Volume 1 | Issue 2 | Jul - Dec 2023
ISSN: 2984-9969

Geospatial Assessment on the Distribution and Level of Mechanization in Pamplona, Cagayan, Philippines

John Paul B. Malicdem
johnjohncahero12@gmail.com
Michelle Lyza J. Mogado
Marvin D. Adorio
Cagayan State University – Sanchez Mira Campus
Centro II, Sanchez Mira 3518, Cagayan, Philippines

ABTRACT

This study developed a GIS-based approach for the spatial distribution and level of mechanization in crop production and post-production operations in the Municipality of Pamplona, Cagayan Province. The assessment of the mechanization level for different farming operations on crops such as rice, corn, and high-value crops (banana, cacao, cassava, citrus, coconut, mango, pineapple, lesser yam, watermelon, and vegetables) was conducted using the Modified Agricultural Mechanization Index (MAMI) and Sufficiency Level. Two map layers were used, and the corresponding sufficiency levels of each of the farm operations were entered in the attribute table. The average farm holding for rice is 1.73 hectares and 1.71 hectares for corn, while for high-value crops, coconut records the highest average farm holding area of 1.3 hectares. Results showed that the utilization of four- wheel and two-wheel tractors for land preparation, knapsack sprayers for spraying, water pumps for irrigation, and combine harvesters for harvesting and threshing contributes to a high mechanization level for rice and corn production with a sufficiency level of 65.21% and 59.64%, respectively. For high-value crops, it was noted that farmers generally employed manual labor in performing farm operations, which resulted in a low level of mechanization except for vegetable and watermelon productions with a low to intermediate mechanization level. In addition, most farmers hire machines for hauling and transporting harvested crops and often practice sun drying. The results of the study offer baseline data and serve as a basis for policymaking regarding the mechanization program of LGU-Pamplona.

Keywords: *Mechanization, Spatial Distribution, Farm Operations, Sufficiency Level*

INTRODUCTION

The Philippines, characterized as an archipelago with an agricultural-based economy, exhibits a combination of small, medium, and large farms. However, the country's level of mechanization remains low, attributed to various factors such as farmers' limited purchasing power, abundant rural labor, small landholdings per farmer, high machinery costs, and unfavorable government policies toward agricultural mechanization (Bautista et al., 2017). The predominant use of manual technology is evident in planting, weeding, fertilizer application, spraying, and harvesting in rice and corn farming, while machinery utilization is primarily observed in land preparation, shelling, and threshing processes.

In November 2020, rice farmers in Cagayan Province received machinery grants worth Php199.5 million under the Rice Competitiveness Enhancement Fund Mechanization Program. The distributed machinery consisted of various equipment such as tractors, tillers, planters, harvesters, dryers, and mills. These grants covered 28 municipalities and 1 city in the province.

The Municipality of Pamplona, classified as a 4th class municipality in Cagayan, boasts abundant land suitable for agriculture, with primarily flat terrain and some forested mountains and hilly areas. Agriculture serves as a major livelihood in the municipality, and an ordinance has been enacted to register ownership of agricultural and fishery machinery and equipment. This registration requirement applies to individual owners, registered farmer cooperatives, associations, and private entities involved in crop, livestock, and fisheries production, as well as related activities. Furthermore, the municipality's Taxation Code includes a one-time registration fee for agricultural and farm machinery, payable upon equipment acquisition.

Farm mechanization entails the application of engineering and technology to agricultural operations, aiming to enhance productivity through the development, application, and management of mechanical aids for various tasks such as field production, water control, material handling, storage, and processing. The use of machines in agriculture has been recognized as an essential input to increase labor productivity, reduce drudgery, improve timeliness, maintain quality, and minimize post- harvest losses.

Objectives of the Study

Mapping agricultural mechanization levels goes beyond mere determination and aims to create a spatial database that can be periodically updated with a wide range of data, enabling precise evaluation, modeling, and traceability for decision-makers. This will provide reliable scientific support in developing the agricultural structure and farming systems of the municipality. Both the government and private investors must carefully plan and make reasonable assumptions when selecting production areas for mechanization interventions. To aid in this decision- making process, a Geographic Information System (GIS)-based model is being developed as a decision- support framework to identify the most suitable locations for mechanization projects. The outcomes of this study will serve as guidelines for determining machinery placement in the area.

MATERIALS AND METHODS

Research Design

This study employed a cross-sectional research design to assess the Sufficiency Level and Mechanization Level in the Municipality of Pamplona, Cagayan Province.

Sampling Technique

The data for this research were collected using a questionnaire administered to farmers in the Municipality of Pamplona, Cagayan. A systematic random sampling method was employed to select the respondents from the farming population.

Locale of the Study

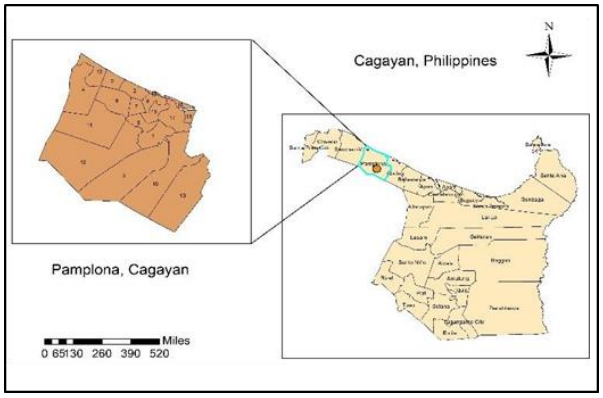

Fig.1. Location map of the study area.

Figure 1 shows the area (Municipality of Pamplona, Cagayan Province) under study which is located at 18°25'35.93" N and 121°19'52.64" E in the island of Luzon. The study area has a total land area of 7,949.40 hectares for agriculture which constitutes around 35.55% percent of the total land area of the Municipality. It is bounded on the east by the Municipality of Abulug, the Municipality of Sanchez in Mira in the west, the Babuyan group of Islands and the Balintang channel on the north, and the Municipality of Luna in the Province of Apayao in the south.

Research Instruments

Data were collected using a structured questionnaire designed to gather information on farming practices, machinery, and power sources used in agriculture.

Data Gathering Procedure

The data was obtained through the questionnaire for the farmers in the Municipality of Pamplona, Cagayan, and the determination of Sufficiency and Level of Mechanization per farm operation are determined by the following equations.

1. ***Sufficiency Level and Mechanization Level* (UPLB-BIOMEC)**

$$Sufficiency\ Level = \frac{Actual\ Area}{A_T} X\ 100$$

where:
Sufficiency Level = %
Actual Area = area covered for one cropping season (ha)
AT = total area (ha)

2. ***Modified Agricultural Mechanization Index for each operation (Rodriguez et al., 2013)***

$$MAMI = \frac{(Pmachine/\ Panimal) + (No.\ operator\ x\ Pman)}{\sum AT}$$

where:
MAMI = MAMI contribution per operation (hp/ha)
Pmachine or Panimal = power rating of machine or animal (hp)
= 1hp (animal) Pman = power rating of human (hp)
= 0.10 hp (male)
= 0.075 hp (female) AT = total area covered (ha)

On the other hand, the determination of the mechanization level was based on Table 1.

Table 1. Combination Analysis of Sufficiency Level and Modified Agricultural Mechanization Index for mechanization level of the farming operation. (PCAARD,2009)

Mechanization Level	Range	Code
Low	0-30 % / 0-0.25 hp/ha	LML
Low to Intermediate	31-60 % / 0.31-0.60 hp/ha	LIML
Intermediate to High	61-90 % / 0.61-1.00 hp/ha	IHML
High	91-100 % / 1.01 hp/ha and above	HML

Analysis of the Data/ Statistical treatment

The data collected were analyzed by reclassifying the sufficiency levels of each farming operation according to the categories defined in Table 1.0. The reclassified data were then visualized using Geographic Information System (GIS) software, utilizing base maps obtained from diva-gis.org/Data. Each category was assigned a unique color for visual representation, and the final map was exported in image format for presentation and analysis.

RESULTS AND DISCUSSION

Profile of the Respondents

Most respondents are men between the ages of 35 and 69, except for cacao, cassava, and citrus cultivation, where females are most recorded. The average farm holding area for rice is 1.73 ha. and 1.71 ha. for corn while for high-value crops, coconut records the highest average farm holding area of 1.3 ha and lesser yam records the lowest with an area of 0.25 ha. The highest average annual income of the farmer respondent is ₱60,000.00 for corn production while about ₱43, 000.00 for rice. On the other hand, watermelon and coconut recorded the two highest annual average incomes of ₱50,000.00 and, ₱13,000.00, respectively for high-value crops.

Machinery and Farm Equipment Used

Rice and Corn

Table 2. Land Preparation.

Machine and Equipment	No. of Farmer/ User	
	RICE	CORN
Moldboard Plow	11	28
Bolo/Tabas	9	34
Walking-Type Ag. Tractor	366	82
Four–Wheel Drive Tractor	288	152
Total	**674**	**296**

The data collected in this study provides insights into the machinery and equipment utilized by rice and corn farmers for land preparation. Common machines and tools such as moldboard plows, bolos/tabas, walking-type agricultural tractors, and four-wheel agricultural tractors (as depicted in Table 2) are employed for this operation.

Table 3. Crop Establishment for Corn.

Machine and Equipment	No. of Farmer/ User
Hand-held Corn Planter	502
Dibber	311
Corn Seeder	56
Total	**869**

In terms of crop establishment, rice farmers predominantly rely on traditional methods. These include manual pulling of rice seedlings, manual transplanting, and broadcasting of rice seeds. However, mechanical corn seeders were utilized to some extent, although the majority of corn farmers utilize hand-held corn planters (inpaltog) and dibbers, as indicated in Table 3.

Table 4. Irrigation and Spraying

Machine and Equipment	No. of Farmer/ User	
	RICE	CORN
Pump and Engine	268	67
Lever-Operated Knapsack Sprayer	278	142
Electric Knapsack Sprayer	102	86
Total	**657**	**295**

Table 5. Harvesting and Threshing

Machine and Equipment	No. of Farmer/ User	
	RICE	CORN
Sickle/Scythe	661	-
Thresher/Sheller	61	69
Combine Harvester	308	116
Total	**369**	**185**

For irrigation purposes, farmers utilize pump and engine units, while chemical applications are performed using lever-operated and electric knapsack sprayers, as shown in Table 4. The harvesting and threshing techniques employed in the area follow conventional practices. Manual harvesting of rice using sickles/scythes is the most prevalent method, often combined with the use of rice threshers and corn shellers for threshing, although the usage of rice and corn combine harvesters were also recorded (Table 5).

Regarding drying methods, sun drying remains the primary approach employed by most farmers in the municipality. The survey revealed the absence of mechanical dryers as an alternative drying method in the study area. Additionally, some farmers reported that they only dry a portion of their harvested rice, as the majority is sold immediately after harvest. The use of cono-type milling machines with varying power ratings was recorded as the prevalent practice for rice milling in the study area.

High-Value Crops (Banana, Cacao, Cassava, Citrus, Coconut, Lesser Yam, Mango, Pineapple, Vegetables, and Watermelon)

In general, these high-value commodities share common tools for land preparation, crop establishment, crop care, and maintenance and harvesting. Data indicates that, of the seven high- value commodities identified, bolos and tabas were utilized the most in land preparation. Also, it was observed that these tools were used for cacao, and lesser yam crop establishment, cacao, cassava, citrus, pineapple, and lesser yam crop care and maintenance, and pineapple harvesting. In addition, bolo and tabas were observed in each of the identified agricultural operations in producing bananas.

Table 6. Crop Establishment Equipment for Coconut

Machine and Equipment	No. of Farmer/ User
Auger Drill	1
Shovel	412
Crowbar	462
Total	**875**

Table 7. Crop Care and Maintenance for Coconut

Machine and Equipment	No. of Farmer/ User
Grass Cutter	21
Lever Operated Knapsack Sprayer	40
Electric Sprayer	16
Total	**77**

For coconut cultivation, it has been observed that coconut growers adopt zero-tillage practices. When it comes to planting coconut trees, coconut growers still prefer the traditional method, utilizing crowbars and shovels (as presented in Table 6). The study area does not exhibit a practice of irrigating coconut trees. Instead, coconut growers rely on rainfall as their primary source of irrigation. However, weed management techniques, as indicated in Table 7, demonstrate the use of various equipment such as lever-operated or electric knapsack sprayers and grasscutters. These tools are employed for effective weed control. During the harvesting process, survey results indicate that farmers employ bamboo poles and spike shoes to collect coconut fruits. Post-harvest operations encompass de-husking, deshelling, peeling, grinding, oil or milk extraction, filtering, drying, packing, and hauling. Although machinery is available, farmers claim that its usage is limited to household purposes and that all post-harvest operations are conducted manually. Hauling and transportation methods vary among farmers, depending on the physical area of their farms. Farms that are not directly accessible by trucks resort to the manual practice of carrying coconut fruits.

In Barangay Masi, a watermelon farmer employs a four-wheel drive tractor for land preparation, while the transplanting of seedlings is carried out manually. The farmer utilizes pumps for irrigation purposes and utilizes two lever-operated knapsack sprayers for weed and pest control, as documented in the

data. The harvesting of watermelons is done manually by the grower. As for post-harvest operations, the survey results indicate that watermelon growers in the study area do not engage in processing their produce. Instead, watermelons are promptly sold after harvest. Since the farming area is surrounded by a river, watermelons are manually collected and placed alongside the river for subsequent hauling. The transportation is facilitated by boats and/or tractors.

Table 8. Land Preparation for Vegetables

Machine and Equipment	No. of Farmer/ User
Bolo/Tabas	26
Moldboard Plow	15
Walking Type Ag. Tractor	12
Four-Wheel Drive Tractors	14
Total	**67**

Table 8 illustrates the machinery and equipment employed by vegetable growers for land preparation. Manual tools such as bolos/tabas are utilized for the manual cutting and clearing of vegetation. Moreover, walking-type agricultural tractors and 4-wheel drive tractors equipped with implements are utilized to perform soil tillage operations.

Table 9. Crop Care and Maintenance

Machine and Equipment	No. of Farmer/ User
Pump and Engine	11
Lever Operated Knapsack Sprayer	15
Electric Sprayer	13
Total	**39**

Growers rely on manual methods like direct seeding and transplanting for crop establishment. However, for irrigation and spraying activities, pumps and engines are predominantly used by most farmers for irrigation purposes. Sprayers, on the other hand, are employed for fertilizer application, pest management, and weed control (as indicated in Table 9). Harvesting activities in the municipality of Pamplona, among all the barangays, solely involve manual picking for vegetable growers. No mechanical operations have been recorded in this aspect. Due to limited accessibility to machinery and equipment for post-harvest operations, manual labor remains the primary method employed.

It should be noted, however, that the bitter gourds cultivated in the study area are specifically intended for seed production in collaboration with a private company. After the vegetable growers have dried the bitter gourd seeds to achieve the desired moisture level, the partner institution collects them. The transportation of most vegetables is carried out manually.

MAPPING OF THE TOTAL FARM AREA AND AVERAGE ANNUAL NET INCOME OF IDENTIFIED FARMERS IN PAMPLONA, CAGAYAN, PHILIPPINES

Rice

The spatial distribution map presented in Figure 2 depicts the farm areas and annual net income associated with rice cultivation. Most rice farmers cultivate farmland that is below 25 hectares and generate an annual net income lower than 1.6 million pesos. However, in barangays Bagu, Curva, and Sta. Cruz, rice cultivation encompasses larger land areas of 78 hectares and above, resulting in an annual net income exceeding 1.6 million pesos. It is worth noting that rice cultivation is not prevalent in barangay Nagtupacan, which is situated along the coast and primarily focuses on fishing activities.

Corn

The study findings reveal that the predominant cultivable area within the municipality

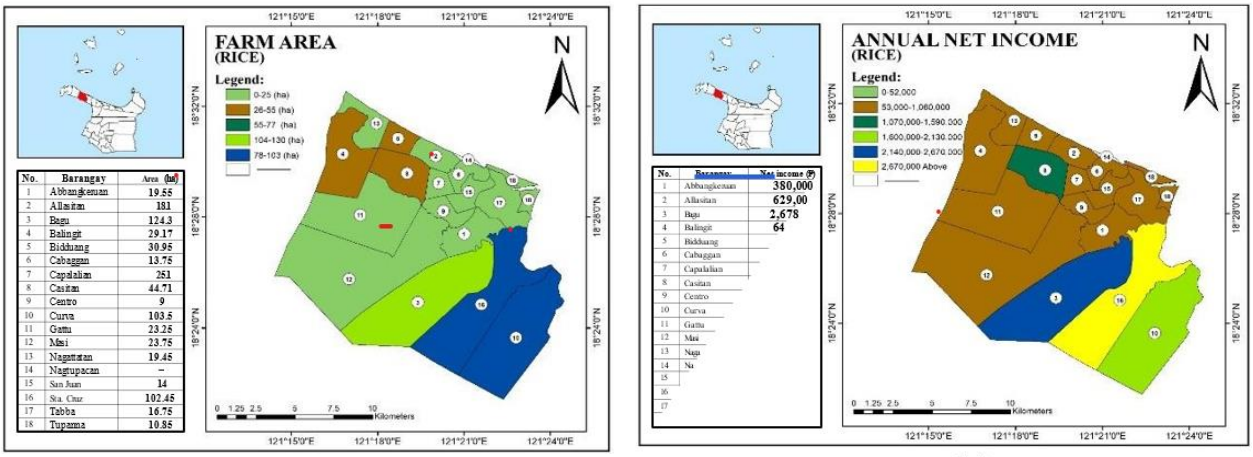

Fig. 2. Spatial distribution of total farm area (a) and annual net income (b) of Rice in Pamplona, Cagayan.

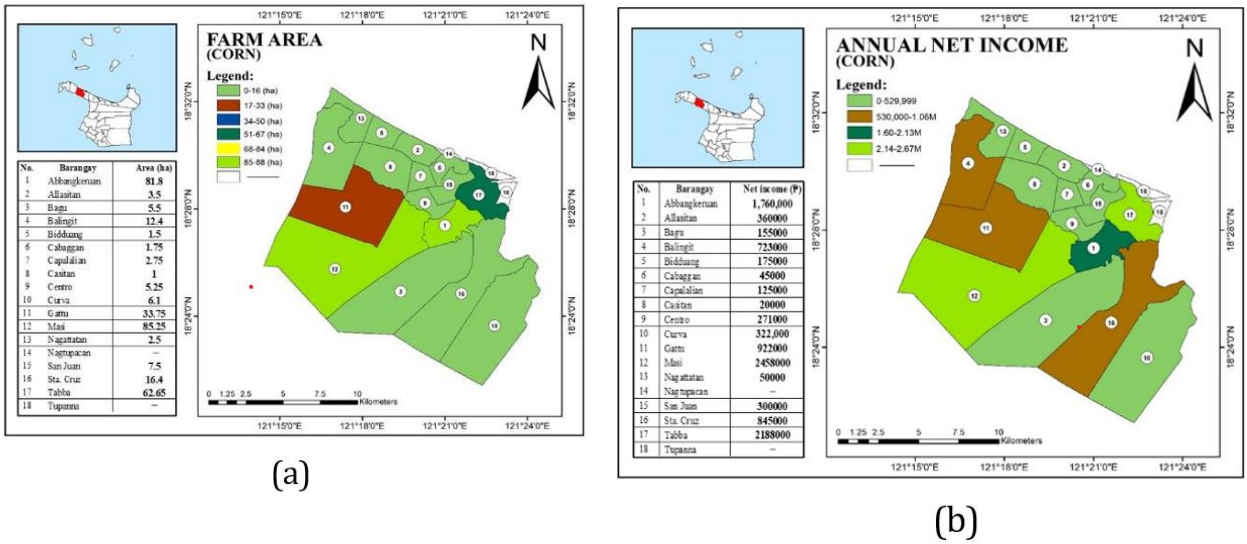

Fig. 3. Spatial distribution of total farm area (a) and annual net income (b) of Corn in Pamplona, Cagayan.

measures less than 16 hectares, mainly due to the limited availability of suitable land for corn cultivation. However, there exists a specific area, spanning between 85 and 88 hectares, situated in barangay Masi and Tabba, which represents the largest cultivated area for corn. This particular region generates an annual net income of approximately 2.67 million pesos. Additionally, barangay Abbangkeruan yields an annual net income ranging from 1.60 to 2.13 million pesos while Santa Cruz, Balingit, and Gattu, earn an annual net income ranging from 53,000 to 1.06 million pesos. These income figures correspond to farm areas measuring less than 33 hectares. Detailed graphical representations of these findings are provided in Figure 3.

High-Value Crops (Banana, Cacao, Cassava, Citrus, Coconut Mango, Pineapple, and Lesser Yam, Vegetables, and Watermelon)

The cultivation of high-value crops was examined in terms of farm areas and recorded annual net incomes. Pineapple emerged as the crop with the largest cultivated area, spanning

12 hectares, and generating an annual net income of ₱320,000.00. Similarly, bananas exhibited a maximum cultivation area of 11 hectares, yielding an annual net income exceeding
₱116,000.00. Other high-value crops were cultivated in smaller areas, typically 4 hectares or less, resulting in incomes of ₱50,000.00 or lower. Spatial distribution maps depicting the distribution of these crops are provided in Figures 4 to 11.

Coconut cultivation was observed across the barangays of Pamplona, except Nagtupacan. Among the recorded data, Bagu records the largest cultivated area of approximately 109.85 hectares, while Tabba attains the highest net income, exceeding 2 million pesos annually. Other barangays cultivating coconuts on areas below 87 hectares exhibit annual net incomes of approximately ₱425,999.00 or lower, potentially attributed to most coconut trees not yet bearing fruits. The spatial distribution map illustrating these findings can be found in Figure 11

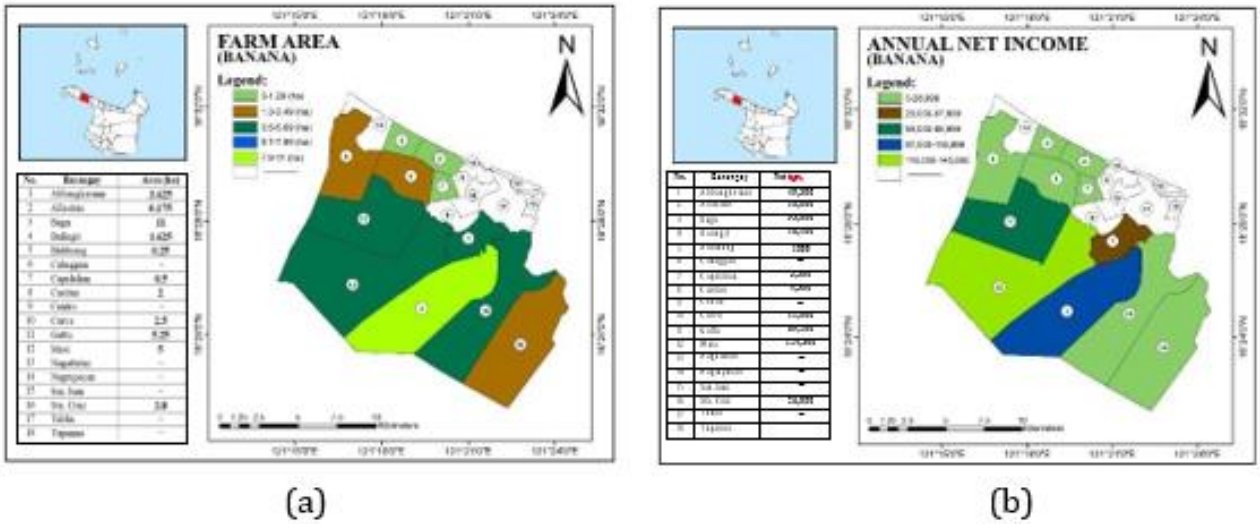

Fig. 4. Spatial distribution of total farm area (a) and annual net income (b) of Banana in Pamplona, Cagayan.

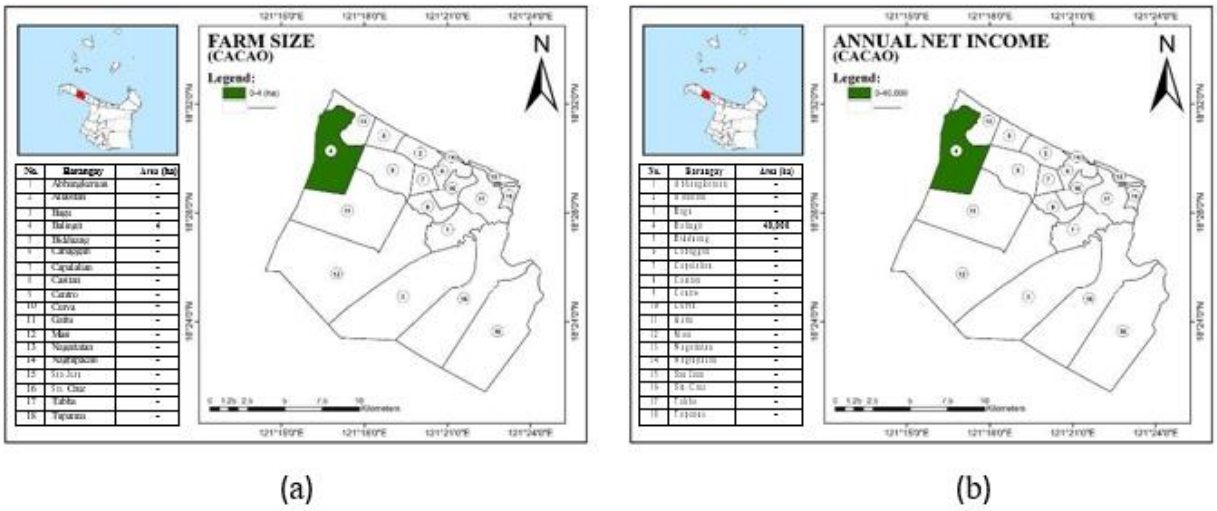

Fig. 4. Spatial distribution of total farm area (a) and annual net income (b) of Banana in Pamplona, Cagayan.

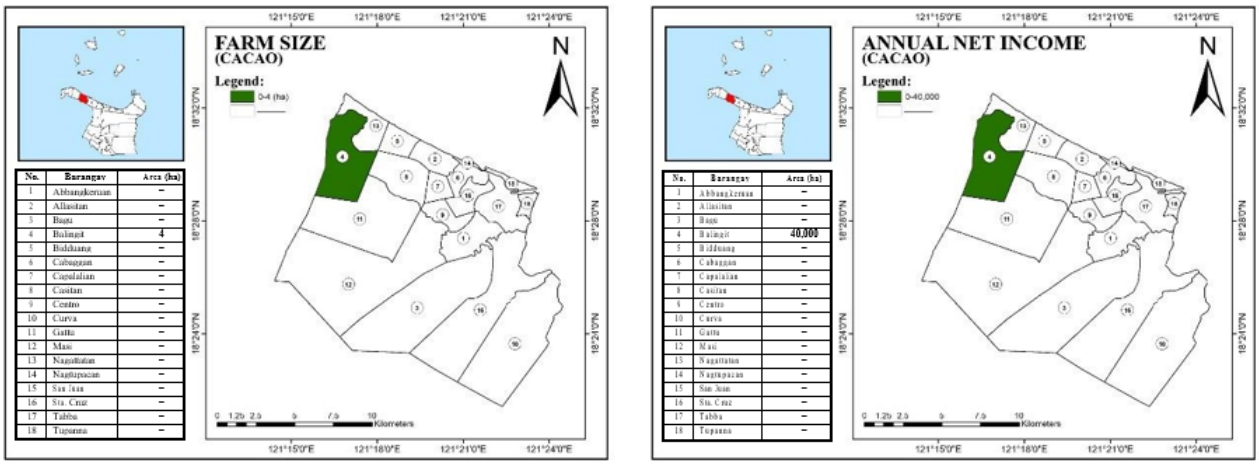

Fig. 5. Spatial distribution of total farm area (a) and annual net income (b) of Cacao in Pamplona, Cagayan.

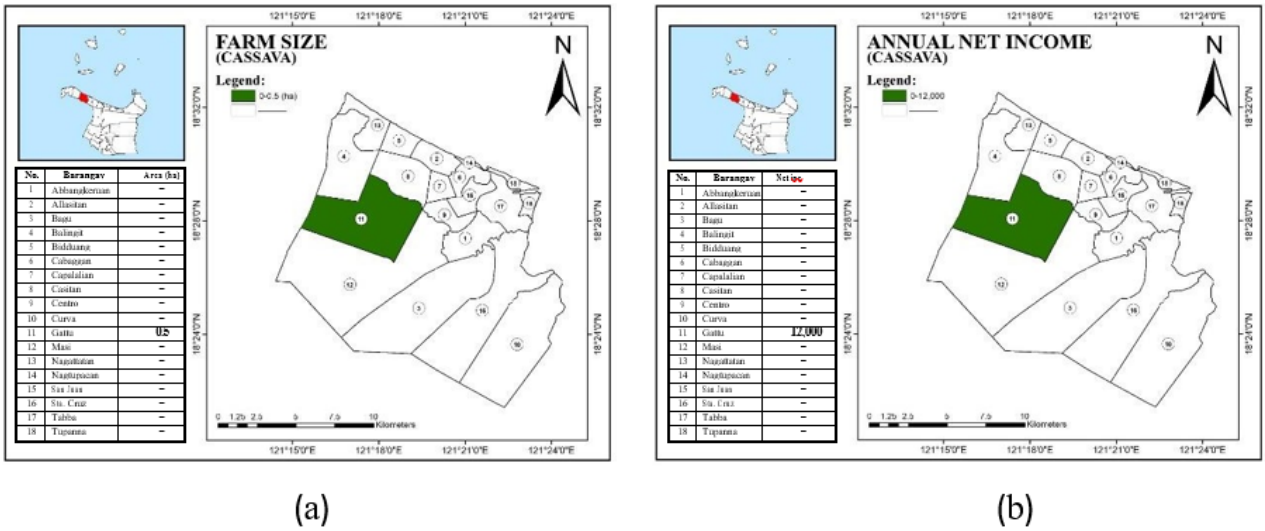

Fig. 6. Spatial distribution of total farm area (a) and annual net income (b) of Cassava in Pamplona, Cagayan.

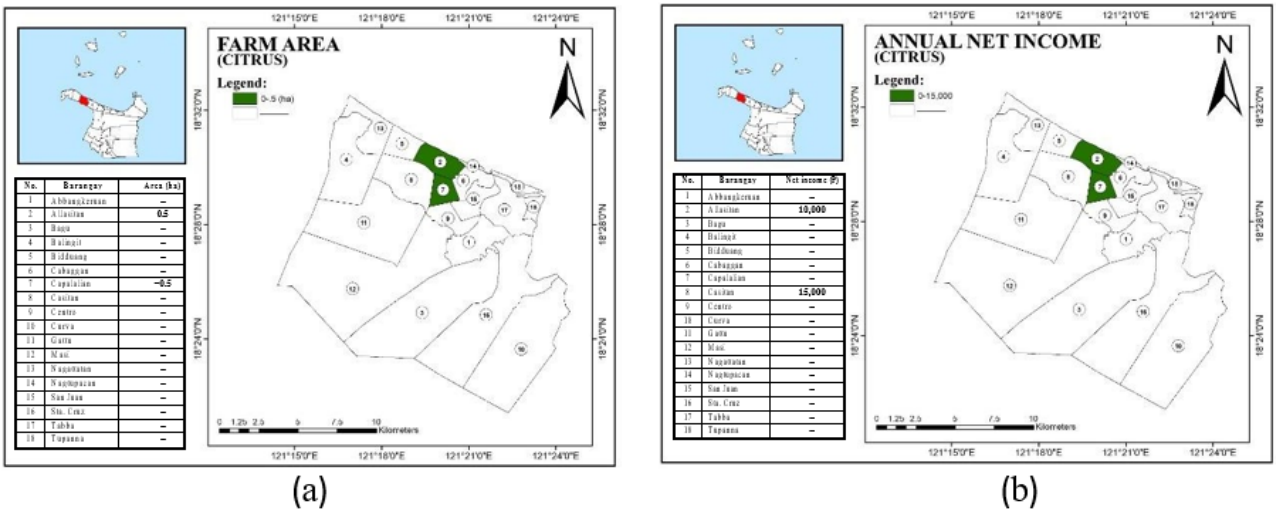

Fig. 7. Spatial distribution of total farm area (a) and annual net income (b) of Citrus in Pamplona, Cagayan

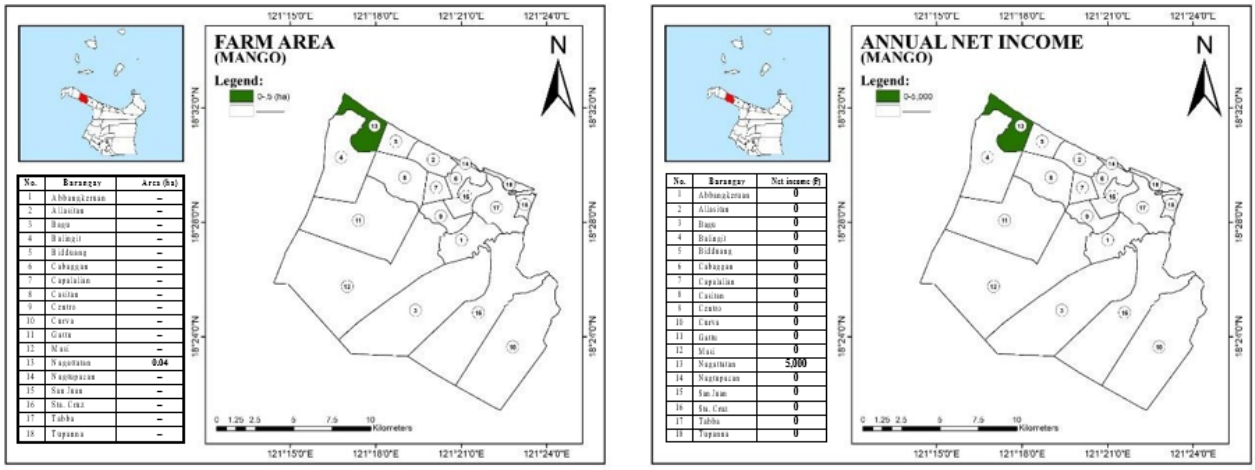

Fig. 8. Spatial distribution of total farm area (a) and annual net income (b) of Mango in Pamplona, Cagayan.

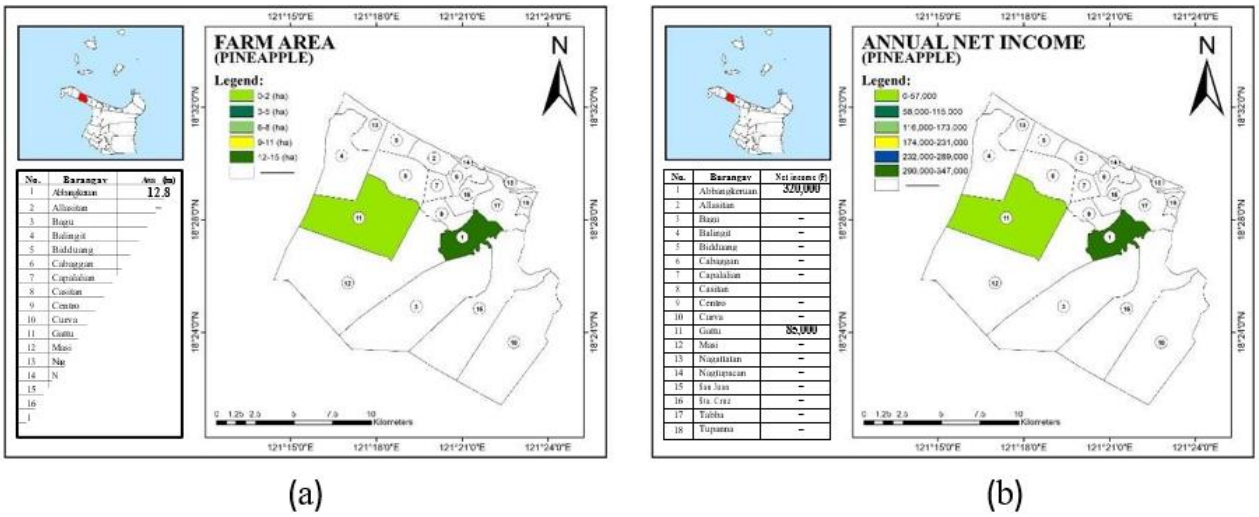

Fig. 9. Spatial distribution of total farm area (a) and annual net income (b) of Pineapple in Pamplona, Cagayan.

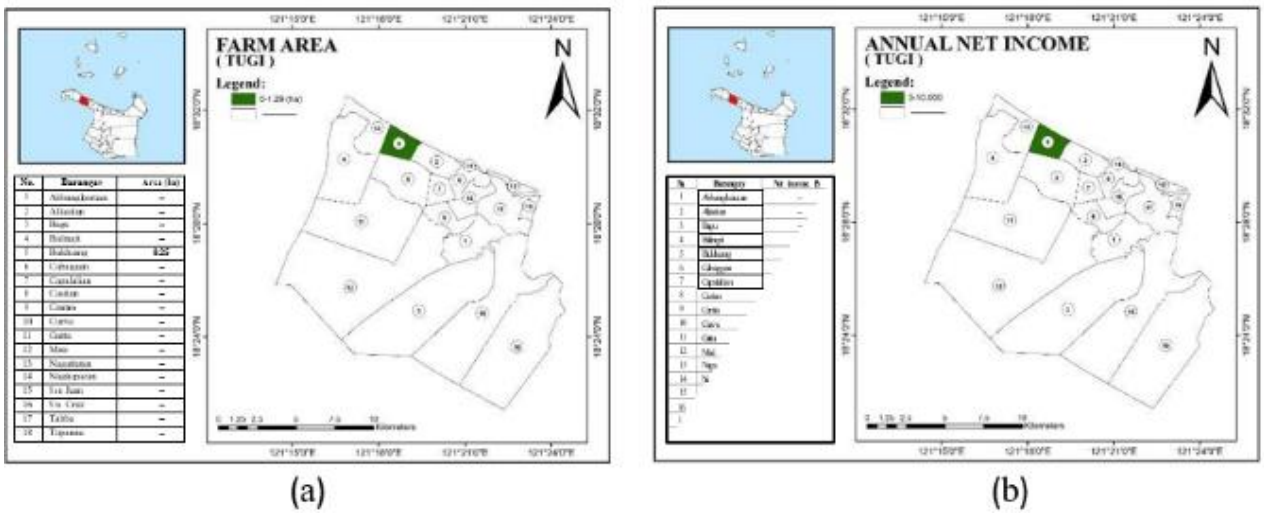

Fig. 10. Spatial distribution of total farm area (a) and annual net income (b) of Lesser Yam in Pamplona, Cagayan.

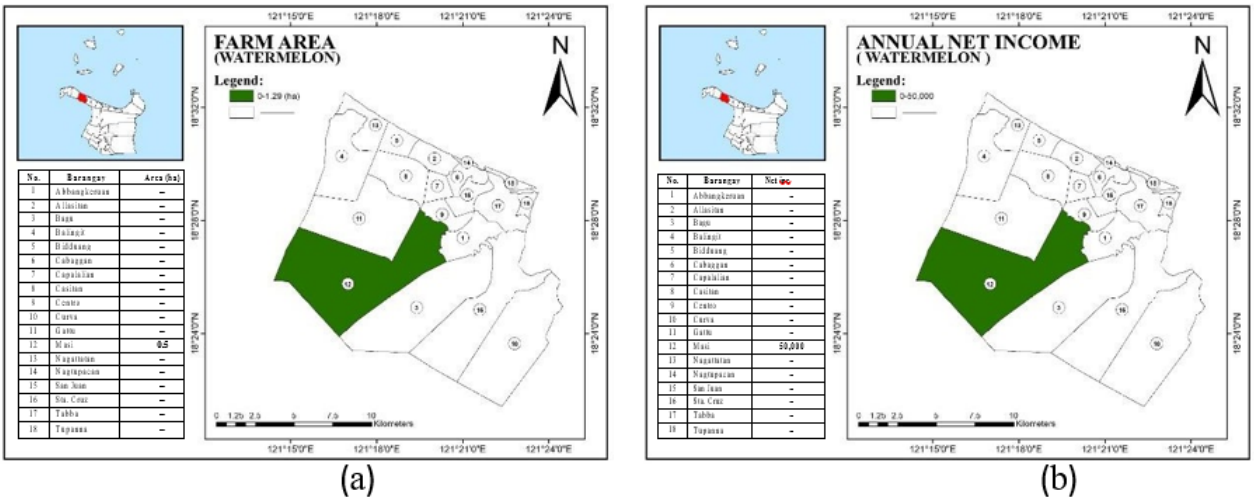

Fig. 11. Spatial distribution of total farm area (a) and annual net income (b) of Watermelon in Pamplona, Cagayan.

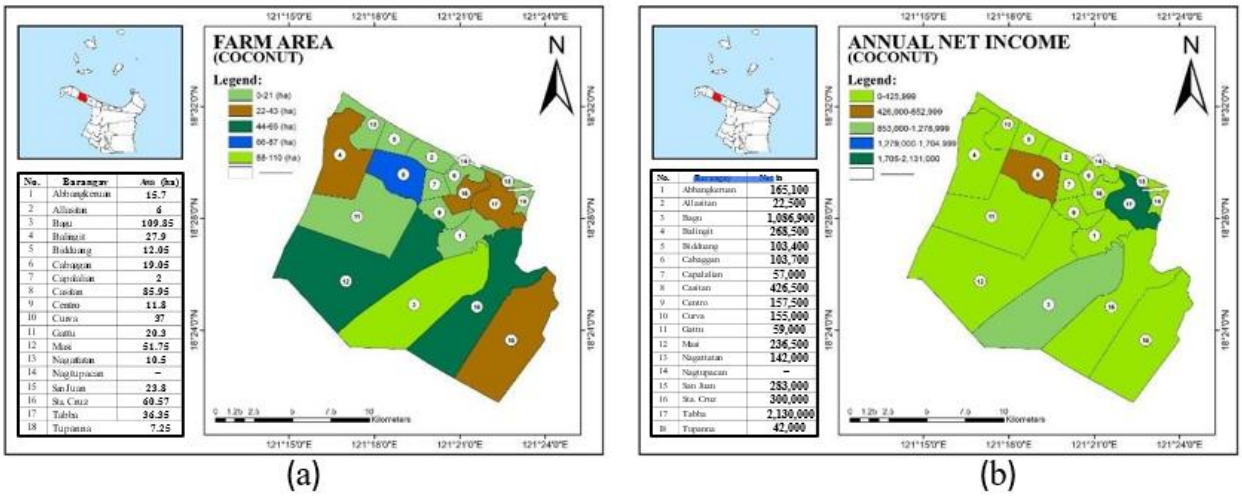

Fig. 12. Spatial distribution of total farm area (a) and annual net income (b) of Coconut in Pamplona, Cagayan.

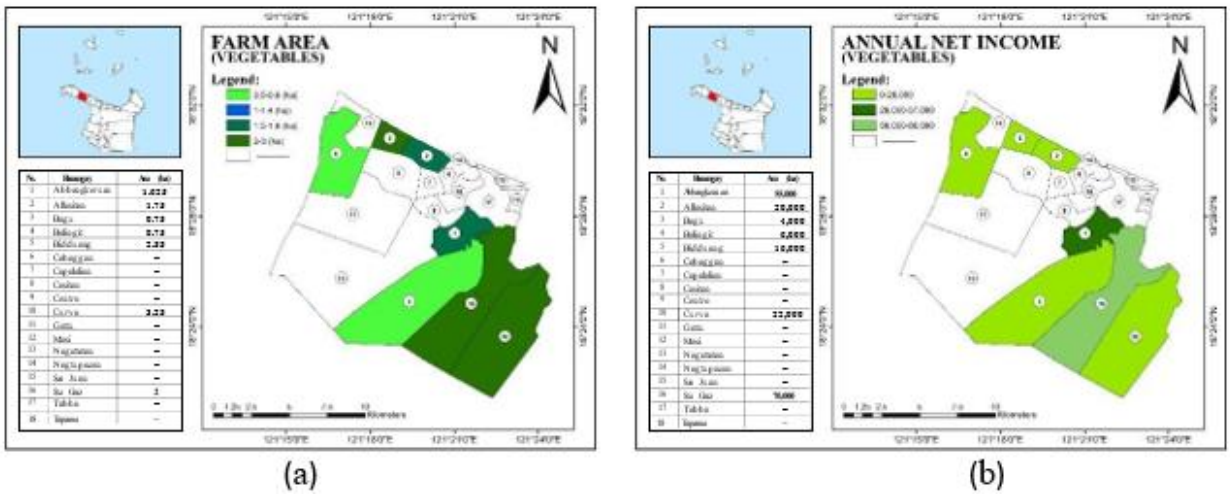

Fig. 13. Spatial distribution of total farm area (a) and annual net income (b) of Vegetables in Pamplona

In terms of vegetable production, the barangays of Bidduang, Curva, and Sta. Cruz feature agricultural lands ranging from 2 to 3 hectares, as presented in Figure 13a. Other cultivable areas for vegetables are below 1.9 hectares. Among the seven barangays engaged in vegetable cultivation, only Sta. Cruz generates a net income surpassing ₱58,000.00 annually, while most growers earn a lower income.

Spatial Distribution of the Mechanization Level of Each Barangay in Pamplona, Cagayan On the Crop Production and Post–Production Operations

Rice

Based on the findings of the study, the results reflected in Figure 14 demonstrate the varying levels of mechanization in rice cultivation operations. Specifically, operations such as land preparation, crop care, and maintenance (including spraying and irrigation), as well as harvesting and threshing, exhibit a high level of mechanization. This can be attributed to the farmers' utilization of available machinery and equipment to effectively carry out these operations.

The milling operation demonstrates a low to intermediate mechanization level (LIML). This is possible due to the prevailing practice among farmers of directly selling their harvested crops, with only a portion of the harvest undergoing the milling process. As a result, the overall level of mechanization in milling operations remains relatively limited. Furthermore, the study reveals that crop establishment and drying operations exhibit a low level of mechanization. This is primarily due to the farmers' reliance on traditional methods for performing these operations, which involve manual labor and less utilization of mechanized equipment.

These findings emphasize the existing disparities in mechanization levels across different stages of rice cultivation. The high mechanization observed in certain operations highlights the potential for increased efficiency and productivity. However, the low mechanization levels in milling, crop establishment, and drying operations indicate areas for improvement and the need for targeted interventions to enhance mechanization in these aspects of rice cultivation.

In terms of crop establishment, a combination of hand tools and the practice of corn seeder usage results in a low-to-intermediate level of mechanization. This indicates a partial dependence on mechanized tools for certain aspects of the crop establishment process. The drying operation demonstrates a low level of mechanization (LIML). This can be attributed to the prevailing practice among farmers of directly selling their harvested corn, with only a portion of the harvest being subjected to consumptive use. Consequently, the overall level of mechanization in the drying operation remains relatively limited.

These findings shed light on the mechanization status of various corn cultivation operations, highlighting the areas where technological interventions can be employed to enhance efficiency and productivity. The high level of mechanization in land preparation, crop care, and maintenance, as well as harvesting and threshing operations, underscores the potential benefits of employing machinery and equipment in these stages. However, the low mechanization levels in crop establishment and drying operations suggest opportunities for further improvements and targeted initiatives to advance mechanization in these specific aspects of corn cultivation. Spatial distribution maps illustrating the assessed operations can be found in Figure 15, providing visual representations of the mechanization levels across different corn cultivation processes.

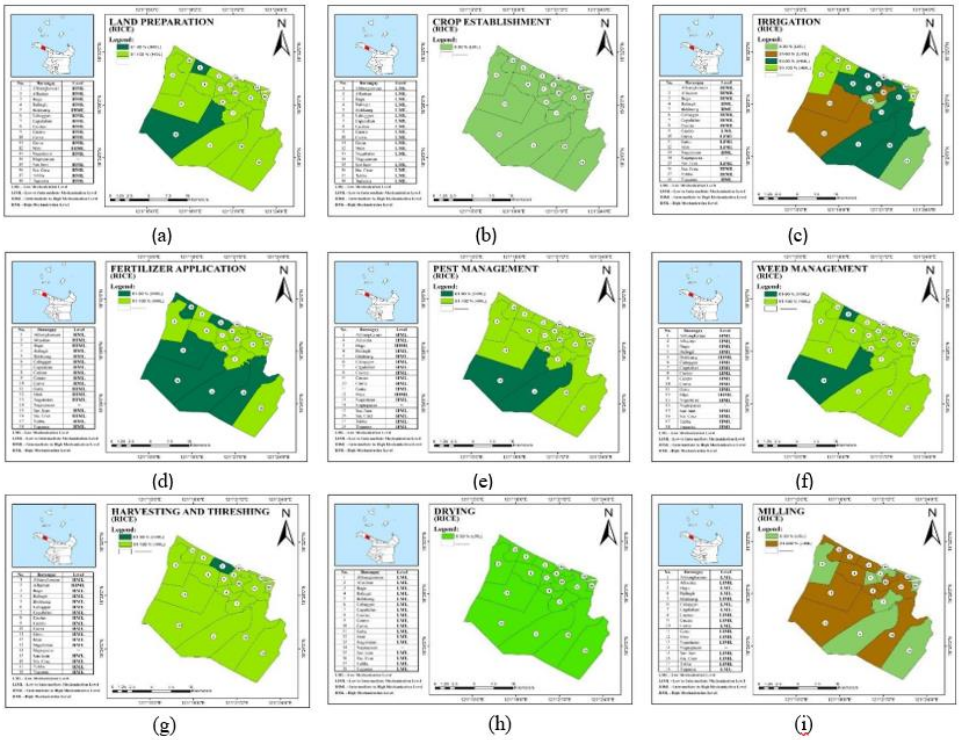

Fig. 14. Spatial distribution maps on the mechanization level of different farm operations (a) land preparation, (b) crop establishment, (c) irrigation, (d) fertilizer application, (e) pest management, (f) weed management, (g) harvesting and threshing, (h) drying, and (i) milling for Rice.

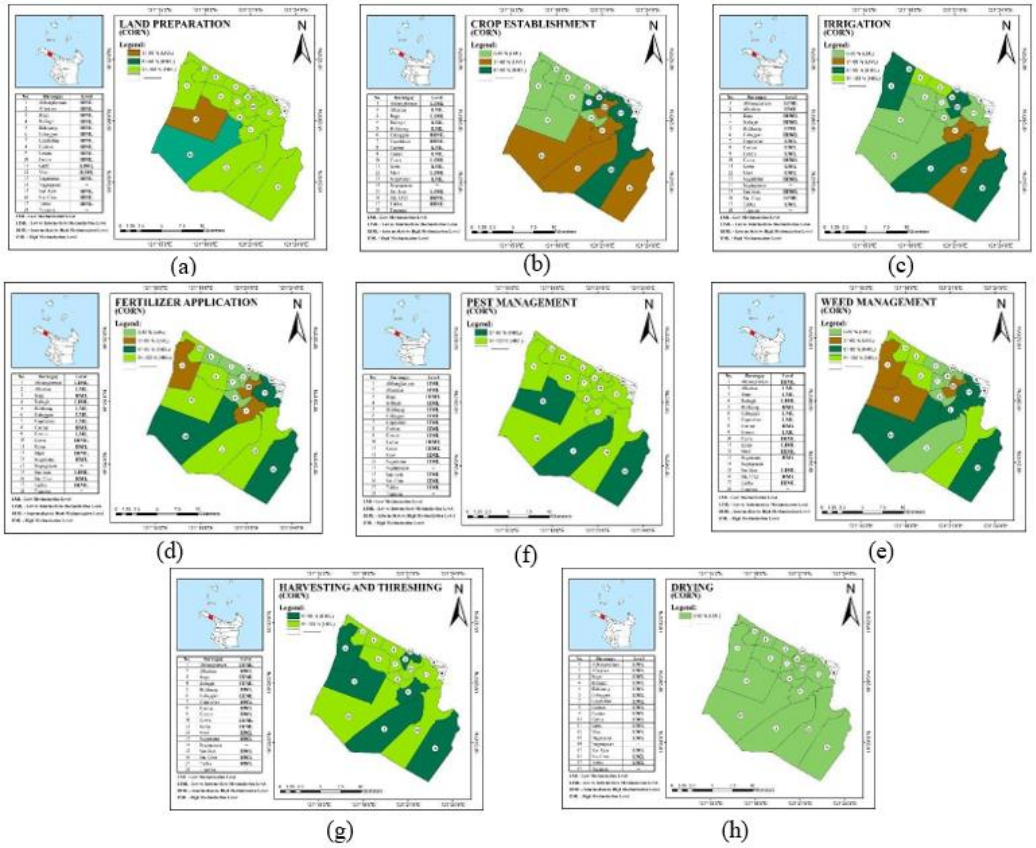

Fig. 15. Spatial distribution maps on the mechanization level of different farm operations ((a) land preparation, (b) crop establishment, (c) irrigation, (d) fertilizer application, (e) pest management, (f) weed management, (g) harvesting and threshing, and (h) drying for Corn.

High-Value Crops (Banana, Cacao, Coconut, Cassava, Citrus, Mango, Pineapple, and Lesser Yam, Vegetables, and Watermelon)

The mechanization levels of various crops, including banana, cacao, cassava, citrus, coconut, mango, pineapple, and lesser yam, were found to be consistently low. This conclusion is based on the assessment of operations, which revealed the predominant use of bolo/tabas in nearly all stages, except for crop establishment where shovel and crowbar were employed. Furthermore, survey findings indicated a lack of available machinery for post-harvest operations, resulting in an overall low mechanization level. It is worth noting that none of the mentioned barangays were involved in processing these crops, except for hauling, where some growers relied on tricycles and boats for transportation.

Regarding watermelon cultivation, a low-to-intermediate level of mechanization was observed in most farming activities as reflected in Figure 16. Notably, land preparation, irrigation, and spraying operations exhibited a high mechanization level. However, the overall mechanization level was impacted by traditional practices followed by farmers during harvesting and crop establishment stages.

Figure 17 presents the mechanization levels in vegetable cultivation. The assessment revealed a range from low to intermediate mechanization across operations such as land preparation, crop care and maintenance (including spraying, and irrigation) and harvesting. This outcome is attributed to the absence of mechanical equipment and the prevalent use of tools during crop establishment, harvesting, and post-harvest activities.

These results highlight the limited integration of machinery and equipment in the farming processes of the mentioned crops. The low levels of mechanization provide the possibility of applying technology solutions to improve efficiency, production, and overall agricultural development. Further exploration and initiatives are necessary to promote the adoption of mechanized practices and address the challenges associated with traditional methods to optimize crop production and meet the demands of a dynamic agricultural sector.

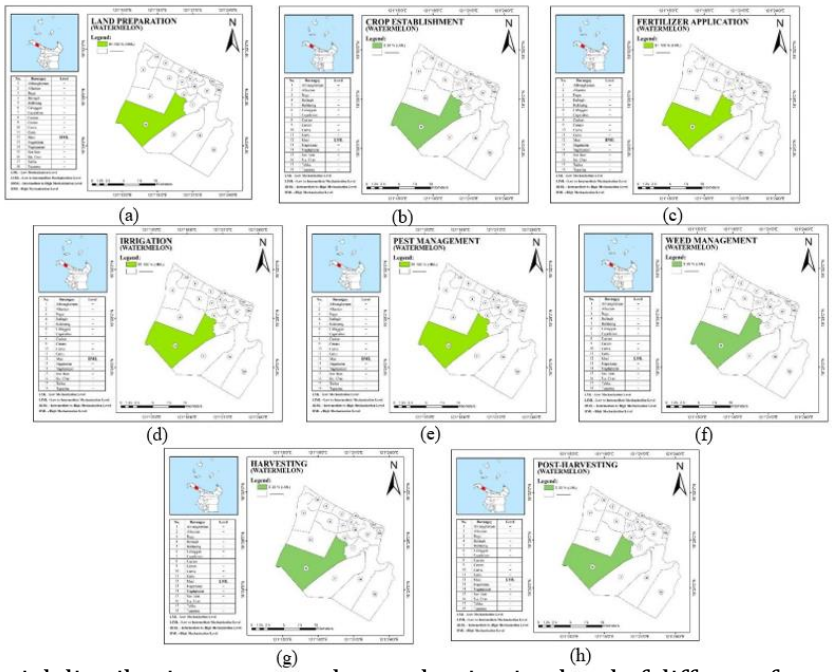

Fig. 15. Spatial distribution maps on the mechanization level of different farm operations ((a) land preparation, (b) crop establishment, (c) irrigation, (d) fertilizer application, (e) pest management, (f) weed management, (g) harvesting and threshing, and (h) drying for Corn.

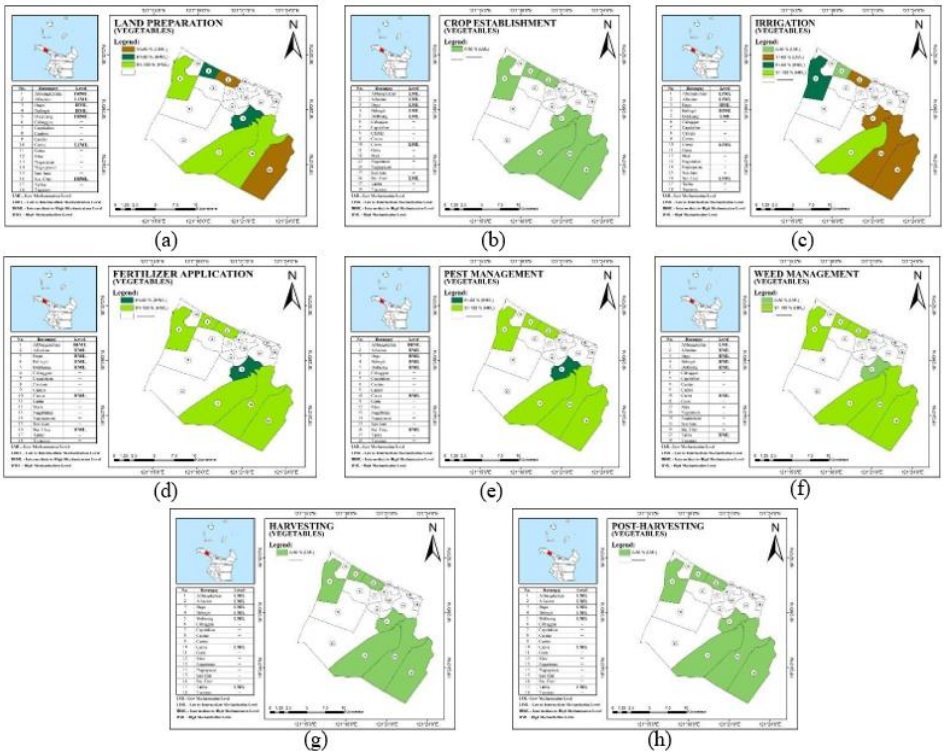

Figure 17. Spatial distribution maps on the mechanization level of different farm operations (a) land preparation, (b) crop establishment, (c) irrigation, (d) fertilizer application, (e) pest management, (f) weed management, (g) harvesting, and (h) post-harvesting) for Vegetables.

CONCLUSION

The analysis results yield several notable conclusions regarding agricultural practices in the municipality. The available farm power is primarily focused on rice and corn production, with mechanization prominently employed in operations like land preparation, spraying, irrigation, and harvesting. While crop establishment is still done manually, some farmers are beginning to use corn seeders. Notably, both rice and corn drying processes continue to rely on the sun's heat.

High-value crops such as banana, cacao, cassava, citrus, coconut, corn, mango, pineapple, and lesser yam exhibit limited mechanization across all assessed farm operations. In contrast, watermelon and vegetable farming display a higher level of mechanization, specifically in land preparation and spraying activities like fertilizer application and pest management. However, other practices within these crops remain primarily manual.

Regarding hauling and transport, the methods employed vary according to the physical size of the farms. Rice and corn growers often opt for machinery such as drop-side trucks, four-wheel drive tractors, hand tractors, engine-powered boats, and tricycles to facilitate these operations. On the other hand, coconut hauling is typically done manually, with transport determined by the harvest volume. High-value crop transportation, in general, heavily relies on human labor for these essential farm activities.

RECOMMENDATION

Based on the results of the study, the researchers recommend several measures to enhance the level of mechanization in the municipality of Pamplona. Firstly, this study

can provide valuable insights into the municipality's overall crop production, which is crucial for stakeholders seeking to address the mechanization challenges. Furthermore, it can serve as a foundation for policymaking concerning the mechanization program of LGU-Pamplona, facilitating informed decisions and targeted interventions.

To bolster mechanization, it is imperative to invest in capacity building, training, and seminars for farmers and end-users. These initiatives should focus on imparting knowledge and skills related to the use of readily available farm machinery, implements, equipment, and tools. By enhancing their proficiency in mechanized farming techniques, farmers can maximize their productivity and efficiency.

Additionally, a key step in advancing the agricultural sector of Pamplona is the thorough profiling and registration of all high-value crops grown in the municipality. This comprehensive database will not only aid in monitoring and managing crop production but also highlight the export potential of these crops. By updating this information regularly, Pamplona can further improve its agricultural sector, attracting more opportunities for growth and development.

REFERENCES

Amongo, R. M. C., Onal, M. K. S., Larona, M. V., Arthur, L. F., Clarissa, I. L. I., Lalap, G. N. L., ... & Sumague, J. V. (2018). Level of Agricultural Mechanization in Oriental Mindoro, Laguna and Quezon, Philippines Using the Modified Agricultural Mechanization Index for Lowland Rice. Philippine Journal of Agricultural and Biosystems Engineering, 14(2018). https://biomech.ceat.uplb.edu.ph/level-of-agricultural-mechanization-in=orientalmindoro- laguna-and-quezon-philippines-using-the-modified-agricultural-mechanization-index-for-lowland-rice/

Bautista, E. G., Kim, J. S., Kim, Y. J., & Panganiban, M. E. (2017). Farmer's Perception on Farm mechanization and Land reformation in the Philippines. Journal of the Korean Society of International Agriculture, 29(3), 242-250.

Bureau of Agricultural Research (BAR). (2017). Agriculture and Fisheries Mechanization (AFMech) in the Philippines. Department of Agriculture.

Cruz, R. D., & Bobier, S. (2016). Farm power available for utilization in Philippine agriculture. Postharvest Mech. J, 2, 16p. https://www.researchgate.net/publication/315783506_Farm_Power_Availablefor_Utilization_in_Philip pine_Agriculture

Emami, M., Almassi, M., & Bakhoda, H. (2018). Agricultural mechanization, a key to food security in developing countries: strategy formulating for Iran. Agriculture & Food Security, 7(1), 1 12. https://www.researchgate.net/publication/323967688_Agricultural_mechanization_a_key_to_food_security_in_developing_countries_Strategy_formulating_for_Iran

Gavino, R. B., & Tiw-an, C. C. (2020). Assessment of Mechanization Level of Onion Production in Nueva Ecija. CLSU International Journal of Science & Technology,4(1), 81-98. https://www.researchgate.net/publication/343347242_Assessment_of_Mechanization_Level_of_Onion_Production_in_Nueva_Ecija Official Gazette of the Philippines. Republic Act No. 10601-Agricultural and Fisheries Mechanization (AFMech) Law.

https://www.officialgazette.gov.ph/2013/06/05/repu blic-act-no-10601/

Osti P.R. (2021). How the Growing Use of Geographic Information Systems Can Benefit Society. https://blogs.adb.org/blog/how-growing- use-geographic-information-systems-can-benefit- society

PCARRD Book Series No. 179 / 2009. Agricultural Mechanization in the Philippines. https://www.fftc.org.tw/htmlarea_file/library/20110726161100/eb570.pdf#:~:text=In%20the%20Philippines%2C%20the%20transfer%20of%20agriculturalmechanization%20technology,and%20were%20thenutilized%20solely%20by%20big%20farm%20enterprises.

Philippine Statistics Authority. Regional Agricultural Production Accounts. https://psa.gov.ph/content/cagayan-valley-posted- highest-increment-agricultural-production-2019-66-percent Philippine Center for Postharvest Development and Mechanization website.

Simon, M.R.A (2021). Farming Technologies: assessment in the availability and extent of use of improved farming technology by farmers in North- western, Cagayan, Philippines.https://innspub.net/ijaar/farming- technologies-assessment-on-the-availability-and- extent-of-use-of-improved-farming-technologies- by-farmers-in-north-western-cagayan-philippines/

Suministrado, Delfin C. 2013. Status of Agricultural Mechanization in the Philippines. Regional Forum on Sustainable Agricultural Mechanization in Asia and the PAcific.

Sundaram, P. K., Singh, S. S., Sharma, S. C., & Rahman, A. (2012). Prospect of farm mechanization. ICAR-RCER, PATNA publishers India, 279-292. https://krishi.icar.gov.in/jspui/bitstream/123456789/33050/1/Prospects%20of%20mechanization%20in%20nursery%20development%20and%20management.pd