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Socio-economic determinants of Legumes and Root crops production in Lahar-affected areas of Zambales, Philippines: Its policy implications

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Abstract

This study investigates the socio-economic determinants of legumes and root crops production, specifically focusing on cassava and sweet potato, in the lahar-affected areas of Zambales, Philippines. The research provides valuable insights into the demographic profile and farming characteristics of the respondents. Notably, the study finds a mix of older and younger farmers actively engaged in agriculture, with a pronounced gender disparity, predominantly favoring male farmers. Education emerges as a critical factor influencing crop production, emphasizing the significance of educational interventions in enhancing farming practices and overall productivity. Furthermore, the number of children, farm size, and farming experience demonstrate positive associations with crop yields, underscoring the importance of family labor and farming knowledge in bolstering productivity. Additionally, the study identifies preferred varieties of sweet potato and cassava, offering valuable information to promote the adoption of high-yielding and resilient crops in the region. The research also sheds light on key challenges faced by farmers, including weather conditions, pest infestations, financial constraints, and production costs. To enhance agricultural resilience and productivity in the lahar-affected areas, targeted support and interventions are necessary to address these challenges effectively. Based on the findings of this study on the socio-economic determinants of legumes and root crops production in the lahar-affected areas of Zambales, Philippines, several policy recommendations can be proposed to enhance agricultural productivity and rural development.

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Introduction

Agriculture plays a crucial role in the global food system, providing sustenance for billions of people and supporting livelihoods for millions of farmers worldwide. However, agricultural productivity and food security are constantly challenged by various factors, including natural disasters, environmental changes, and socio-economic constraints. In many regions, volcanic eruptions and subsequent lahar flows pose significant threats to agricultural lands, affecting crop production and the livelihoods of farming communities.

The lahar-affected areas of Zambales, Philippines, represent one such region where farmers grapple with the aftermath of volcanic activity. These towns are located in the western part of Luzon Island, which is known for its volcanic activity. The region is home to several active and dormant volcanoes, including Mount Pinatubo, which erupted violently in 1991. The eruption of Mount Pinatubo resulted in devastating lahar flows, which are volcanic mudflows that can bury large areas of fertile land under layers of volcanic debris and sediment. The aftermath of the 1991 eruption of Mount Pinatubo had severe consequences for the agricultural sector in Zambales. Lahar flows covered vast agricultural lands, destroying crops and rendering large areas unsuitable for farming. The fertility of the soil was significantly affected, and farmers faced the daunting task of reclaiming and rehabilitating their lands to resume agricultural activities. In the years following the eruption, farmers in the lahar-affected areas have had to adapt to the new realities of farming in a post-volcanic landscape. They have had to develop innovative farming practices, such as contour farming and terracing, to prevent soil erosion and improve water retention in the volcanic soils. Additionally, farmers have had to choose crop varieties that are resilient to the challenging growing conditions presented by the volcanic aftermath.

Despite these efforts, the lahar-affected areas continue to face numerous challenges that impact crop production. The fertility of the soil remains a concern, and farmers often have to rely on fertilizers and soil amendments to improve productivity. The threat of future volcanic activity and the potential for additional lahar flows loom large, creating uncertainties and risks for farmers in the region.

The impact of volcanic eruptions on agriculture, research conducted by Gertisser *et al.* (2018) on the impact of the 1991 Mount Pinatubo eruption on soil fertility in the Philippines highlights the long-term consequences of volcanic events on agricultural lands. The study found that the eruption significantly altered the chemical composition of the soil, affecting nutrient availability and crop productivity. This supports the notion that farmers in the lahar-affected areas of Zambales face unique challenges in maintaining agricultural productivity due to the volcanic aftermath.

In the face of these challenges, there is a need for comprehensive policies and interventions to support farmers in the lahar-affected areas. Research by Heong *et al.* (2020) on sustainable agricultural practices in disaster-prone regions emphasizes the importance of building resilience among farming communities through education, training, and access to resources. This highlights the relevance of educational interventions and the significance of socio-economic factors, such as education and farming experience, in determining crop production outcomes in the context of volcanic hazards.

Addressing the socio-economic determinants of legumes and root crops production in the lahar-affected areas of Zambales is essential for developing effective policy implications. By understanding how factors like education, farm size, and farming experience influence crop yields, policymakers can tailor support measures to the specific needs of farmers in the region. Moreover, promoting the adoption of high-yielding and resilient crop varieties, as identified in the study, can contribute to enhancing agricultural productivity and food security in the face of environmental challenges.

Legumes and Root Crops in Lahar Affected Areas of Zambales

In the lahar-affected areas of Zambales, various root crops and legumes play crucial roles in agriculture and food production. Mungbean, peanuts, cassava, taro, and sweet potatoes are among the important crops cultivated in the region. Mungbean has achieved high production volumes, while peanuts are valued not only for oil production but also for their nutritional content. Cassava is gaining popularity for animal feed export and starch industry inputs, and taro serves as a staple food rich in nutrients. Sweet potatoes offer health-promoting compounds and contribute to the functional food market. This study aims to provide comprehensive data on the challenges and opportunities faced by farmers in the area, including their socio-economic profile, production practices, and marketing strategies. By understanding these aspects, targeted interventions and recommendations can be developed to enhance agricultural practices and income-generating opportunities in the region. Additionally, addressing gender issues and incorporating gender-sensitive development interventions are essential, recognizing the significant roles played by women in agriculture. The study's findings can inform the development of adaptive mechanisms and technologies to cope with climate change impacts and build resilience in agricultural practices in the lahar-affected areas of Zambales.

Objectives

The primary objective of the project is to establish benchmark information as regards the Socio-Economic Determinants of Legumes and Root Crops Production in Lahar-Affected Areas of Zambales, Philippines. It specifically aimed at: (1) describing the selected socio-economic profile of the respondents; (2) ascertain the determinants of f Legumes and Root Crops Production in Lahar-Affected Areas.

Materials and methods

Research Design

The cross-sectional research design was selected for this study to gather data from farmers producing peanut, cassava, mungbean, and legumes in Zambales, Philippines, at a specific moment in time. This design allowed the researchers to capture a snapshot of the farmers' characteristics, production practices, and marketing methods within a defined period. By collecting data from multiple respondents simultaneously, the researchers efficiently obtained a comprehensive understanding of the current situation in the target areas. One of the major advantages of the cross-sectional design is its cost-effectiveness and time-efficiency. Conducting a cross-sectional study requires data collection at a single point in time, making it more manageable compared to longitudinal studies that require follow-up visits over an extended period. Given the nature of the research objectives, which primarily focused on establishing benchmark information and identifying current practices and challenges, the cross-sectional design provided a suitable approach to achieve these goals without incurring extensive resources and time commitments. Additionally, the cross-sectional design allowed for the exploration of relationships between variables in a snapshot format. By examining data from various respondents at the same time, the researchers could identify patterns and associations between socio-economic variables and production practices. This analysis helped to determine relevant factors contributing to increased production and the efficiency of the present marketing system. However, it is essential to acknowledge the limitations of the cross-sectional design. As data are collected at a single time point, it does not provide insights into changes or developments over time. To address this limitation, complementary longitudinal studies might be required to observe trends and variations in farmers' practices and socio-economic profiles over more extended periods.

Sources of Data and Information, and Survey Questionnaire

This study utilized a survey-interview approach to collect primary data from legume and root crops farmers in the lahar-affected areas of Zambales. The survey focused on socio-economic and demographic characteristics, production systems, crops cultivated, farm sizes, production levels, inputs used, farming experience and

other relevant factors. The questionnaire was designed to gather information on the respondents' profiles, production data, marketing channels, and sales methods. Through this data collection process, the study aimed to gain insights into the farmers' practices, challenges, and opportunities in legume and root crops production in the region.

Sampling and Ethical Consideration

For this study, purposive sampling was employed to select representative participants from the specific lahar-affected areas in Zambales. The list of respondents was obtained through collaboration with Provincial Agricultural Officers and Municipal Agricultural Officers. Due to the large number of potential participants, complete enumeration was not feasible, and Slovin's formula was used to calculate the appropriate sample size, resulting in 186 farmer-respondents. Ethical considerations were prioritized, with informed consent obtained from all participants, ensuring they were fully aware of the study's purpose and their voluntary involvement. Data confidentiality and anonymity were maintained, and personal identifiers were removed from the datasets. The data collected were used exclusively for the study's purposes and were not shared with any external parties.

Data Analysis

The analysis of the data in this study involved basic descriptive statistics, such as mean, percentage, and frequency counts. These statistical tools were used to present the primary data on the respondents' profiles and other characteristics in a qualitative manner, supported by the use of tables.

Additionally, correlation and regression analysis were utilized to examine the relationships between production and independent variables, such as farm size, crops raised, input costs, and others. These analytical methods helped to identify patterns and associations that could provide valuable insights into the factors influencing crop production in the lahar-affected areas of Zambales.

Results

Socio-Demographic Profile of the Respondents

Table 1 presents the age distribution of farmer respondents in the lahar-affected areas of Zambales, Philippines, varied across different towns. The majority of respondents were in the 51 and above age group, representing 49.46% of the total sample.

This finding suggests that older farmers are actively engaged in legumes and root crops production. However, there was also a significant representation of farmers in the 21-40 age group, comprising 26.34% of the respondents, indicating that younger individuals are also involved in the farming activities.

The age range for farmers was relatively wide, spanning from 23 to 81 years, reflecting a diverse group of individuals contributing to the agricultural sector in the region. The study's insights into the age distribution of farmer respondents provide valuable information for policymakers and agricultural authorities to design targeted interventions and support measures that consider the needs and preferences of different age groups in the lahar-affected areas.

Table 1. Age Distribution of the Farmer respondents.

Age	Botolan		Cabangan		San Felipe	San Marcelino		San Narciso		Total	Percent
	Cassava	Sweet Potato	Cassava	Sweet Potato	Cassava	Cassava	Sweet Potato	Cassava	Sweet Potato		
Below 20	0	0	0	0	0	0	0	0	0	0	0.00
21 - 40	13	8	6	2	2	4	4	4	6	49	26.34
41 - 50	11	13	7	2	1	4	3	3	1	45	24.19
51 - above	9	4	10	11	4	15	11	13	15	92	49.46
Total	33	25	23	15	7	23	18	20	22	186	100.00
Range	23-61	27-64	35-70	35-69	30-69	37-62	30-70	23-80	32-81		
Average	44	48	49	53	46	52	53	52	54		

The table 2 shows the sex distribution of farmer-respondents in the lahar-affected areas of Zambales, Philippines, shows that the majority of farmers were male, constituting 95.16% of the total sample. Female farmers accounted for a smaller proportion, representing only 4.84% of the respondents. This finding highlights the prevailing gender disparity in the agricultural sector, with a significantly higher number of male farmers actively engaged in legumes and root crops production compared to their female counterparts. Addressing this gender gap is crucial to promote inclusivity and diversity in the agricultural workforce. Encouraging more women to participate in farming activities and providing them with equal access to resources, training, and support can contribute to the sustainable development of agriculture in the region.

Table 2. Sex Distribution of Farmer-respondents.

Sex	Botolan		Cabangan		San Felipe	San Marcelino		San Narciso		Total	Percent
	Cassava	Sweet Potato	Cassava	Sweet Potato	Cassava	Cassava	Sweet Potato	Cassava	Sweet Potato		
Male	31	24	23	15	7	21	16	19	21	177	95.16
Female	2	1	0	0	0	2	2	1	1	9	4.84
Total	33	25	23	15	7	23	18	20	22	186	100.00

As show in the Table 3, the educational attainment of farmer respondents in the lahar-affected areas of Zambales, Philippines, varied across different towns. The majority of respondents had attained either elementary graduate (32.80%) or high school graduate (30.65%) levels of education. Notably, a significant proportion of farmers (8.06%) had completed elementary education but did not pursue higher levels of schooling. The study also found that a small percentage of respondents (11.83%) were college graduates, while an even smaller number (2.69%) were college undergraduates. This diversity in educational backgrounds suggests that formal education is not a strict requirement for engaging in legumes and root crops farming. However, efforts to promote agricultural training and extension programs could enhance farmers' knowledge and skills, contributing to improved farming practices and productivity in the region.

Table 3. Educational attainment of farmer-respondents.

Educational Attainment	Botolan		Cabangan		San Felipe	San Marcelino		San Narciso		Total	Percent
	Cassava	Sweet Potato	Cassava	Sweet Potato	Cassava	Cassava	Sweet Potato	Cassava	Sweet Potato		
Elem undergrad	3	2	7	3	0	0	0	0	0	15	8.06
Elem graduate	16	6	4	7	3	6	3	9	7	61	32.80
HS undergrad	2	4	6	0	0	0	0	0	0	12	6.45
HS graduate	8	9	4	4	3	9	7	6	7	57	30.65
College undergrad	1	1	1	1	1	0	0	0	0	5	2.69
College graduate	3	0	1	0	0	4	5	4	5	22	11.83
Vocational	0	3	0	0	0	4	3	1	3	14	7.53
Total	33	25	23	15	7	23	18	20	22	186	100.00

Showing in Table 4, the farm size ownership of farmer-respondents in the lahar-affected areas of Zambales, Philippines, revealed a diverse distribution of landholdings. The majority of farmers (44.05%) owned farms ranging from 0.6 to 1.5 hectares. Specifically, 26.34% of respondents owned farms between 0.6 and 1.0 hectares, and 20.97% owned farms from 1.1 to 1.5 hectares.

Additionally, 16.67% of farmers had farm sizes ranging from 1.6 to 2.0 hectares. On the other hand, smaller landholdings were less common, with 17.74% of respondents having farms below 0.5 hectares, and only 0.54% owning farms between 2.1 and 2.5 hectares. Farms larger than 2.5 hectares were held by 17.74% of the farmer-respondents. The average farm size was approximately 1.18 hectares.

The distribution of farm sizes highlights the need for targeted support and interventions tailored to the different categories of landowners. Smaller landholders may benefit from programs aimed at increasing land productivity and resource management, while larger landholders may require support in scaling up their agricultural operations and improving market linkages.

Table 4. Farm size ownership of farmer-respondents.

Farm Size (has.)	Botolan		Cabangan		San Felipe	San Marcelino		San Narciso		Total	Percent
	Cassava	Sweet Potato	Cassava	Sweet Potato	Cassava	Cassava	Sweet Potato	Cassava	Sweet Potato		
Below 0.5	0	0	0	0	3	7	7	8	8	33	17.74
0.6 - 1.0	5	4	9	4	0	6	7	7	7	49	26.34
1.1 - 1.5	6	4	6	4	2	9	2	3	3	39	20.97
1.6 - 2.0	11	6	4	4	1	1	1	1	2	31	16.67
2.1 - 2.5	0	1	0	0	0	0	0	0	0	1	0.54
2.6 and above	11	10	4	3	1	0	1	1	2	33	17.74
Total	33	25	23	15	7	23	18	20	22	186	100.00
Average	2.2	2.26	2.15	2.19	1.35	1.01	1.05	1.18	1		

In Table 5, the farming experience of farmer-respondents in the lahar-affected areas of Zambales, Philippines, varied significantly among different individuals. The majority of farmers (26.34%) had farming experience of 26 years and above, indicating a group of seasoned farmers with extensive knowledge and expertise in agricultural practices. Similarly, 24.19% of respondents had farming experience ranging from 6 to 10 years, while another 24.19% had experience below 5 years. These groups represent farmers with diverse levels of experience, including both newcomers and those with a few years of experience. On the other hand, 10.22% of respondents had farming

experience between 11 and 15 years, while 10.75% had experience ranging from 16 to 20 years. These mid-range experienced farmers may be at a critical point in their farming careers where additional support and training can significantly enhance their productivity. A smaller percentage of respondents (4.30%) had farming experience ranging from 21 to 25 years, reflecting a group of farmers with relatively moderate experience. Understanding the distribution of farming experience among the respondents can aid in designing targeted capacity-building programs and mentoring initiatives to support farmers at different stages of their agricultural journey.

Table 5. Farming Experience of farmer-respondents.

Range (years)	Botolan		Cabangan		San Felipe	San Marcelino		San Narciso		Total	Percent
	Cassava	Sweet Potato	Cassava	Sweet Potato	Cassava	Cassava	Sweet Potato	Cassava	Sweet Potato		
Below 5	1	4	3	2	2	7	8	8	10	45	24.19
6 - 10	5	9	4	2	3	6	4	6	6	45	24.19
11 - 15	5	1	6	2	0	4	1	0	0	19	10.22
16 - 20	5	4	2	4	0	2	1	1	1	20	10.75
21 - 25	3	1	0	0	0	2	2	0	0	8	4.30
26 above	14	6	8	5	2	2	2	5	5	49	26.34
Total	33	25	23	15	7	23	18	20	22	186	100.00

The variety of cassava and sweet potato used by farmer-respondents in the lahar-affected areas of Zambales, Philippines in Table 6, revealed interesting patterns in crop preferences. Among the respondents, two main varieties of sweet potato were identified: Bureau and Super Taiwan. Super Taiwan was the more popular choice, accounting for 66.25% of the sweet potato variety used by farmers, while Bureau constituted 33.75%. This finding suggests that Super Taiwan is favored by a significant majority of farmers, potentially due to its desirable traits such as high yield and adaptability. On the other hand, the main varieties of cassava used were Lakan 2, Pinusuan, and Matabia. Lakan 2 was the most widely adopted variety, representing 75.47% of cassava plantings, while Pinusuan and Matabia constituted 17.92% and 6.60%, respectively. These findings indicate that Lakan 2 is the preferred cassava variety among farmers, possibly due to its high yield potential and resilience to the challenging growing conditions in the lahar-affected areas. Understanding the preferences for specific crop varieties can help agricultural extension agencies and seed companies in providing targeted support and promoting the adoption of high-yielding and resilient varieties to enhance crop productivity in the region.

Table 6. Variety of Cassava and sweet potato of farmer-respondents.

Variety	Botolan		Cabangan		San Felipe	San Marcelino		San Narciso		Total	Percent
	Cassava	Sweet Potato	Cassava	Sweet Potato	Cassava	Cassava	Sweet Potato	Cassava	Sweet Potato		
Bureau	0	5	0	7	0	0	7	0	8	27	33.75
Super Taiwan	0	20	0	8	0	0	11	0	14	53	66.25
Total	0	25	0	15	0	0	18	0	22	80	100.00
Pinusuan	3	0	5	0	0	7	0	4	0	19	17.92
Matabia	7	0	0	0	0	0	0	0	0	7	6.60
Lakan 2	23	0	18	0	7	16	0	16	0	80	75.47
Total	33	0	23	0	7	23	0	20	0	106	100.00

The problems encountered by farmer-respondents in the lahar-affected areas of Zambales, Philippines showed in Table 7, provide valuable insights into the challenges faced by the agricultural community. The most prevalent issue reported by farmers was weather conditions, affecting 34.38% of the respondents. The region's weather, including unpredictable rainfall and extreme events, poses significant risks to crop production and can lead to reduced yields and financial losses. Pest and insect infestations were also a major concern, impacting 25.98% of respondents. Controlling pests and diseases is crucial to ensure crop health and productivity.

Financial challenges were reported by 9.77% of farmers, highlighting the need for improved access to credit and financial support to address funding constraints in agriculture. Theft of products was a concern for 7.42% of respondents, emphasizing the need for security measures in farming areas. High production costs were reported by 10.74% of farmers, underscoring the importance of optimizing production practices and exploring cost-efficient techniques. The issue of growing weeds was identified by 6.64% of respondents, indicating the necessity for weed management strategies to avoid competition with crops for nutrients and resources. Lastly, unproductive seeds were a problem for 5.08% of farmers, signaling the importance of using high-quality and certified seeds to enhance crop performance. Understanding the key challenges faced by farmers is crucial for policymakers and agricultural stakeholders to develop targeted interventions and support systems that can help address these issues and enhance the productivity and resilience of farming communities in the lahar-affected regions.

Table 7. Problems Encountered.

Problems Encountered	Botolan		Cabangan		San Felipe	San Marcelino		San Narciso		Total	Percent
	Cassava	Sweet Potato	Cassava	Sweet Potato	Cassava	Cassava	Sweet Potato	Cassava	Sweet Potato		
Weather Condition	33	20	22	15	7	23	18	20	18	176	34.38
Pest/Insect	23	5	20	10	7	20	15	16	17	133	25.98
Financial	2	2	5	8	5	10	2	6	10	50	9.77
Stealing of products	5	8	4	4	0	8	5	3	1	38	7.42
High Cost of Production	6	7	11	1	3	5	6	7	9	55	10.74
Growing of weeds	7	4	7	5	5	0	0	5	1	34	6.64
Unproductive seeds	0	3	0	5	0	0	12	0	6	26	5.08
Total	76	49	69	48	27	66	58	57	62	512	100

Socio-Economic Determinants of Legumes and Root Crops Production

The table 8 presents the results of the statistical analysis on the socio-economic determinants of legumes and root crops production, specifically focusing on cassava and sweet potato. The coefficients represent the percentage increase in production associated with each predictor variable. For cassava production, age was found to have a positive coefficient of 1.65%. This suggests that as farmers' age increases, cassava production also tends to increase by approximately 1.65%. This could be attributed to the accumulation of knowledge and experience in farming practices among older farmers, leading to improved productivity. Education showed a significant positive coefficient of 19.81%. This indicates that farmers with higher levels of education tend to have a 19.81% higher cassava production compared to those with lower education levels. Education equips farmers with better agricultural practices, management skills, and access to information, contributing to increooased yields. The number of children had a positive coefficient of 12.43%. This implies that as the number of children in the family increases, cassava production also tends to increase by 12.43%. This might be attributed to the additional labor and support provided by family members, allowing farmers to manage larger farm areas and boost production. Farm size had a positive coefficient of 8.28%. This indicates that as the farm size increases, cassava production tends to increase

by 8.28%. Larger farm areas provide more opportunities for diversification and investment, leading to enhanced output. Farming experience had a positive coefficient of 1.42%.

This suggests that with each additional year of farming experience, cassava production tends to increase by approximately 1.42%. Experience in farming brings improved understanding of local conditions, better decision-making, and efficient resource management, contributing to higher yields.

Table 14. Socio-economic Factors affecting Increased Production.

Predictors	Cassava (R^2 = 40%)	Sweet potato (R^2 = 56%)
	Coefficients (%)	Coefficients (%)
Age	1.65	1.22
Education	19.81	16.11
Children	12.43	7.59
Farm size	8.28	5.69
Farming experience	1.42	1.23

For sweet potato production, similar patterns were observed. Age had a positive coefficient of 1.22%, indicating a slight increase in production with increasing age. Education had a significant positive coefficient of 16.11%, emphasizing the role of education in enhancing sweet potato yields. The number of children, farm size, and farming experience also had positive coefficients, indicating their impact on sweet potato production.

Discussion

The results of the statistical analysis provide valuable insights into the socio-economic determinants of legumes and root crops production, particularly focusing on cassava and sweet potato. The positive coefficients for age in both cassava and sweet potato production suggest that as farmers grow older; their crop yields tend to increase. This finding is consistent with the notion that older farmers accumulate valuable knowledge and experience over time, leading to improved farming practices and productivity. Older farmers may have honed their skills in managing weather-related risks and pest infestations, contributing to better crop performance. Education emerges as a significant predictor for increased cassava and sweet potato production. Farmers with higher levels of education have notably higher crop yields. This finding is in line with previous research that emphasizes the importance of education in agriculture. Educated farmers are more likely to adopt modern agricultural techniques, optimize resource management, and access crucial information through agricultural extension services and research. Education equips farmers with the skills to tackle challenges more effectively, contributing to increased productivity. The positive association between the number of children in the family and cassava and sweet potato production indicates that larger families tend to have higher crop yields.

This can be attributed to the additional labor and support provided by family members. In regions where family labor plays a crucial role in farming activities, having more children can lead to increase agricultural output as more hands are available to work on the farm. Farm size also emerges as a significant determinant of cassava and sweet potato production. Larger farm areas provide more opportunities for diversification and investment. Farmers with larger landholdings may have the capacity to grow different crops, engage in intercropping practices, or adopt agroforestry techniques, contributing to enhanced output and improved resilience in the face of climate variability. Farming experience, as expected, positively influences

cassava and sweet potato production. With each additional year of farming experience, farmers tend to achieve higher yields. Experience enables farmers to make better decisions, tailor their practices to local conditions, and efficiently manage resources. This finding underscores the importance of continuous learning and capacity-building initiatives for both new and experienced farmers to enhance their agricultural skills and knowledge.

The findings of this study align with prior research on the socio-economic determinants of crop production. Several studies have highlighted the positive impact of education on agricultural productivity (e.g., Jayne *et al.*, 2018; Asfaw *et al.*, 2019). Education equips farmers with improved management practices and enhances their ability to adopt innovations, ultimately leading to higher yields. The positive relationship between farming experience and crop productivity is consistent with earlier studies that have emphasized the role of experience in improving farming outcomes (e.g., Adeoti *et al.*, 2017; Deininger *et al.*, 2019). Experienced farmers are better equipped to adapt to changing conditions and navigate various challenges, resulting in increased productivity.

The positive impact of farm size on crop production is also supported by existing literature (e.g., Barrett *et al.*, 2012; Doss *et al.*, 2014). Larger farm areas provide scope for diversification and investment, enabling farmers to optimize resource use and increase their overall output. Furthermore, the finding that family labor, as represented by the number of children, positively influences crop production is in line with research highlighting the importance of family support in agriculture (e.g., Otsuka *et al.*, 2017; Bellemare *et al.*, 2020). Family labor contributes significantly to farm activities, especially during peak seasons, and can be a critical determinant of farm productivity. The results of this study emphasize the significance of age, education, family labor, farm size, and farming experience as key socio-economic determinants affecting legumes and root crops production. Policymakers and agricultural authorities should consider these factors when

designing targeted interventions and support measures to enhance crop productivity and improve the livelihoods of farmers in lahar-affected areas. Moreover, the findings align with existing literature, reinforcing the importance of education, capacity-building programs, and family support in promoting sustainable agriculture and rural development.

Conclusion

This study examined the socio-economic determinants of legumes and root crops production in the lahar-affected areas of Zambales, Philippines, with a specific focus on cassava and sweet potato. The findings revealed valuable insights into the demographic profile and farming characteristics of the respondents. Older farmers were actively engaged in agricultural activities, but there was also significant representation from younger individuals. However, a gender disparity was evident, with a higher proportion of male farmers compared to female farmers. Education emerged as a significant predictor of increased crop production, highlighting the importance of educational interventions to enhance farming practices and productivity. The number of children, farm size, and farming experience also had positive associations with crop yields, emphasizing the role of family labor and farming knowledge in improving productivity. The study identified the preferred varieties of sweet potato and cassava, providing useful information for promoting the adoption of high-yielding and resilient crops in the region. The study also highlighted the key challenges faced by farmers, including weather conditions, pests, financial constraints, and production costs. Addressing these challenges through targeted support and interventions is essential for improving the resilience and productivity of the agricultural sector in the lahar-affected areas.

Recommendations

Based on the findings of this study on the socio-economic determinants of legumes and root crops production in the lahar-affected areas of Zambales, Philippines, several policy recommendations can be proposed to enhance agricultural productivity and rural development: (1) The government should invest in agricultural education and training programs to equip farmers with modern and sustainable farming practices. This can include providing workshops, seminars, and access to agricultural extension services to improve farmers' knowledge and skills in crop management, pest control, and resource optimization; (2) To promote inclusivity and diversity in the agricultural workforce, initiatives should be implemented to encourage more women to engage in farming activities. This can be achieved through targeted programs that provide women with equal access to resources, credit facilities, and training opportunities; (3) Smallholder farmers with smaller landholdings should be given special attention and support. The government can introduce policies to provide them with access to credit, affordable inputs, and market linkages to improve their productivity and income; (4) The promotion of diverse crop varieties, including high-yielding and resilient ones, can help farmers mitigate the risks associated with weather variability and pest infestations. Government initiatives should focus on providing farmers with improved seed varieties and technical support for crop diversification; (5) Given the impact of weather conditions on crop production, the government should invest in weather monitoring and early warning systems to help farmers make informed decisions. Additionally, the development of climate-resilient agricultural practices and infrastructure can help farmers adapt to changing weather patterns; (6) To address financial constraints faced by farmers, the government can establish credit facilities and subsidy programs to provide affordable loans and inputs. This will enable farmers to invest in improved technologies and practices; (7) Implementing integrated pest management strategies can help control pest and disease outbreaks effectively. The government can collaborate with agricultural research institutions to develop and disseminate pest-resistant crop varieties and organic pest control methods; (8) Supporting and strengthening farmer organizations can enhance farmers' collective bargaining power, access to information, and market opportunities.

This can lead to better representation of farmers' interests and increased collaboration among stakeholders and (9) The government should invest in rural infrastructure development, such as irrigation systems and farm-to-market roads, to improve farmers' access to resources and markets.

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