তা ছাড়াও আর কোন ধরণের সহায়তার প্রয়োজন আছে?	□ অর্থায়ন সহায়তা □ প্রশিক্ষণ ও কর্মশালা □ বাজার সংযোগ □ প্রযুক্তিগত পরামর্শ □ সরকারি প্রণোদনা / ভর্তুকি □ অন্যান্য (উল্লেখ করুন):		

১৯। গ্রহণকৃত RECP চর্চা সম্পর্কিত তথ্য:

কী RECP গ্রহণ করেছেন?	RECP গ্রহণ করার অঙ্গীকার করার তারিখ	RECP বাস্তবায়ন করার তারিখ	RECP টি বাস্তবায়নের কারণ কী?	RECP টি বাস্তবায়নের খরচ কত?	RECP টি বাস্তবায়নের অর্থায়নের উৎস
পানি ব্যবস্থাপনা: □ স্প্রিংলার সেচ স্থাপন করা □ ড্রিপ সেচ স্থাপন করা □ হোস পাইপ স্থাপন করা □ নজেল স্থাপন করা □ ফ্লো-মিটার স্থাপন করা			□ উৎপাদন খরচ কমানো □ উৎপাদন বৃদ্ধি □ পরিবেশবান্ধব করা □ অন্যান্য (উল্লেখ করুন):	মোট:	SMART অনুদান: নিজস্ব:

বিদ্যুৎ ব্যবস্থাপনা: □ স্প্রিংলার সেচ স্থাপন করা □ ড্রিপ সেচ স্থাপন করা □ হোস পাইপ স্থাপন করা □ সোলার সেচ স্থাপন করা □ সোলার লাইট ট্র্যাপ			□ উৎপাদন খরচ কমানো □ উৎপাদন বৃদ্ধি □ পরিবেশবান্ধব করা □ অন্যান্য (উল্লেখ করুন):	মোট: SMART অনুদান: নিজস্ব:	
উপাদান: □ জৈব সার ব্যবহার □ জৈব বালাইনাশক ব্যবহার □ সমন্বিত বালাই ব্যবস্থাপনা: আলোক ফাঁদ □ সমন্বিত বালাই ব্যবস্থাপনা: ফেরোমন ফাঁদ □ সমন্বিত বালাই ব্যবস্থাপনা: রং ফাঁদ			□ উৎপাদন খরচ কমানো □ উৎপাদন বৃদ্ধি □ পরিবেশবান্ধব করা □ অন্যান্য (উল্লেখ করুন):	মোট: SMART অনুদান: নিজস্ব:	
বর্জ্য ব্যবস্থাপনা: □ জৈব সার তৈরী □ আনারসের পাতা থেকে সুতা তৈরী □ আনারসের পাতা দিয়ে সাইলেজ তৈরী □ আনারস হতে প্রক্রিয়াজাত পণ্য			□ উৎপাদন খরচ কমানো □ উৎপাদন বৃদ্ধি □ পরিবেশবান্ধব করা □ অন্যান্য (উল্লেখ করুন):	মোট: SMART অনুদান: নিজস্ব:	
প্রক্রিয়া উন্নয়ন: □ নতুন জাত সম্প্রসারণ □ আন্ত:ফসল □ কৃষি যান্ত্রিকীকরণ			□ উৎপাদন খরচ কমানো □ উৎপাদন বৃদ্ধি □ পরিবেশবান্ধব করা □ অন্যান্য (উল্লেখ করুন):	মোট: SMART অনুদান: নিজস্ব:	
□ অন্যান্য (উল্লেখ করুন):			□ উৎপাদন খরচ কমানো □ উৎপাদন বৃদ্ধি □ পরিবেশবান্ধব করা □ অন্যান্য (উল্লেখ করুন):	মোট: SMART অনুদান: নিজস্ব:	

Section C: Economic and Environmental Impact Indicators

২০। RECP গ্রহণের আগে এবং পরের তথ্য:

সূচক (Indicator)	RECP গ্রহণের আগে	RECP গ্রহণের পরে
আনারস চাষের জমির পরিমাণ(Decimal)		
আনারস উৎপাদনের পরিমাণ (সংখ্যা)		
উৎপাদিত আনারসের দাম (প্রতি পিস)		
উৎপাদন ব্যয় (প্রতি মৌসুম)		
রাসায়নিক সারের পরিমাণ (কেজি/মৌসুম)		
রাসায়নিক কীটনাশকের পরিমাণ(লিটার/মৌসুম)		
রাসায়নিক আগাছানাশকের পরিমাণ (লিটার/মৌসুম)		
রাসায়নিক হরমোন ব্যবহারের পরিমাণ(লিটার/মৌসুম)		
জৈব সারের পরিমাণ(কেজি/মৌসুম)		
জৈব কীটনাশকের পরিমাণ(লিটার/মৌসুম)		
অন্যান্য কাঁচামালের ব্যবহার(কেজি/মৌসুম)		
উৎপাদনে ব্যবহৃত পানির পরিমাণ(লিটার/মৌসুম)		
উৎপাদনে সৃষ্ট কঠিন বর্জ্যের পরিমাণ (কেজি)		
পুনর্ব্যবহৃত বর্জ্যের পরিমাণ(কেজি)		
ব্যবস্থাপনাকৃত বর্জ্যের পরিমাণ(কেজি)		

২১। আপনার উদ্যোগে বর্জ্য কীভাবে এবং কী পরিমাণে ব্যবস্থাপনা করা হয়? (একাধিক উত্তর)

বর্জ্য ব্যবস্থাপনা প্রক্রিয়া	RECP গ্রহণের আগে	RECP গ্রহণের পরে
□ মাটিতে ফেলা:		
□ পুড়িয়ে ফেলা:		
□ কম্পোস্টিং:		
□ পুনর্ব্যবহার:		
□ অন্যান্য(উল্লেখ করুন):		

২২। আপনার উদ্যোগে বর্জ্য কীভাবে পুনর্ব্যবহার করা হয়?

10.3 Qualitative Questionnaire

Section A: Behavioral Changes & Sustainability Commitment

১। RECP প্রক্রিয়া বাস্তবায়নের পরে সামাজিকভাবে বা অন্যত্র কোনো পরিবর্তন লক্ষ্য করেছেন কি?

□ হ্যাঁ

□ না

২। হ্যাঁ হলে, কী ধরনের পরিবর্তন লক্ষ্য করেছেন?

৩। RECP প্রক্রিয়ার পূর্বে রাসায়নিক ব্যবহারের ফলে স্বাস্থ্যগত কী ক্ষতি হতো?

৪।বর্তমানে এসব স্বাস্থ্যগত ক্ষতি হচ্ছে কী?

৫। পূর্বের তুলনায় বর্তমান পদ্বতিতে (RECP সহ) উৎপাদনে স্বাচ্ছন্দ্য বোধ করেন কি না?

□ হ্যাঁ

□ না

৬। যদি হ্যাঁ হয় তবে কেন? যদি না হয় তবে কেন নয়?

৭। RECP প্রক্রিয়া প্রকল্প শেষ হয়ে যাওয়ার পর চলমান রাখবেন কী?

□ হ্যাঁ

□ না

৮। যদি হ্যাঁ হয় তবে কেন? যদি না হয় তবে কেন নয়?

Section B: Knowledge and Awareness

৯। আপনি কি জলবায়ু বিপদাপন্নতা এবং পরিবেশ ব্যবস্থাপনা সম্পর্কিত প্রশিক্ষণ পেয়েছেন?

□ হ্যাঁ

□ না

১০। আপনি কি RECP সম্পর্কিত প্রশিক্ষণ পেয়েছেন?

□ হ্যাঁ

□ না

১১। এই প্রশিক্ষণগুলো থেকে কী শিখেছেন?

১২। প্রশিক্ষণগুলোর মাধ্যমে আপনার ধারণার কী রকম পরিবর্তন হয়েছে?

১৩। এই প্রশিক্ষণগুলো থেকে প্রাপ্ত জ্ঞান অনুযায়ী আপনি দৈনন্দিন জীবনে কী ধরণের চর্চা করেন?

১৪। আপনি কি আশেপাশের অন্য উদ্যোক্তাদের সাথে RECP সম্পর্কিত জ্ঞান শেয়ার করেন? শেয়ার করার/না করার কারণ কী?

১৫। অন্য উদ্যোক্তা আপনার মত RECP বাস্তবায়নে আগ্রহ প্রকাশ করেছেন কি? আগ্রহ প্রকাশ করার/না করার কারণ কী?

১৫। যদি হ্যাঁ হয় তবে কতজন? যারা আগ্রহ প্রকাশ করেছেন তাদের সাথে আপনার সম্পর্ক কী?

১৬। উদ্যোগকে আরো টেকসই করতে আর কী কী পদক্ষেপ নেয়া প্রয়োজন বলে মনে করেন?

10.4 STATA Analysis Table

Variable	Obs	Mean	Std. dev.	Min	Max
q20_land_b~P	25	134.16	195.2269	30	990
q20_land_a~P	25	145.32	224.2554	30	1089
q20_output..	25	132.217	50.69332	.2888889	275.5906
q20_output..	25	126.2212	39.83307	.2166667	200
q20_price_b~	25	30.28	3.878574	25	40
q20_price_a~	25	41.52	6.671582	30	50
q20_produc..	25	2006.027	978.9893	40.40404	4800
q20_produc..	25	1395.24	834.9808	33.05785	4133.333
q20_cferti..	25	36.48218	32.11476	7.142857	166.6667
q20_cferti..	25	14.3366	13.18579	2.232143	51.62963
q20_cpesti..	25	.0256115	.0209675	0	.0833333
q20_cpesti..	25	.0021678	.0053976	0	.0222222
q20_cherbi..	25	.0095625	.0118473	0	.0333333
q20_cherbi..	25	0	0	0	0
q20_chormo..	25	.1415751	.0741557	.0333333	.25
q20_chormo..	25	.0449996	.0490087	0	.12
q20_oferti..	25	2.131963	2.209429	0	10.74074
q20_oferti..	25	20.42097	49.07551	1	250
q20_opesti..	25	.0073333	.011232	0	.0333333
q20_opesti..	25	.0229658	.0223446	0	.0833333
q20_otheri..	25	.8738889	3.99846	0	20
q20_otheri..	25	.2222647	.9955465	0	5
q20_i~e_RECP	25	769.2304	422.8574	100	1511.111
q20_i~r_RECP	25	476.9407	303.8709	8.333333	1000
q20_h~e_RECP	25	52.95792	96.79399	0	500
q20_h~r_RECP	25	53.53031	95.41186	15	500
q20_r~e_RECP	25	0	0	0	0
q20_r~r_RECP	25	45.71115	78.78078	12.5	416.6667
q20_m~e_RECP	25	0	0	0	0
q20_m~r_RECP	25	38.28814	79.26697	0	416.6667