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Abstract

Sustainable farming systems have been acknowledged as an approach that balances the production of food and preservation of the environment. It involves practices that protect natural ecosystems such as soil conservation and water management, while also supporting the long-term economic viability for the farmers. To promote sustainable agriculture, various soil conservation technologies were introduced to corn farmers in Ilagan City, Isabela, Philippines through Sustainable Land Resource Management Approach (SLRMA). This study aimed to assess the intervention design and benefits of SLRMA to the 49 farmer-beneficiaries using the collected data on contour farming systems, crop diversification, training, and challenges encountered. A quantitative research design was utilized, incorporating descriptive and comparative approaches to examine and interpret the collected data. The analysis was focused on changes in production and profit before and after the implementation of SLRMA, using paired t-tests to compare these variables. Results revealed that SLRMA has had a positive and significant effect on farming practices and livelihoods, particularly for those with 2 to 5 years of participation. These beneficiaries experienced increased income, improved farming practices, and enhanced land productivity, including reduced soil erosion, restored cultivation areas, and higher crop yields. Beneficiaries with 5 years of involvement saw significant increases in ROI (from 16.54% to 147.81%), net income (from PhP5,504.45 to PhP45,724.45), and overall income (from PhP42,979.35 to PhP94,095.64). Similarly, 4-year, 3-year, and 2-year participants experienced notable improvements in ROI, net income, and overall income, with significant statistical results. On the other hand, only minimal changes with no significant impact on ROI and net income in the production were observed with 1-year participants. The study found that prolonged participation in the program was associated with higher income, but further analysis using more robust statistical methods is needed to determine the actual drivers of income changes. Based on the findings, recommendations include provision of additional support on manpower or financial assistance on the first year to ensure crop survival; evaluation of the suitability of the research design and methodologies employed for future researches; and formulation and implementation of strategic adaptation and upscaling plan for the SLRMA.

Keywords: *Contour Farming Systems, Corn Farmers, Crop Diversification, Soil Erosion, Sustainable Land Resource Management*

Introduction

With the Philippines' continuous growing population, conversion of agricultural lands into industrial, housing, and other facilities also continue to increase. With the decrease of arable areas in the lowland, people are forced to cultivate upland areas for food and feed production without considering the negative impact on the environment such as soil erosion and land degradation. Sustainable farming systems are increasingly recognized to address these issues. A sustainable farming system is an approach that balances the production of food and preservation of the environment. It involves practices that protect natural ecosystems such as soil conservation and water management, while also supporting the long-term economic viability for the farmers.

To help the farmers have a sustainable farming system that enhances productivity and increases income, the Bureau of Soils and Water Management (BSWM) through its Soil Conservation and Management Division (SCMD) promotes Sustainable Land Resource Management Approach (SLRMA) in sloping areas cultivated with corn crops. SLRMA is defined as a paradigm in managing upland areas for optimum and sustained agricultural production while restoring ecological balance for the benefit of most of the population (BSWM, 2019). Central to SLRMA are the key objectives of improving farmers' productivity and boosting their income through sustainable practices and appropriate technologies that prolong soil fertility. Project implementation involved the establishment of 20-hectare community-managed pilot farms in selected corn and cassava growing provinces of the country considered hot spots for land degradation - Ifugao, Isabela, Camarines Sur, Capiz, Zamboanga del Norte, and Bukidnon. To support the project's growth and successful expansion to 120 hectares, a four-year plan was implemented to provide assistance and resources to new areas, adding 20 hectares per site each year until 2023. However, the program's support was limited to the provision of planting materials, fertilizers, and basic tools for weeding and irrigation. Highlights of the approach include the application of contour farming systems to reduce soil erosion; crop diversification to increase source of income; and specialized capability enhancement training to capacitate the farmers in Sustainable Land Management (SLM).

Ilagan City, Isabela, being the Corn Capital of the Philippines, was strategically chosen to be one of the pilot sites for SLRMA due to its significant role in national corn production. According to the Philippine Statistics Authority (2022), Isabela has a total land area of 600,000 ha in which a great percentage of it is devoted to corn farming. In 2020 and 2021, the province produced 1,115,514 metric tons and 1,080,653 metric tons of corn, respectively, highlighting its importance to the agricultural economy. However, local farmers commonly engage in monocropping wherein they plant corn repeatedly over multiple seasons or years, which leaves them vulnerable to multiple risks such as typhoons, pest infestations, plant diseases, and the increasing cost and price volatility of farm inputs and outputs. These challenges underscore the need for sustainable interventions like SLRMA, which promotes contour farming systems, crop diversification, and other conservation practices aimed at building resilience and ensuring long-term land productivity.

This study assessed the design and implementation effectiveness of the training program under SLRMA, with particular emphasis on enhancing farmer knowledge and skills in sustainable farming practices. It also assessed the benefits gained from adopting contour farming systems and crop diversification, focusing on their contributions to environmental sustainability and agricultural productivity. Furthermore, the study analyzed the economic outcomes of SLRMA in terms of net income and ROI. Lastly, it identified problems encountered and lessons learned throughout the implementation process to support the continuous improvement of future sustainable land management initiatives.

Materials and Methods

A quantitative research design was utilized, incorporating descriptive and comparative approaches to examine and interpret the collected data. The data included contour farming systems, crop diversification, training, and challenges encountered by the SLRMA farmer-beneficiaries. The analysis focused on changes in production and profit before and after the implementation of SLRMA, using paired t-tests to compare these variables.

The respondents were the farmer-beneficiaries of the SLRMA in Ilagan City, Isabela, Philippines from 2019 to 2023. Having a limited number of farmer-beneficiaries for each year, the entire population served as the participants of the study. The research interview was conducted in October 2024 using a modified BSWM questionnaire, which featured a formal set of questions or a structured data collection tool composed of predefined, standardized questions presented in a consistent order to all respondents. It involved a five-point Likert scale to gather data systematically for consistent responses. Furthermore, secondary data from the SCMD, including information on production and marketing were also utilized in this study. The modified data gathering instruments were pre-tested and underwent reliability and validity analysis.

Table 1

Frequency distribution of farmer-beneficiaries of SLRMA over five years.

Year	Number of farmer-beneficiaries
2019	10
2020	9
2021	12
2022	10
2023	8
Total	**49**

Table 1 presents the frequency distribution of all farmer-beneficiaries of SLRMA over a five-year period, who served as the research respondents. The data collected from them were analyzed using the Statistical Package for the Social Sciences (SPSS) software to perform the necessary statistical computations. The farmers' profile in terms of age, sex, civil status, highest educational attainment, size of the farm, number of years residing in the area, number of years in farming, size of the family, number of family members working in the farm, and number of years as beneficiary of SLRMA were presented using frequency distribution, percentage, mean, and standard deviation. To test the relationship between the socio-demographic characteristics of the farmer-beneficiaries such as sex, civil status, and highest educational attainment, ANOVA was used. Multiple Linear Regression following Durbin-Watson's methodology was used to test the relationship between the socio-demographic profile, interventions introduced to the corn farmers and profitability of farmer-beneficiaries. A dependent t-test was used to describe the production and profit of the farmer-beneficiaries before and after the SLRMA was implemented.

Results and Discussion

Effectiveness of Contour Farming

Table 2 displays the analysis of the response of the farmer-beneficiaries on the effectiveness of contour farming in controlling soil erosion on the farms, including its effect on fertilizer application, crop yield, power and time requirement, and land improvement.

Table 2 shows that contour farming through SLRMA has generally had a positive impact on

farming practices, with respondents strongly agreeing that it has reduced soil erosion (mean of 4.469) and helped restore degraded land for cultivation (mean of 4.429). This aligned to the study of Choudhary et al. (2024) revealing that contour farming can significantly reduce soil loss by up to 49.5% and water loss by 30% compared to conventional perpendicular crop cultivation. This practice also decreases annual surface runoff by 10%, effectively mitigating soil erosion and conserving water.

There is also a notable increase in crop yields (mean of 4.041), aligning to the results of the review study of Farahani et al. (2016), stating that farmers practicing contour farming and strip cropping reported a 15-25% increase in yields over five years. However, the reduction in fertilizer use (mean of 3.612) and labor and time requirements for cultivation (mean of 3.776) showed more mixed results. The results imply that the adoption of contour farming is beneficial to farmers as it helps to maintain the health of the soil by reducing erosion, and it restores unusable lands. Through contour farming, production costs can also be reduced while at the same time, increasing crop yields.

Table 2

Effectiveness of Contour Farming

Statement	Mean	Median	Mode	Verbal Description
1. Soil erosion is no longer a problem in my farm after implementing SLRMA.	4.469	5	5	Strongly Agree
2. Fertilizer requirement of the crops was reduced.	3.612	3	3	Agree
3. Degraded portions of the farm can now be utilized and cultivated.	4.429	5	5	Strongly Agree
4. The amount of crop yield was increased.	4.041	4	4	Agree
5. Power and time requirement for cultivation was reduced.	3.776	4	3	Agree
Weighted Mean	**4.066**			**Agree**

Legend: Strongly Disagree (1.00 - 1.80); Disagree (1.81 - 2.60); Neither Agree nor Disagree (2.61 - 3.40); Agree (3.41 - 4.20); Strongly Agree (4.21 - 5.00)

Effectiveness of Crop Diversification

Table 3 displays the analysis of the response of the farmer-beneficiaries on the effectiveness of crop diversification in increasing income, lessening production cost, and withstanding price fluctuation, climate change, and pests and diseases.

As exhibited in Table 3, crop diversification is generally viewed as an effective strategy for enhancing farm income, with a mean of 4.510, indicating strong agreement and consistency among respondents. Adam and Abdulai (2024) found that crop diversification greatly boosts farm net returns while also reducing their variability. The practice is also considered effective in mitigating price fluctuations (mean of 4.224), with most participants agreeing it helps stabilize income. Nahar et al. (2024) revealed that households practicing greater crop diversification were more likely to be food secure or marginally food secure compared to less diversified households. It also plays a significant role in improving resilience to climate change, with a mean of 4.347, suggesting a generally positive perception. According to Vernooy (2022), in the context of climate change, diversification plays a significant role as it helps to increase yields, household incomes, and food security. Crop diversification is also recognized for its ability to increase profits by reducing production costs (mean of 4.245). However, while still viewed positively, its role in reducing risks from pests and diseases received a slightly lower mean of 4.020. These results imply that diversification of crops has significantly benefited the farmers as they experienced reduced production cost and increased income. It also enabled them to adapt to the changing weather conditions caused by climate change. Having diverse commodities increased their resilience to the very volatile price of produce.

Table 3

Effectiveness of Crop Diversification

Statement	Mean	Median	Mode	Verbal Description
1. Crop diversification is effective in increasing farm income.	4.510	5	5	Strongly Agree
2. Diversified farming is effective in helping to withstand price fluctuation of commodities.	4.224	4	4	Strongly Agree
3. The crop diversification technology is effective in providing resilience to highly variable weather conditions caused by climate change.	4.347	4	4	Strongly Agree
4. Crop Diversification is effective in increasing profits by reducing production cost.	4.245	4	4	Strongly Agree
5. Crop diversification is effective in reducing risk from pests and diseases.	4.020	4	4	Agree
Weighted Mean	**4.269**			**Strongly Agree**

Legend: Strongly Disagree (1.00 - 1.80); Disagree (1.81 - 2.60); Neither Agree nor Disagree (2.61 - 3.40); Agree (3.41 - 4.20); Strongly Agree (4.21 - 5.00)

Effectiveness of the Topics Discussed in the Training Conducted

A specialized capability enhancement training was conducted to ensure that farmer-beneficiaries fully understood the objectives of SLRMA and were equipped with the necessary skills to adopt the technologies aimed at improving agricultural production and environmental protection. The training program combined theoretical discussions on the benefits of SLRMA and sustainable land management practices with practical, hands-on activities. This approach allowed the farmer-beneficiaries to not only grasp the concept behind the technologies but also to gain direct experience with the actual field practices implemented under the project.

Table 4 shows that the training on soil erosion and sustainable farming practices had a significant positive impact on the farmer-beneficiaries. Most respondents strongly agreed that the training improved their understanding of soil erosion and its environmental effects, with a high mean of 4.714, indicating consistency across participants. Similarly, participants felt confident in their understanding of sustainable land management practices and how to apply them in farming to combat soil erosion, reflected by a mean of 4.653. Kansanga et al. (2021) found that increased awareness through training significantly influences the adoption of sustainable land management practices among smallholder farmers.

The A-Frame tool, with a mean of 4.796, was especially effective in helping participants identify optimal planting lines to reduce soil erosion, demonstrating a strong consensus on its usefulness. Wassif and Meselhy (2022) highlights the effectiveness of the A-Frame tool in identifying optimal planting lines to reduce soil erosion by preventing runoff and conserving soil. The training also helped participants understand the importance of farm planning for long-term land productivity, with a mean of 4.490, indicating strong agreement and consistency. In the study of Wonde et al. (2022), it was found that farmers who received training in farm planning and sustainable practices experienced notable improvements in crop yields and soil health.

While the responses were still positive regarding farm record-keeping, with a mean of 4.245, the result suggests some variability in how well participants applied this practice for planning and economic analysis. The study of Wulandari et al. (2023) reveals a significant positive relationship between financial

record training and farmers' likelihood to record farm finances, suggesting that targeted training can enhance record-keeping practices. However, Omotilewa et al. (2021) found that the common challenges hindering effective record-keeping include lack of understanding of its benefits, complexity of maintaining records for multiple plots, and limited literacy levels. Addressing these challenges through education and simplified record-keeping systems can improve adoption rates.

Table 4

Effectiveness of the Topics Discussed in the Training Conducted

Statement	Mean	Median	Mode	Verbal Description
1. After attending the training, I understand what soil erosion is and its effect on the environment.	4.714	5	5	Strongly Agree
2. I understand sustainable land management and soil conservation technologies and helped in my farming practice to address soil erosion and make my farming sustainable.	4.653	5	5	Strongly Agree
3. The idea of A-Frame helped me identify and locate lines where my fruit trees will be planted to help reduce soil erosion.	4.796	5	5	Strongly Agree
4. I was able to understand the importance of farm planning to maintain the productivity of the land for a longer period through soil conservation technologies.	4.490	5	4 and 5	Strongly Agree
5. I was able to practice farm record keeping and use it as a basis for planning and economic analysis.	4.245	4	5	Strongly Agree
Weighted Mean	**4.580**			**Strongly Agree**

Legend: *Strongly Disagree (1.00 - 1.80); Disagree (1.81 - 2.60); Neither Agree nor Disagree (2.61 - 3.40); Agree (3.41 - 4.20); Strongly Agree (4.21 - 5.00)*

Challenges Encountered by the Farmer-beneficiaries in Adopting SLRMA

Table 5 displays the analysis of response of the farmer-beneficiaries on the challenges that they might have encountered during the adoption of the technologies introduced to them through SLRMA.

Table 5 reveals that the farmer-beneficiaries largely disagreed with claims about the program's negative impacts on farms. Most respondents did not believe the program incurred high establishment costs (mean of 1.449) or required excessive labor (mean of 1.816). There was also strong disagreement about high maintenance costs (mean of 1.449) and the need for additional time compared to traditional farming practices (mean of 1.796). Gathagu et al. (2018) found that contour farming requires less labor and has lower implementation costs than structural practices. Also, the farmer-beneficiaries overwhelmingly rejected the idea that the program reduced corn production area (mean of 1.347), increased pests and diseases (mean of 1.714), or harmed soil productivity (mean of 1.041). This aligns with the statement of Huss et al. (2022) that integrating contour farming with other sustainable agricultural practices, such as crop rotation and intercropping, can further mitigate pest and disease issues. While there was moderate disagreement regarding increased water use (mean of 2.020), most participants strongly disagreed that the program caused marketing difficulties (mean of 1.204). Goldhamer et al. (1995) found that hedgerows can increase water usage during their establishment phase but become

more water-efficient over time. However, the program's impact on grazing areas received more varied responses, with a moderate level of agreement (mean = 2.347). This is likely because livestock tend to feed on the tree crops planted along the contour lines, which in turn reduces the available space for grazing.

Table 5

Challenges Encountered by the Farmer-beneficiaries in Adopting SLRMA

Statement	Mean	Median	Mode	Verbal Description
1. The implementation of the program produces high establishment costs for my farm.	1.449	1	1	Never
2. Implementing the program requires laborious activities that add more man-power.	1.816	2	2	Occasionally
3. The program requires high maintenance costs.	1.449	1	1	Never
4. The program requires additional time compared to old farming practice.	1.796	2	1 and 2	Never
5. The program results in reduced area for corn production that affects profitability.	1.347	1	1	Never
6. With this new program, more pests and diseases occur in the farm.	1.714	2	2	Never
7. The program reduces soil productivity due to inappropriateness of the technologies.	1.041	1	1	Never
8. The program requires a high volume of water.	2.020	2	3	Occasionally
9. The program resulted in difficulties in marketing the product.	1.204	1	1	Never
10. The program reduced the area for grazing.	2.347	3	3	Occasionally
Weighted Mean	**1.6183**			**Never**

Legend: *Strongly Disagree (1.00 - 1.80); Disagree (1.81 - 2.60); Neither Agree nor Disagree (2.61 - 3.40); Agree (3.41 - 4.20); Strongly Agree (4.21 - 5.00)*

Comparison of Net Income Before and After Implementation of Program

Table 6 presents the analysis of the net income of the farmer-beneficiaries before and after the implementation of SLRMA, considering varying durations of participation. Prior to the implementation of SLRMA, most farmer-beneficiaries practiced monocropping, predominantly wherein they tend to plant corn, which limited their income opportunities from other crops. Following the introduction of SLRMA, they began diversifying their crops by incorporating fruit trees into their landscapes. This shift toward crop diversification significantly contributed to the increase of their net income.

Table 6 compares net income before and after the implementation of SLRMA for farmer-beneficiaries with varying durations of participation (1 to 5 years). For beneficiaries with 5 years of participation, net income increased from PhP5,504.45 before the program to PhP45,724.45 after (T-value = 47.67, p-value = 0.000), showing a highly significant improvement. Similarly, for 4 years, net income rose from PhP11,414.68 to PhP39,084.68 (T-value = 30.11, p-value = 0.000), and for 3 years, it increased from a negative value of PhP9,058.49 to positive value of PhP14,692.38 (T-value = 28.83, p-value = 0.000). For 2 years of participation, net income increased from PhP10,662.95 to PhP38,119.95 (T-value

= 50.53, p-value = 0.000), all showing significant positive changes. However, for those with only 1 year of participation, net income decreased from PhP689.88 to negative value of PhP389.90 (T-value = -0.473, p-value = 0.651), with no statistically significant change. This is because the additional crops planted along the contour lines begin to bear fruit after the first year, generating more income starting on the second year. Additionally, Do et al. (2020) revealed in their study that combining fruit trees like longan and son tra with corn and forage grass generated 2.4 to 3.5 times higher average annual income, with productivity gains starting on the second year and increasing as the trees matured.

Table 6

Comparison of Net Income Before and After Implementation of Program

Number of Years (as Beneficiary)	Mean Before (PhP)	SD	Mean After (PhP)	Standard Deviation	T-value	P-value	Results
5	5504.45	12518.36	45724.45	11774.65	47.67	0.000	Significant
4	11414.68	5080.93	39084.68	6134.14	30.11	0.000	Significant
3	-9058.49	5384.54	14692.38	7420.40	28.83	0.000	Significant
2	10662.95	6595.50	38119.95	6839.36	50.53	0.000	Significant
1	689.88	4136.72	-389.90	7271.28	-0.473	0.651	Not Significant

*Legend: p=0.000 **Highly significant, p<0.05 *Significant*

Comparison of ROI Before and After Implementation of SLRMA

Table 7 displays the analysis of ROI of the farmer-beneficiaries before and after the implementation of SLRMA with varying durations of participation.

Table 7

Mean ROI (%) Before and Mean ROI (%)

Number of Years (as Beneficiary)	Mean Before	SD	Mean After	Standard Deviation	T-value	P-value	Results
5	16.54	31.84	147.81	92.62	5.18	0.001	Significant
4	28.07	15.42	136.37	26.49	11.19	0.000	Significant
3	-22.55	13.11	132.71	37.57	17.93	0.000	Significant
2	29.13	18.05	89.23	21.39	6.05	0.000	Significant
1	1.42	9.50	-.047	14.80	-.308	0.757	Not Significant

*Legend: p=0.000 **Highly significant, p<0.05 *Significant*

Conclusion

The study highlights observed improvements in net income among farmer-beneficiaries who engaged in agricultural interventions such as contour farming, crop diversification, and targeted training programs. While these findings suggest potential benefits in terms of productivity and resilience, the study does not establish a direct causal relationship between the interventions and income gains. Factors such as changes in corn market prices, input costs, and production levels were not controlled or analyzed in depth. Therefore, the results should be interpreted with caution. Prolonged participation in the program was associated with higher income, but further analysis using more robust statistical methods is needed to determine the actual drivers of income changes. To ensure lasting impact, future programs should be adaptive, address diverse farmer needs, and promote sustainable farming practices. These efforts can contribute to long-term agricultural productivity, environmental health, and economic stability for farming communities.

Recommendations

Based on the results of the study, the following are the plans and programs devised for further improvement of SLRMA to meet the needs of the farmer-beneficiaries:

1. Since the program is limited to provision of planting materials, fertilizers, and basic tools for weeding and irrigation, some farmer-beneficiaries are unable to deliver the necessary care and maintenance to the crops. This often leads to a high mortality rate in the first year. To address this, additional support and resources should be provided to ensure the successful establishment of the crops planted along the contour lines. Such support may include manpower or financial assistance to cover the labor needed for intensive care and maintenance during this critical period.
2. Future research should not only assess the challenges encountered by farmer-beneficiaries—particularly concerning income and net income—but also evaluate the suitability of the research design and methodologies employed in this study. This will help determine whether these approaches are appropriate for replication or require modification in future investigations. In particular, future studies are encouraged to employ multivariate statistical methods, such as regression analysis, to more accurately identify the specific factors that influence changes in income. Such follow-up assessments will be instrumental in refining the program's design and enhancing its overall effectiveness.
3. Based on the outcomes of the research, the BSWM and the respective Local Government Units should collaborate to formulate and implement a strategic adaptation and upscaling plan for the SLRMA. This plan should showcase the demonstrated benefits of the interventions to neighboring farming communities, thereby encouraging wider adoption. Furthermore, the program should be expanded to other parts of the country, particularly in sloping areas cultivated with corn, to maximize its impact on sustainable land management and farmer productivity.

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