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# Impact of agricultural intervention on socio-economic development of farmers: Evidence from regression discontinuity design

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## Abstract

The contribution of agriculture in the socio-economic development is undeniable and is truly an important part of the Philippine economy. It is also a major source of livelihood and employment of most Filipinos, especially in the rural areas. The general intent of this study is to evaluate the impact of the government agricultural intervention on selected upland communities in Goa, Camarines Sur, especially in the far-flung barangays of the municipality, using Regression Discontinuity Design. This study assessed the socio-economic and poverty status of the local farmers through the agricultural interventions received. The results showed that the distribution of seeds, fertilizers and cash assistance to the upland farmers could improve the overall outputs of the farmers, which can help alleviate their lives. Similarly, the government's agricultural interventions have a significant and positive impact on alleviating poverty and improving the quality of life of the local farmers. However, irrigation and farm-to-market roads need to be prioritized to ensure an increase in agricultural production output.

**Keywords:** *impact evaluation, socio-economic development, agricultural interventions, upland farmers, regression discontinuity design*

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# 1. Introduction

The growth observed in the agricultural sector can be attributed to various government-implemented agricultural intervention programs designed to support the sector's requirements. As reported by the Department of Agriculture (DA, 2019), their programs prioritize production support services, market development, extension support, education and training, research and development, irrigation network expansion, and the provision of agricultural equipment and facilities. These initiatives aim to enhance productivity in rice, corn, high-value crops, livestock, and organic agriculture. These programs play a direct role in advancing Sustainable Development Goals (SDG) 2, 8, and 11, which target issues related to food security, poverty alleviation, and sustainable growth by increasing farm income and productivity. By focusing on these key areas, the agricultural sector in the Philippines not only contributes significantly to the national economy but also plays a crucial role in achieving broader developmental objectives outlined in the SDGs.

In Goa, Camarines Sur, agriculture stands out as a primary livelihood source for residents in upland communities, involving the cultivation of rice, corn, coconut, abaca, root crops, and the raising of livestock such as native chickens, pigs, carabaos, and cows. To bolster this crucial sector, the Local Government Unit (LGU), in collaboration with various agencies and private organizations, implements diverse programs and agricultural interventions as a fundamental strategy to enhance the well-being of upland farmers (Onsay & Rabajante, 2024; Onsay, 2022). This study is designed to assess the impact of these agricultural interventions, with a specific focus on selected far-flung barangays that are identified as vulnerable entities facing significant challenges in meeting the Sustainable Development Goals (SDGs) related to food security and poverty alleviation.

Despite the presence of these interventions, there is a notable absence of studies and reports evaluating the effectiveness of these programs in generating positive impacts on the economic and social welfare of farmers. The research aims to shed light on the government interventions received by farmers, the types of irrigation systems and housing structures utilized by upland farmers, the poverty status of both registered and unregistered farmers, the effects of government agricultural interventions on local upland farmers, and the local average treatment effects of these interventions. By delving into these aspects, the study seeks to provide valuable insights into the efficacy of existing agricultural programs and their influence on the livelihoods and prosperity of upland farmers in the region. Through a comprehensive analysis of these factors, the research aims to contribute to the ongoing efforts to enhance agricultural sustainability, address poverty, and promote economic development in upland communities in Goa, Camarines Sur.

## 2. Literature Review

### *2.1 Challenges and strategies in the farming sector*

In the context of the Sustainable Development Goals (SDGs), traditional rural livelihood practices include hunting, fishing, gathering, shifting cultivation, pastoralism, and high mountain agriculture. These practices not only promote cultural heritage but also play a crucial role in defining the identity and well-being of communities while ensuring food security (United Nations, 2022). Mphande (2016) states that 90% of the world's population depends on farming, with a significant portion of income derived from agricultural activities. Additionally, the agricultural, fisheries, and forestry industries serve as vital sources of employment for rural communities (Kainyande et al., 2022; Sheludkov et al., 2020). In the Philippines, farming is a major livelihood source for many Filipinos, particularly those residing in upland areas where agriculture is essential (Mercado & Osbahr, 2023). Notably, approximately 8.6% of the country’s Gross Domestic Product (GDP) comes from the agriculture sector (Mopera, 2016; Diaz, 2022). However, agriculture is considered a vulnerable sector in light of climate change (Jamshidi et al., 2019; Chimi et al., 2023; Mohapatra et al., 2022). For instance, upland farmers in La Trinidad, Benguet, Philippines, have experienced adverse effects from climate change, negatively impacting crop production, water resources, and household economies (Alfonso & Laruan, 2020). Furthermore, Cerio (2018) identifies several additional challenges faced by farmers, including their limited capacity to produce food and generate agricultural income—factors influenced by their farm holdings, land tenure, and access to farm inputs. Farmers also struggle to generate non-agricultural income, possess low household wealth, and have inadequate access to formal credit facilities.

To address the issue of climate change in the Philippines, farmers adopt various strategies. For instance, Peñaflor et al. (2020) highlight the practices of smallholder upland farmers in the Barobbob Watershed, located in Bayombong, Nueva Vizcaya. These practices include establishing diversion canals and rain-based sprinklers, conducting farm experiments with fertilizers and watering devices, and implementing contour farming. While many farmers in the country heavily rely on changing cropping patterns (Landicho et al., 2016; Pulhin et al., 2016), Elauria et al. (2017) emphasize the importance of Conservation Farming (CF) Technologies, which aim to transform the traditional mono-cropping system into a diversified cropping system in La Libertad, Negros Oriental. However, these farmers often lack adequate support from local government authorities. Furthermore, Philippine farming practices lag behind those of other countries (Briones, 2021), with some farmers still inclined to adhere to indigenous beliefs and traditional practices (Israel & Sierra, 2023). Despite this, there is a growing openness among farmers to integrate and adapt new technologies (Jalotjot & Tokuda, 2024; Briones et al., 2023). In Ethiopia, rural livelihood diversification is practiced to cope with increasing challenges in agricultural production (Abebe et al., 2021). Similarly, partnerships with private sectors, shared farming, and contract farming have been shown to enhance rural livelihoods and agricultural output (Ingram & Kirwan, 2011).

### *2.2 Agricultural Interventions*

Governments around the world subsidize agriculture in three primary forms: land settlement programs, price and income supports, and energy and emissions initiatives. However, the implementation of these state subsidies has been linked to negative effects on soil fertility, freshwater supplies, biodiversity, and atmospheric carbon levels (Williams, 2017). For instance, agricultural interventions by the Chinese government—specifically, the subsidies granted to farmers—have facilitated the growth of agricultural enterprises in China (Wu et al., 2022). In Bangladesh, the Integrated Rice–Fish Farming System (IRFFS) has been implemented to alleviate poverty and improve the living conditions of marginalized small-scale rural households (Islam et al., 2015). In Rwanda, the government established the Crop Intensification Program targeting farmers with larger and more dispersed land areas. However, this initiative did not yield beneficial results for impoverished farmers in rural regions, who often possess extremely small plots of land (Muyombano, 2020). In South Korea, the Rural Development Administration initiated the Korean Programs on International Agriculture (KOPIA) to introduce new agricultural technologies (Park et al., 2019). Meanwhile, the Indian government has placed a strong emphasis on organic farming to promote sustainable agricultural practices (Roychowdhury et al., 2013; Meena et al., 2020). Among the various government interventions, Bisht et al. (2020) argue that four crucial strategies include the integration of traditional and organic farming, support for smallholder farming, improved market access, and reducing rural populations' over-dependence on agriculture as their primary source of income. According to Gautam (2015), production price supports and trade policies are significant factors contributing to the establishment of these subsidies.

According to Setboonsarng (2008), the creation of farm-to-market roads has had a significant impact on communities by facilitating the easy transport of goods from farms. Overall, public infrastructure plays a crucial role in enhancing productivity growth in agriculture in the Philippines (Teruel & Kuroda, 2005). Karlberg et al. (2015) emphasize the importance of agricultural water interventions; a proper irrigation system is essential for farming, as it contributes to good harvests and abundant yields. To achieve maximum and sustainable farming benefits, specific policies and programs are needed. This includes an expansive farm-to-market infrastructure program, institutional and business support interventions to connect farmers with markets, conditional cash farming subsidies in lieu of direct provision of farm inputs, and promotion of crop diversification through dedicated support programs. For example, the Government of Nueva Ecija adopted the Palay Check System, which addresses key aspects of crop management, including seed quality, land preparation, crop establishment, nutrient management, water management, pest management, and harvest management (Cuevas et al., 2021). This comprehensive approach has led to increased yields. Barnedo et al. (2021) argue that government subsidies significantly impact both the agriculture and manufacturing sectors, as they can enhance market power within the agricultural market. However, agricultural policies have not been adequately reviewed, leading to financial difficulties for farmers (Balkrishna et al., 2020). In the Philippines, Briones (2013) emphasizes the importance of properly reviewing projects due to various issues and anomalies encountered during implementation. Additionally, farmers in Southeast Asia face numerous challenges, including limited land for agriculture, soil degradation, and economic obstacles (Blackmore et al., 2021).

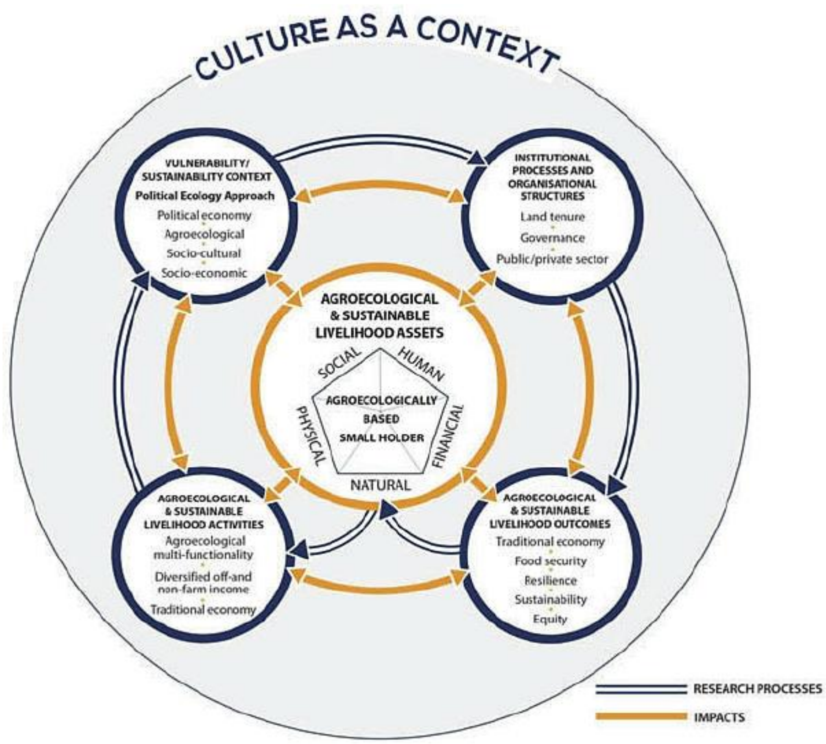
Farmers' yield and productivity serve as crucial indicators of agricultural success and sustainability. The productivity of agricultural systems is influenced by various factors, including household conditions and financial expenditures. Understanding these impacts can guide interventions aimed at improving agricultural outcomes. Research indicates that housing quality significantly influences farmers' productivity. Proper housing provides farming families with a stable living environment, directly contributing to their physical and mental well-being. Studies have shown that higher housing quality correlates with increased labor efficiency and reduced stress levels among farm workers, ultimately enhancing productivity (Geffersa, 2023). Adequate housing for farmers and their laborers significantly affects overall productivity. Evidence suggests that living in substandard conditions can lead to health issues, thereby diminishing a worker's efficiency and output. Conversely, improved housing conditions can increase worker satisfaction and productivity, ultimately benefiting agricultural output (Umanailo et al., 2021). Seed quality is also paramount in determining agricultural productivity. Research demonstrates that high-quality seeds yield superior results compared to lower-quality varieties, largely due to their enhanced physiological purity and disease resistance. When farmers utilize premium seeds, they can expect improved crop yields, which help mitigate the risk of food insecurity and enhance profitability (Wimalasekera, 2015). The relationship between housing conditions, seed quality, and economic factors is multifaceted. For instance, enhanced housing can lead to a more motivated labor force, which, when coupled with high-quality seeds, can significantly boost productivity (Das et al., 2021). Furthermore, effective economic management, including optimal resource allocation, is crucial for maximizing agricultural yields (Emran et al., 2021).

### *2.3. Theoretical Framework*

Figure 1 illustrates the agro-ecology model, emphasizing investments in smallholder family farming and the pursuit of food sovereignty. Family farming, as described by Addinsall et al. (2015), encompasses all family-based agricultural activities associated with various facets of rural development. The 2009 annual report of the International Assessment of Agricultural Knowledge, Science, and Technology for Development highlighted the adverse effects of conventional agricultural practices, their indirect socio-environmental repercussions, and positioned smallholder farmers at the core of sustainable agriculture and food security. Small-scale farming plays a crucial role in ensuring security by underscoring the significance of the future food system and fostering a vibrant, diverse rural economy that benefits all communities. Within the agricultural context, 'sustainability' denotes the ability of the agro-system to harmonize economic efficiency with social acceptability and the mitigation of adverse environmental impacts (ACF-International, 2014).

**Figure 1**

*Agro-Ecology and Sustainable Rural Livelihood Framework (ASRLF)*




***Source***: Addinsallab et al. (2015)

A research design framework positions the rural smallholder at the core, encircled by their agro-ecological and sustainable livelihood assets. Within this framework (ASRLF), solid arrows represent the impacts and interactions among social, economic, biophysical, and sustainability factors, while hollow arrows indicate the flow of research activities and processes. Culture functions as a contextual backdrop within the ASRLF, underscoring the necessity for research activities, processes, and outcomes to be tailored to suit the local context effectively (ASRLF). This adaptation to local culture is crucial for ensuring the relevance and applicability of research within the specific community setting.

## 3. Methodology

### *3.1. Research Design*

This study employed a quantitative approach, crucial for delineating and elucidating the socio-economic status of local farmers using regression analysis. Regression, a quasi-experimental evaluation method, utilizes a treatment assignment mechanism grounded in a continuous eligibility index—a variable with a continuous distribution—to gauge the impact of a particular intervention or program. This method is invaluable for assessing the effectiveness of agricultural interventions or programs for rural farmers in Goa, Camarines Sur. It also aids in elucidating the relationship and significance between independent and dependent variables within the study context.

### *3.2. Research Instrument*

The study used primary data from the respondents through house-to-house interview. In order to collect data, the study used survey questionnaire and interview guide/questions. The questionnaire utilized in this study encompasses a range of critical variables aimed at assessing the socio-economic status of respondents in relation to agricultural interventions. These variables include poverty status (P_S), educational attainment of the household head (Educ), cash assistance received (CASH), seeds received (SD), fertilizer received (FERT), access to water irrigation system (IR), access to farm-to-market road (FMR), available machineries, tools, and equipment (MET), age of the respondents (AGE), gender of the respondents (GEN), marital status of the respondents (MS), highest educational attainment of the respondent (HEA), household size (HS), and average monthly income (AMI).

To ensure the questionnaire's validity and reliability, content validity was maintained by aligning the variables with research objectives and theoretical frameworks. Construct validity was established by designing the questionnaire based on established theoretical constructs and expert reviews. The reliability of the questionnaire was assessed through measures such as test-retest reliability and internal consistency checks like Cronbach's alpha.

The data collection process involved house-to-house interviews with respondents, utilizing the survey questionnaire and interview guide/questions. This approach facilitated the direct collection of primary data from the target population, providing a personalized and in-depth understanding of respondents' circumstances. The structured questionnaire enabled systematic data collection on specific socio-economic characteristics and access to agricultural resources, while the interview guide ensured consistency in data collection by guiding discussions towards relevant topics. Through these methods, the study aimed to gather comprehensive and reliable data to analyze the impact of agricultural interventions on rural farmers' socio-economic status, elucidating relationships between various factors and outcomes effectively.

### *3.3. Research Participants*

The study focused on registered farmers in the locality of Goa, Camarines Sur, Philippines, specifically from barangays Lamon, Scout Fuentebella (Laki-Laki), and Tamban (Mabini), with a total of 155 participants selected from the 199 total population using the Cochran Sampling Technique. To collect data effectively, stratified proportional sampling was employed due to the large and dispersed nature of the population. This method involved dividing the population into subgroups, as illustrated in table 1.

**Table 1**

*The respondents from the treatment and the control group per barangay*

| Name of Barangay | Treatment Group (Registered Farmers) | | | Control Group (Unregistered Farmers) | | |
|---|---|---|---|---|---|---|
| | Population | Proportion | Sample | Population | Proportion | Sample |
| Lamon | 67 | 0.3 | 54 | 67 | 0.3 | 54 |
| Scout Fuentebella (Laki-Laki) | 100 | 0.5 | 73 | 100 | 0.5 | 73 |
| Tamban (Mabini) | 32 | 0.16 | 28 | 32 | 0.16 | 28 |
| **Total** | **199** | **0.96** | **155** | **199** | **0.96** | **155** |

**Figure 2**

*The treatment and control groups for the impact evaluation*

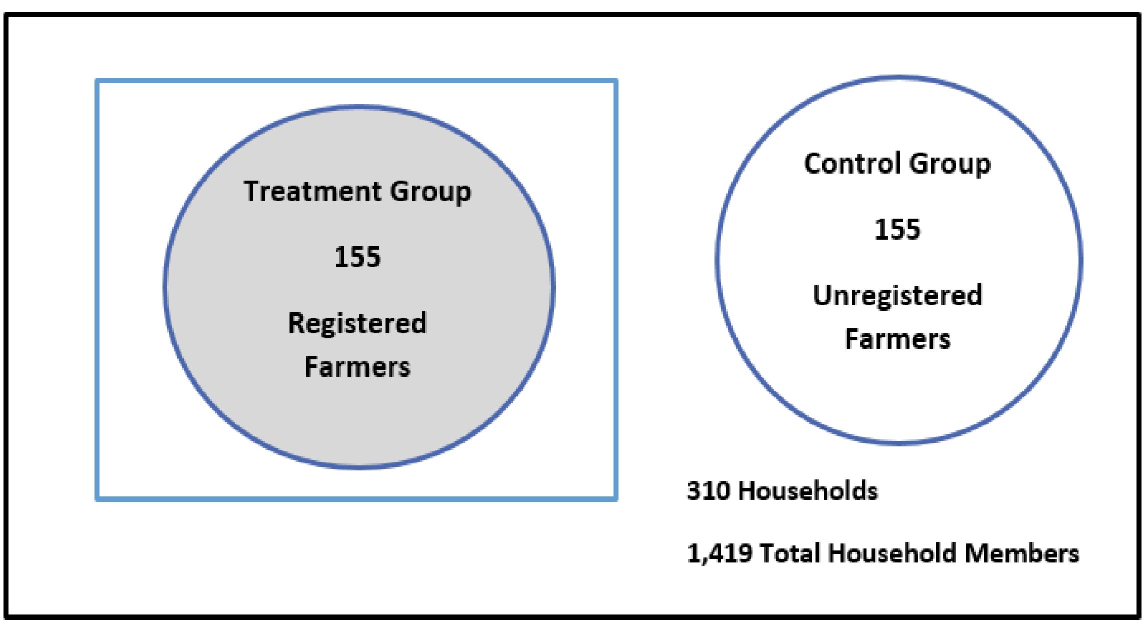


**Table 2**

*Socio-economic profile of participants from treatment and control community*

| Characteristics | | Registered Farmers | | | Unregistered Farmers | | |
|---|---|---|---|---|---|---|---|
| | | F | % | Rank | F | % | Rank |
| Age | 21-30 | 6 | 3.87 | 5 | 8 | 5.16 | 5 |
| | 31-40 | 25 | 16.13 | 4 | 39 | 25.16 | 2 |
| | 41-50 | 47 | 30.32 | 1 | 38 | 24.52 | 3 |
| | 51-60 | 40 | 25.81 | 2 | 41 | 26.45 | 1 |
| | 61-70 | 32 | 20.64 | 3 | 22 | 14.19 | 4 |
| | 71-80 | 5 | 3.23 | 6 | 6 | 3.87 | 6 |
| | 81-90 | 0 | 0 | 0 | 1 | 0.65 | 7 |
| Gender | Male | 85 | 54.84 | 1 | 90 | 58.06 | 1 |
| | Female | 70 | 45.16 | 2 | 65 | 41.94 | 2 |
| Marital Status | Single | 0 | 0 | 0 | 3 | 2.56 | 3 |
| | Married | 133 | 85.81 | 1 | 128 | 82.58 | 1 |
| | Widowed | 22 | 14.19 | 2 | 17 | 10.98 | 2 |
| | Live – in | 0 | 0 | 0 | 3 | 1.93 | 4 |
| | Separated | 0 | 0 | 0 | 3 | 1.93 | 4 |
| Highest Educational Attainment | Elementary Level | 80 | 51.61 | 1 | 84 | 54.19 | 1 |
| | High School Level | 73 | 47.10 | 2 | 65 | 41.94 | 2 |
| | College Level | 2 | 1.29 | 3 | 6 | 3.87 | 3 |
| Name of Commodities | Rice | 152 | 96.06 | 1 | 131 | 84.52 | 1 |
| | Coconut | 50 | 32.26 | 2 | 53 | 34.19 | 2 |
| | Corn | 2 | 1.29 | 4 | 1 | 0.65 | 4 |
| | Others | 8 | 5.16 | 3 | 8 | 5.16 | 3 |
| Average Monthly Income | Below 3000 | 1 | 0 | 0 | 2 | 0 | 0 |
| | 3001-5000 | 9 | 0 | 0 | 9 | 0 | 0 |
| | 5001-7000 | 3 | 0 | 0 | 10 | 0 | 0 |
| | 7001-9000 | 8 | 0 | 0 | 11 | 0 | 0 |
| | 9001-11000 | 7 | 0 | 0 | 18 | 0 | 0 |
| | 11001-13000 | 11 | 0 | 0 | 18 | 0 | 0 |
| | 13001- 15000 | 12 | 0 | 0 | 19 | 0 | 0 |
| | 15001 above | 7 | 0 | 0 | 114 | 0 | 0 |

Table 2 shows the socio-economic profile of the respondents from treatment and control community. In terms of age distribution, the data reveals that among registered farmers, the largest group falls within the 41-50 age range, accounting for 30.32% of the total, closely followed by the 51-60 age group at 25.81%. On the other hand, unregistered farmers show a different pattern, with the highest percentage in the 51-60 age group at 26.45%, followed by the 31-40 age group at 25.16%. Gender-wise, both registered and unregistered farmers are predominantly male, with males constituting 54.84% and 58.06%, respectively. Marital status data indicates that a significant majority of both registered (85.81%) and unregistered (82.58%) farmers are married. When looking at educational attainment, the primary level achieved by most farmers in both groups is at the elementary level. This highlights a potential area for educational support or training programs to enhance the skills and knowledge of farmers. Rice emerges as the predominant commodity for both registered and unregistered farmers, with a substantial percentage engaged in rice cultivation compared to other commodities like coconut and corn. In terms of income distribution, the data suggest that a considerable number of unregistered farmers report incomes of 15,001 and above, indicating a potential income disparity between the two groups. Understanding these demographic and socio-economic characteristics is crucial for tailoring targeted agricultural interventions and support services effectively. By leveraging these insights, programs can be designed to address the specific needs and challenges faced by farmers, whether in terms of educational support, income generation opportunities, or agricultural training, ensuring a more impactful and sustainable approach to rural development.

### *3.4. Data Analysis*

Microsoft Excel and R Studio were utilized in the statistical analysis of the data. The study employed the frequency method, ranking, percentage techniques, empirical procedures, as well as econometric models, the logit regression and multivariate regression. Logit Regression is an econometric technique focused on establishing causal relationships between variables. It was utilized to uncover the connection between agricultural interventions and the multidimensional poverty index. Multivariate Regression, on the other hand, examines the effects of government agricultural interventions on the quality of life among registered upland farmers, utilizing continuous dependent variables. The dependent variables considered in this analysis are the quality of life and education levels of registered upland farmers, while the independent variable is the government's agricultural intervention.

### *Logit Model*

$$y = \beta_0 + \beta_1 x\,1 + \beta_2\,x\,2 + \beta_3\,x\,3 + \beta_4\,x\,4 + \ldots\ldots\,\mu$$

(1) $P_S = \beta_0 + \beta_1 CASH + \beta_2 SD + \beta_3\,FERT + \beta_4 IR + \beta_5 FMR + \beta_6 MET + \beta_7 AGE + \beta_8 GEN + \beta_{09} MS + \beta_{10} HS + \beta_{11} AMI + \beta_{12} HEA + \mu$

(2) $Educ = \beta_0 + \beta_1 CASH + \beta_2 SD + \beta_3 FERT + \beta_4 IR + \beta_5 FMR + \beta_6 MET + \beta_7 AGE + \beta_8 GEN + \beta_{09} MS + \beta_{10} HS + \beta_{11} AMI + \beta_{12}\,HEA + \mu$

where:

$P_S$= Poverty status of the respondents

Educ= educational attainment of the household head

CASH= cash assistance received

SD = seeds received

FERT = fertilizer received by the respondents

IR = access to water irrigation system

FMR= access to farm-to-market road

MET= available machineries, tools, and equipment

AGE= age of the respondents

GEN = Gender of the respondents

MS = Marital status of the respondents

HEA= Highest educational attainment of the respondent

HS = Household size

AMI= Average monthly income

$\beta_0$ = Coefficient of constant

$\beta_1$ = The coefficient of the independent variable

μ= error term

**Table 3**

*List of variables, sources and descriptions*

| Variables | | VAR | Descriptions/ Definition | Prior Expectations |
|---|---|---|---|---|
| DEPENDENT VARIABLES | Quality of Life | $P_S$ | This refers to the status of farmers based on their socio-economic status ( Average Monthly Income and House Structure) | 0 (Yes/Poor/HH Living below Poverty Threshold), 1 (No/Non-Poor/ HH Not Living below Poverty Threshold) |
| | Education | *Educ* | This is the status of household members in terms of education . | 1 = Enrolled (member attending class) 0 = Not Enrolled (member not attending class) |
| INDEPENDENT VARIABLES | Cash Assistance | *CASH* | Cash received by the upland farmers | Positive (+) |
| | Seeds | *SD* | Upland farmers who received seeds | Positive (+) |
| | Fertilizer | *ERT* | Upland farmers who received fertilizer | Positive (+) |

| Variables | | VAR | Descriptions/ Definition | Prior Expectations |
|---|---|---|---|---|
| INDEPENDENT VARIABLES | Irrigation | *IR* | Upland farmers who have an access to irrigation | Positive (+) |
| | Farm to Market Roads | *FMR* | With access to farm-to-market roads. | Positive (+) |
| | Machineries, Tools and Equipment | *MET* | Upland farmers who received farm machineries, tools and equipment | Positive (+) |
| | Age | *AGE* | This refers to the age of the respondent or farmers. | Age of the respondents |
| CONTROL VARIABLES | Gender | *GEN* | This refers to the gender of the respondent or farmers. | Gender of the Respondents 1= Male 2= Female |
| | Marital Status | *MS* | This refers to the marital status of the respondent or farmers. | Single, Married , Separated x Widowed |
| | Household Size | *HS* | This refers to the number of household member. | Number of household member |
| | Average Monthly Income | *AMI* | This refers to the average monthly income of the family or of the household. | Average Monthly Income of the Household |
| | Highest Educational Attainment | *HEA* | This refers to the highest educational attainment obtained by the respondent | None, Elementary Level, High School Level , College Level etc. |

### *3.5. Ethical Considerations*

Prior to commencing the research, ethical approval was obtained from the Partido State University. This approval ensures that the study adheres to ethical guidelines and safeguards the rights and well-being of the participants. All participants involved in the study were provided with detailed information about the research objectives, procedures, potential risks, and benefits. Informed consent forms were distributed, outlining the voluntary nature of participation and emphasizing the participants' right to withdraw from the study at any time without facing any consequences. Only those individuals who voluntarily agreed to participate and provided explicit consent were included in the study, ensuring that their participation was based on full understanding and autonomy. Maintaining the confidentiality of information obtained from participants was a paramount ethical consideration. All data collected during the study were treated with strict confidentiality to protect the privacy and anonymity of the participants. Measures were implemented to ensure that individual responses and personal details were kept secure and accessible only to authorized research team members. Data were anonymized and aggregated wherever possible to prevent the identification of individual participants, further safeguarding their confidentiality and privacy throughout the research process.

## 4. Findings and Discussion

The role of agriculture in driving socio-economic advancement is undoubtedly substantial, particularly in the Philippine economic landscape. Through the application of various statistical analysis and Regression Discontinuity Design, this investigation examines the socio-economic status and poverty levels of local farmers concerning the agricultural support they have received. The results demonstrate that the provision of crucial resources like seeds, fertilizers, and financial aid notably boosts the agricultural yields of upland farmers. These enhancements not only lead to increased productivity but also play a pivotal role in ameliorating the overall financial circumstances of these farmers and their households. Each table offers a comprehensive analysis of significant aspects.

**Table 4**

*Logistic Regression on poverty status of the upland farmers*

| Determinants | Coef. | Std. Err. | Z | P>z | 95% Conf. | Interval |
|---|---|---|---|---|---|---|
| Age | -0.036 | 0.02 | 2.39 | 0.02 | -0.07 | -0.01 |
| Gender | -0.51 | 0.28 | -1.81 | 0.07 | -1.06 | 0.04 |
| Highest Educational Attainment | 0.12 | 0.29 | 0.4 | 0.69 | -0.45 | 0.69 |
| Marital Status | -0.59 | 0.41 | -1.43 | 0.15 | -1.40 | 0.22 |
| Other Source Of Income | -0.15 | 0.45 | -0.34 | 0.74 | -1.04 | 0.74 |
| Monthly Salary | 2.21 | 0.00 | 0.63 | 0.53 | -4.6E | 9.06E |
| No. of Household Members | -0.15 | 0.07 | -2.11 | 0.04 | -0.28 | -0.01 |
| No. of Years as a Farmer | -0.03 | 0.02 | -1.75 | 0.08 | -0.05 | 0.00 |
| Total Land Area | -0.08 | 0.08 | -0.95 | 0.34 | -0.24 | 0.08 |
| No. of Parcel | -1.04 | 0.33 | -3.17 | 0.00 | -1.68 | -0.40 |
| _cons | 5.67 | 1.05 | 5.38 | 0 | 3.60 | 7.74 |

The results of the logistic regression analysis shed light on crucial factors influencing the poverty outcomes of upland farmers in the researched communities. Age emerges as a significant predictor, with older farmers likely contributing more to socio-economic development as they engage in economic activities. Conversely, the number of household members plays a pivotal role, with larger families facing increased poverty risks, particularly when members are not actively employed. Land ownership, indicated by the number of parcels, significantly impacts poverty status, suggesting that farmers with more land have a greater potential to escape poverty through increased cultivation capacity. Furthermore, the duration of farming experience correlates positively with improved livelihoods, emphasizing the value of expertise in agricultural practices for poverty alleviation. The statistical significance of these variables underscores their importance in determining farmers' poverty status. These findings not only enhance the understanding of the socio-economic dynamics affecting upland farmers but also highlight the need for targeted interventions that consider age, household size, land ownership, and farming experience. For government and other intervention providers, these results underscore the necessity of tailored approaches to address specific needs and circumstances, ultimately aiding in effective poverty reduction strategies. In alignment with the research objective of evaluating the impact of government agricultural interventions on poverty status in upland communities, these results provide actionable insights to inform future policies and interventions geared towards enhancing the socio-economic well-being of farmers in these regions.

**Table 5**

*Multivariate Regression on LNYa (Yield after receiving the interventions)*

| Determinants | Coef. | Std. Err. | T | P>t | 95% Conf. | Interval |
|---|---|---|---|---|---|---|
| Seeds | 141.88 | 78.35 | 1.81 | 0.051 | -12.30 | 296.06 |
| Fertilizer | 25.06 | 78.47 | 0.32 | 0.08 | -129.36 | 179.48 |
| Machineries & Equipment | -11.14 | 275.05 | -0.04 | 0.09 | -552.39 | 530.12 |
| Cash | 17.41 | 44.37 | 0.39 | 0.07 | -69.89 | 104.72 |
| Irrigation | 43.88 | 67.35 | 1.21 | 0.06 | -13.41 | 296.06 |
| Livelihoods | 11.88 | 48.35 | 1.04 | 0.08 | -23.41 | 321.17 |
| _cons | -166.81 | 21.67 | -7.7 | 0 | -209.45 | -124.17 |

The results derived from the multivariate regression analysis in Table 5 offer crucial insights into the effectiveness of various interventions on agricultural yields following the implementation of the intervention programs. The distribution of seeds appears to have a notably positive impact on farmers' yields, as evidenced by a significant coefficient of 141.8806 and a p-value of 0.051. This emphasizes the importance of providing high-quality seeds to farmers to enhance agricultural productivity. Furthermore, the presence of irrigation, with a coefficient of 43.8806 and a p-value of 0.057, demonstrates a positive influence on yields, highlighting the significance of adequate irrigation systems in improving crop growth and overall yield outcomes. Additionally, the distribution of cash, fertilizers, and agricultural equipment all exhibit positive impacts on yields, as indicated by their respective coefficients and p-values. Cash injections can facilitate essential investments, while fertilizers and equipment enhance farming efficiency and output. The inclusion of livelihood support, as indicated by a coefficient of 11.8806 and a p-value of 0.081, emerges as a crucial predictor of agricultural yields, underlining the importance of providing farmers with diversified livelihood options to boost overall productivity. These results collectively suggest that interventions such as seed distribution, irrigation enhancement, cash injections, provision of fertilizers, and access to machinery and equipment have a significant positive influence on agricultural yields. By recognizing these key factors that affect agricultural productivity, the study offers valuable insights for policymakers and intervention providers. Tailoring interventions to focus on these critical aspects can lead to heightened agricultural productivity and improved livelihoods for farmers, ultimately contributing to sustainable agricultural development and economic growth within the studied communities.

**Table 6**

*Multivariate Regression on the effects of the intervention*

| Determinants | Coef. | Std. Err. | Z | P>z | 95% Conf. | Interval |
|---|---|---|---|---|---|---|
| Seeds | 1.60 | 0.60 | 2.67 | 0.01 | 0.42 | 2.77 |
| Fertilizer | 0.99 | 0.61 | 1.63 | 0.10 | -0.19 | 2.18 |
| Machineries & Equipment | 0.13 | 0.30 | 0.42 | 0.69 | -0.46 | 0.79 |
| Cash | -0.21 | 0.40 | -0.53 | 0.60 | -1.00 | 0.58 |
| Irrigation | 0.22 | 0.30 | 0.38 | 0.59 | -0.56 | 0.85 |
| Livelihoods | 0.23 | 0.28 | 0.43 | 0.48 | -0.34 | 0.73 |
| _cons | -1.00 | 0.18 | -5.58 | 0 | -1.35 | -0.65 |

The results of the analysis in table 6 underscore the pivotal role of different factors in augmenting agricultural yields among farmers. Notably, the distribution of seeds emerges as a primary predictor, with a coefficient of 1.60 and a significant p-value of 0.01, indicating its substantial impact on yield increase. This underscores the critical importance of quality seed provision in enhancing crop productivity. Furthermore, factors such as fertilizer, machinery, tools and equipment, cash, and irrigation are also identified as key influencers in elevating agricultural yields. The strikingly low p-values of 0.000 associated with these variables highlight their significant predictive power in driving yield improvements in agriculture. These findings collectively emphasize the essential nature of various inputs and resources in bolstering agricultural productivity. By recognizing the significance of these factors, policymakers and stakeholders can craft tailored interventions and support strategies aimed at improving farmers' access to these vital resources, ultimately fostering enhanced yields and overall agricultural outcomes for the benefit of farming communities.

**Table 7**

*Result of the multivariate regression in the paid workers*

| Determinants | Coef. | Std. Err. | T | P>t | 95% Conf. | Interval |
|---|---|---|---|---|---|---|
| Seeds | 1.15 | 1.00 | 1.15 | 0.25 | -0.82 | 3.12 |
| Fertilizer | -0.59 | 1.00 | -0.59 | 0.56 | -2.56 | 1.38 |
| Machineries & Equipment | 4.88 | 3.51 | 1.39 | 0.17 | -2.04 | 11.79 |
| Cash | 0.70 | 0.57 | 1.23 | 0.22 | -0.42 | 1.81 |
| Irrigation | -2.52 | 4.92 | 0 | 1 | -9.69 | 9.69 |
| Livelihoods | 0.73 | 0.63 | 1.24 | 0.30 | -0.43 | 1.92 |
| _cons | 3.86 | 0.28 | 13.97 | 0 | 3.32 | 4.41 |

Table 7 shows the result of the Multivariate Regression in the paid workers. According to the results, among registered and unregistered upland farmers, government agricultural intervention was significant as an overall model with a significance level of 5%. However, there was no specific determinant showing effect on the payment to workers. The government efforts in farming are important for both registered and unregistered farmers in the uplands. This means that these interventions have a noticeable impact on how farming is done in these areas. However, when it comes to paying workers, the study did not find any specific reasons or factors that clearly affect how much workers are paid. This suggests that the reasons behind worker payment in these farming communities are likely influenced by many different things that were not looked at in this study. This shows that paying workers in farming is more complicated and involves many factors that were not considered in this research. To better understand and improve how workers are paid in these areas, further investigation into these factors is needed. This can help policymakers and others make better decisions to improve how workers are compensated and ultimately their lives in these farming communities.

**Table 8**

*Result of the multivariate regression on the expenses of farmers*

| Determinants | Coef. | Std. Err. | T | P>t | 95% Conf. | Interval |
|---|---|---|---|---|---|---|
| Seeds | 26.67 | 36.60 | 0.73 | 0.47 | -45.35 | 98.69 |
| Fertilizer | 4.79 | 36.66 | 0.13 | 0.90 | -67.34 | 76.92 |
| Machineries & Equipment | -0.80 | 128.48 | -0.01 | 0.10 | -253.62 | 252.03 |
| Cash | 3.27 | 20.72 | 0.16 | 0.88 | -37.51 | 44.05 |
| Irrigation | -3.80 | 180.11 | 0 | 1 | -354.41 | 354.41 |
| Livelihoods | 0.60 | 0.47 | 1.13 | 0.12 | -0.32 | 1.92 |
| _cons | -22.77 | 10.12 | -2.25 | 0.03 | -42.69 | -2.85 |

The findings presented in table 8, derived from the multivariate regression analysis on farmers' expenses, reveal interesting insights. While the model overall is considered significant, the specific variables examined in the study do not appear to have a direct impact on farmers' expenses. This implies that the factors under consideration in the analysis do not individually influence the expenses incurred by upland farmers. Interestingly, the overall model and the variables related to the expenses of upland farmers did not demonstrate a significant relationship. However, an underlying constant variable seems to play a role in affecting farmers' expenses. This suggests that there might be an underlying, unexplored factor that consistently influences farmers' expenditures in these settings. Moreover, the analysis indicates that there is a correlation between the level of expenses and its impact on the overall outcome. The more expenses that farmers incur, the greater the effect on the final results or outcomes they experience. This highlights the importance of understanding and managing expenses effectively, as they can significantly influence the overall performance and outcomes in agricultural practices.

**Table 9**

*Result on the Tobit Regression on LNEX (expenses)*

| Determinants | Coef. | Std. Err. | t | P>t | 95% Conf. | Interval |
|---|---|---|---|---|---|---|
| Seeds | 0.54 | 0.39 | 1.4 | 0.16 | -0.22 | 1.30 |
| Fertilizer | 0.09 | 0.39 | 0.23 | 0.81 | -0.67 | 0.85 |
| Machineries & Equipment | 1.53 | 1.35 | 1.13 | 0.26 | -1.13 | 4.19 |
| Cash | 3.27 | 20.72 | 0.16 | 0.88 | -37.51 | 44.05 |
| Irrigation | -3.80 | 180.11 | 0 | 1 | -354.42 | 354.41 |
| Livelihoods | 0.60 | 0.47 | 1.13 | 0.12 | -0.32 | 1.92 |
| _cons | 8.81 | 0.11 | 82.63 | 0 | 8.60 | 9.02 |
| /sigma | 1.34 | 0.05 | | | 1.23 | 1.45 |

The Tobit Regression analysis conducted on the natural logarithm of expenses reveals detailed insights into the determinants affecting farmers' expenditures. Among the examined factors, seeds exhibit a coefficient of 0.54 with a standard error of 0.39, showing no statistically significant impact with a t-value of 1.4 and a p-value of 0.16. Similarly, fertilizer's coefficient of 0.09, standard error of 0.39, t-value of 0.23, and p-value of 0.81 suggest that it does not significantly influence expenses. Machineries & equipment, with a coefficient of 1.53 and a standard error of 1.35, also fails to reach statistical significance with a t-value of 1.13 and a p-value of 0.26. Cash, displaying a coefficient of 3.27 and a high standard error of 20.72, lacks statistical significance with a t-value of 0.16 and a p-value of 0.88. Irrigation, despite a coefficient of -3.80, is statistically insignificant with a t-value of 0 and a p-value of 1 due to a substantial standard error of 180.11. Livelihoods, with a coefficient of 0.60 and a standard error of 0.47, also falls short of statistical significance with a t-value of 1.13 and a p-value of 0.12. Notably, the constant term holds significant influence on expenses, with a coefficient of 8.81, a low standard error of 0.11, a high t-value of 82.63, and a p-value of 0. Moreover, the standard deviation of the error term is 1.34 with a standard error of 0.05, emphasizing the variability in predicting expenses. These results collectively highlight the intricate nature of expense determinants in farming, suggesting the presence of unexplored variables that play a crucial role in shaping farmers' spending behaviors.

Table 10 shows the Tobit Regression analysis on the natural logarithm of yield (yield), providing valuable insights into the determinants influencing agricultural productivity.

**Table 10**

*Result of the Tobit Regression on LNYa (yield)*

| Determinants | Coef. | Std. Err. | t | P>t | 95% Conf. | Interval |
|---|---|---|---|---|---|---|
| Seeds | 0.89 | 0.68 | 1.32 | 0.18 | -0.44 | 2.23 |
| Fertilizer | -0.29 | 0.68 | -0.43 | 0.67 | -1.62 | 1.04 |
| Machineries & Equipment | 1.43 | 2.37 | 0.6 | 0.55 | -3.25 | 6.10 |
| Cash | 0.82 | 0.38 | 2.14 | 0.03 | 0.07 | 1.58 |
| Irrigation | 0.98 | 0.59 | 1.42 | 0.19 | -0.45 | 2.27 |
| Livelihoods | 0.72 | 0.24 | 1.36 | 0.37 | 0.08 | 1.66 |
| _cons | 3.56 | 0.19 | 18.73 | 0 | 3.18 | 3.93 |
| /sigma | 2.35 | 0.10 | 0 | 0 | 2.15 | 2.55 |

Among the factors examined, seeds demonstrate a coefficient of 0.89 with a standard error of 0.68, indicating a non-significant effect with a t-value of 1.32 and a p-value of 0.18. Fertilizer, with a coefficient of -0.29 and a standard error of 0.68, also lacks statistical significance, as evidenced by a t-value of -0.43 and a p-value of 0.67. Machineries and equipment show a coefficient of 1.43 and a standard error of 2.37, suggesting no significant impact with a t-value of 0.6 and a p-value of 0.55. Cash, on the other hand, displays a coefficient of 0.82 with a standard error of 0.38, indicating a significant positive effect on yield with a t-value of 2.14 and a p-value of 0.03. Irrigation, with a coefficient of 0.98 and a standard error of 0.59, shows no significant impact on yield, as reflected in the t-value of 1.42 and the p-value of 0.19. Livelihoods exhibit a coefficient of 0.72 and a standard error of 0.24, suggesting a non-significant effect on yield with a t-value of 1.36 and a p-value of 0.37. The intercept term (_cons_) holds substantial importance, with a coefficient of 3.56 and a low standard error of 0.19, yielding a high t-value of 18.73 and a p-value of 0. The standard deviation of the error term is 2.35 with a standard error of 0.10, highlighting the variability in predicting yield. While factors like seeds, fertilizer, and machineries & equipment do not significantly impact yield, cash emerges as a significant determinant, emphasizing the importance of financial resources in enhancing agricultural productivity.

The results of the Logistic Regression analysis on house structure reveal important insights into the impact of government agricultural intervention on the housing conditions of upland farmers as shown in table 11.

**Table 11**

*Result of the Logistic Regression of house structure*

| Determinants | Coef. | Std. Err. | z | P>z | 95% Conf. | Interval |
|---|---|---|---|---|---|---|
| Seeds | 0.25 | 0.64 | 0.39 | 0.69 | -0.99 | 1.49 |
| Fertilizer | 0.55 | 0.64 | 0.85 | 0.39 | -0.71 | 1.80 |
| Cash | 0.44 | 0.41 | 1.06 | 0.28 | -0.37 | 1.24 |
| _cons | 0.41 | 0.16 | 2.49 | 0.01 | 0.09 | 0.72 |

The coefficients for the determinants show that seeds have a coefficient of 0.25 with a standard error of 0.64, indicating a non-significant effect with a z-value of 0.39 and a p-value of 0.69. Fertilizer, with a coefficient of 0.55 and a standard error of 0.64, also shows no significant impact with a z-value of 0.85 and a p-value of 0.39. Cash demonstrates a coefficient of 0.44 with a standard error of 0.41, suggesting a non-significant effect on house structure with a z-value of 1.06 and a p-value of 0.28. The intercept term (cons) holds particular importance, with a coefficient of 0.41 and a standard error of 0.16, resulting in a z-value of 2.49 and a significant p-value of 0.01. The logistic regression model indicates that government agricultural intervention has a significant effect on the housing condition of upland farmers overall, with a significance level of 5%. This suggests that the interventions implemented by the government have influenced the housing conditions of the farmers. However, the exact nature and specifics of the interventions that have the most impact remain unclear, indicating that further investigation or analysis may be needed to understand the specific interventions that are driving these effects on house structure in the studied population.

**Table 12**

*Regression analysis on poverty status and agricultural interventions*

| Source | SS | df | MS | Number of obs | = | 155 |
|---|---|---|---|---|---|---|
| | | | | F(2, 152) | = | 101.21 |
| Model | 22.12 | 2 | 11.05 | Prob > F | = | 0 |
| Residual | 16.60 | 152 | 0.12 | R-squared | = | 0.57 |
| | | | | Adj R-squared | = | 0.57 |
| Total | 38.71 | 154 | 0.25 | Root MSE | = | 0.33 |

| Poverty Status | Coef. | Std. Err. | t | P>t | 95% Conf. | Interval |
|---|---|---|---|---|---|---|
| watts_index_left | -0.52 | 0.08 | -6.43 | 0 | -0.68 | -0.36 |
| watts_index_right | -0.60 | 0.07 | -9.18 | 0 | -0.73 | -0.47 |
| Eligible | -0.42 | 0.06 | -8.86 | 0 | -0.75 | -0.51 |
| _cons | 0.56 | 0.04 | 14.02 | 0 | 0.49 | 0.64 |

At the poverty index, a discontinuity can be observed from point delta to point omicron. The fit of the registered group was at a higher level compared to the fit of the unregistered group. The distance between these levels reflects the discontinuity, which can be interpreted as follows: for those eligible to receive the program or part of the treatment group, both yield and quality of life will increase. This increase can be measured through the regression model shown in table 12. The overall model was significant, and all p-values were also significant. The coefficient for eligibility was -0.41613, indicating that a unit increase in eligibility (or when those farmers become eligible for the program), the yield or quality of life will decrease by -0.41613. Since households on both the left and right sides of the cut-off line have similar attributes and characteristics, the difference in quality of life and number of yields between farmers on these sides can be attributed to eligibility. The left side was eligible to receive or become beneficiaries of the program, while the right side was not. Table 12 presents the local average treatment effects on eligibility, with a coefficient of -0.41613, a standard error of 0.064, and a t-value of -8.86. In the vicinity of the eligibility cutoff, where the treatment and control groups exhibit similarity, the regression discontinuity design provides estimates of the Local Average Treatment Effect (LATE). The degree of similarity between households on the left and right sides of the cutoff line can be inferred by how close the estimate is to the 58-index. Regression discontinuity analysis evaluates the impact on the treatment and comparison groups around the 58-index. Consequently, LATE is not suitable for assessing individuals who are far from the 58-index. When the characteristics of participants on the left and right sides of the 58-index are not comparable, the LATE estimate lacks the ability to validate measurements accurately. This underscores the importance of ensuring similarity between groups in regression discontinuity designs to reliably gauge the treatment effects.

## 5. Conclusion

This study concludes that the distribution of seeds, fertilizers and cash assistance to the upland farmers can improve the overall outputs of the farmers. The study proved that government agricultural interventions had a positive and significant impact on the lives of the upland farmers in Goa, Camarines Sur. This in turn had a positive impact in alleviating poverty and improving the quality of life of the local farmers. Hence, irrigation and farm-to-market road need to be considered and prioritized by the government to ensure increased in production output.

Several limitations need consideration for interpreting the findings and guiding further research. Firstly, establishing causality between government interventions and improved agricultural outputs is complex, although the paper used rigorous experimental designs for stronger causal claims, additional locale relative to the vicinity of the study's locale must be examined. Additionally, the study's context-specific results may lack generalizability to regions with different agricultural practices and socio-economic conditions, emphasizing the importance of replication in diverse settings. Thus, implementing the same methods to other regions is prescribed. Measurement and data limitations, such as biases in self-reported impacts and data reliability, could be addressed through secondary data utilization. Long-term sustainability and durability of observed benefits warrant investigation, as short-term outcomes may not capture lasting impacts. Unaccounted variables, like imputed costs, should be considered for a more comprehensive understanding of intervention effectiveness. For future research, examining the sustainability of benefits over time, exploring differential impacts on farmer subgroups, assessing cost-effectiveness of interventions, and analyzing broader social and economic implications of scaling successful interventions are recommended. By addressing these limitations and pursuing comprehensive research paths, policymakers can make informed decisions to design effective interventions supporting upland farmers, alleviating poverty, and promoting sustainable agricultural development.

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# Appendices

### Appendix A

*The government interventions received by the farmers*

| Interventions | F | % | Rank |
|---|---|---|---|
| Seeds | 151 | 97.42 | 1 |
| Fertilizer | 142 | 91.62 | 2 |
| Cash Assistance | 59 | 38.06 | 3 |

### Appendix B

*Sources of the government interventions received*

| Name of Agency | F | % | Rank |
|---|---|---|---|
| Municipal Agriculture Office | 155 | 100 | 1 |
| Provincial Government | 57 | 36.77 | 2 |

**Appendix C**

*Benefits of farming on the farmers*

| Benefits of Farming | Registered Farmers | | | Unregistered Farmers | | |
|---|---|---|---|---|---|---|
| | F | % | Rank | F | % | Rank |
| Fixed/build their own house | 95 | 61.29 | 3 | 66 | 42.58 | 3 |
| Own consumption | 141 | 90.97 | 1 | 146 | 94.19 | 1 |
| Purchase farm tools | 26 | 16.77 | 4 | 5 | 3.23 | 6 |
| Buy own land/ property | 2 | 1.29 | 7 | 12 | 7.74 | 5 |
| Additional help on Business | 6 | 3.87 | 6 | 16 | 10.32 | 4 |
| Buy own transportation | 6 | 3.87 | 6 | 0 | 0 | 0 |
| Payment for debt | 106 | 69.39 | 2 | 77 | 49.68 | 2 |
| Additional budget on education | 20 | 12.90 | 5 | 3 | 1.74 | 7 |

**Appendix D**

*Type of irrigation in selected upland barangay of Goa, Camarines Sur*

| Irrigation Type | Registered Farmers | | | Unregistered Farmers | | |
|---|---|---|---|---|---|---|
| | F | % | Rank | F | % | Rank |
| Fully Irrigated | 2 | 1.29 | 4 | 0 | 0 | 0 |
| Partially Irrigated | 1 | 0.65 | 5 | 3 | 1.94 | 3 |
| Communal Irrigation | 8 | 5.16 | 3 | 1 | 0.65 | 4 |
| Rainfed | 105 | 67.74 | 1 | 92 | 59.35 | 1 |
| Burabod | 39 | 25.16 | 2 | 59 | 38.06 | 2 |
| **TOTAL** | **155** | **100%** | | **155** | **100 %** | |

**Appendix E**

*House structure of the farmers*

| House Structure | | Registered Farmers | | | Unregistered Farmers | | |
|---|---|---|---|---|---|---|---|
| | | F | % | Rank | F | % | Rank |
| Roof | Nipa / Anahaw | 29 | 18.71 | 2 | 57 | 36.78 | 2 |
| | Galvanized Iron | 124 | 80 | 1 | 91 | 58.71 | 1 |
| | Concrete (Top) | 2 | 1.29 | 3 | 7 | 4.52 | 3 |
| Wall | Concrete | 94 | 60.64 | 1 | 55 | 35.49 | 1 |
| | Half Wood, Half Concrete | 48 | 30.97 | 2 | 48 | 30.97 | 3 |
| | Wood | 12 | 7.74 | 3 | 50 | 32.26 | 2 |
| | Bamboo | 1 | 0.65 | 4 | 2 | 1.29 | 4 |
| Floor | Concrete | 147 | 94.84 | 1 | 144 | 92.90 | 1 |
| | Earth, Sand | 5 | 2.23 | 2 | 8 | 5.16 | 2 |
| | Half Concrete , Half Sand | 3 | 1.94 | 3 | 3 | 1.94 | 3 |