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Comparative analysis of the profitability of small-scale monoculture and diversified yellow corn farms in Cabagan, Isabela, Philippines

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ABSTRACT
The study aimed to compare the profitability of small-scale monoculture and diversified yellow corn production farms in Cabagan, Isabela, while also characterizing the socio-demographic profiles of farmers and determining their farming practices. Using house-to-house surveys of 30 monoculture and 30 diversified farmers, data on cultural management, income, and profitability were collected and analyzed. Findings revealed that older farmers predominantly engaged in both systems, with monoculture farming involving more male farmers (70%) and diversified farming having a higher proportion of female farmers (60%). Most were married and had educational attainment ranging from elementary to high school. Monoculture farmers were largely dependent on tractors (80%), mechanical seeders (75%), and herbicides (90%), whereas diversified farmers preferred manual planting (65%) and araro (plowing) (60%), leading to lower input costs. Profitability analysis showed that monoculture farmers had a higher gross profit margin ratio (0.82) and operating profit margin ratio (0.68) compared to diversified farmers (0.67 and 0.57, respectively). While monoculture farming offers higher immediate profit margins, it demands more inputs and poses environmental risks. Diversified farming, although yielding lower profit margins, promotes sustainability and cost-efficiency. These findings suggest that farmers and policymakers must balance short-term profitability with long-term ecological and economic sustainability when choosing farming systems.

Contribution/Originality: This study uniquely compares the profitability and input usage of monoculture and diversified yellow corn farming in Cabagan, Isabela. By integrating socio-demographic data, detailed cost analysis, and sustainability insights, it contributes original evidence on how farming practices impact economic outcomes and resource use among small-scale Filipino corn farmers.

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1. INTRODUCTION

Corn (*Zea mays L.*) is one of the most important food crops in the Philippines because of its economic significance providing livelihood to small-scale farmers (Salpietra, 2017). Also, it is widely cultivated all over the country due to its many uses, apart from being a good substitute for rice (Cabangbang & Quicoy, 2019). There are two main types of this crop, namely white and yellow corn. Yellow corn is an essential ingredient in feeds for hogs, poultry, and even fish (Salazar, Elca, Lapiña, & Salazar, 2021).

The Philippine Statistics Authority's (PSA) report in 2021 shows that the country produced 6.04 million metric tons (MMT) of yellow corn. The top producing region is Cagayan Valley with 1.87 MMT, which represents almost 31% of the country's yellow corn production. Most of the harvest in Region II comes from the Province of Isabela, which supplied 1.07 MMT in the same year. The demand and productivity of yellow corn production are increasing due to the growing need for feeds for the poultry and livestock sub-sectors in the Philippines. However, Cabangbang and Quicoy (2019) emphasized in their study that even though the demand for this crop has been increasing rapidly, the development of yellow corn production is still minimal.

Monoculture is the practice of growing just one crop species in a field at a time. It enables farmers to use machinery, increasing the efficiency of activities like planting and harvesting. However, it increases the risk of disease and pest outbreaks because monoculture farming lacks other plant and animal species that limit the spread of disease and control pests through predation. Without the natural checks and balances provided by diverse ecosystems, monoculture crops are more susceptible to devastating infestations and infections. This vulnerability often necessitates the heavy use of pesticides and herbicides, which not only adds to production costs but also poses environmental hazards through soil and water contamination. Moreover, the continuous cultivation of a single crop depletes the soil of specific nutrients, leading to soil degradation and reduced fertility over time. This depletion necessitates the application of synthetic fertilizers to maintain productivity, further exacerbating environmental concerns and contributing to the overall cost of production.

In contrast, crop diversification refers to the practice of growing a variety of crops on a farm or in a specific region instead of relying solely on one crop. It involves cultivating different types of crops, such as grains, vegetables, fruits, or legumes, either in rotation or simultaneously. Crop diversification aims to enhance soil health, increase biodiversity, and improve the resilience of agricultural systems to pests, diseases, and climate variability. By diversifying the range of crops grown, farmers can also tap into multiple markets, reduce dependence on a single crop, and potentially increase overall farm profitability. Additionally, crop diversification can contribute to sustainable agricultural practices by promoting ecosystem services, conserving natural resources, and mitigating environmental impacts associated with monoculture farming.

The One DA Reform Agenda's emphasis on crop diversification aligns with these principles, recognizing the potential of diversified farming systems to enhance agricultural productivity and resilience. By encouraging farmers to diversify into high-value seasonal crops, the initiative aims to not only increase farm incomes but also mitigate the risks associated with monoculture farming.

Furthermore, empirical studies by Volsi, Higashi, Bordin, and Telles (2021) and Parreño-de Guzman, Zamora, and Bernardo (2015) provide evidence supporting the economic viability of diversified crop rotation systems. These studies highlight the potential for increased profitability and feasibility compared to monoculture production, underscoring the importance of transitioning towards more diversified agricultural practices.

In the context of Isabela's yellow corn production, the prevalence of monoculture farming suggests an opportunity for comparative studies to evaluate the profitability of different farming systems. By examining the performance of small-scale monoculture and diversified yellow corn farms, researchers can provide valuable insights into the benefits and challenges associated with each approach. Such studies can inform policy decisions and support efforts to promote sustainable agricultural development in the region.

2. MATERIALS AND METHODS

2.1. Selection of Respondents

A formal request letter was submitted to the Municipal Agricultural Office of Cabagan, Isabela, to acquire the list of small-scale corn farmers engaged in both monoculture and diversified farming. Sixty yellow corn farmers were chosen for the study, comprising 30 monoculture farmers and 30 diversified farmers. Specifically, ten farmers from the three top corn-growing barangays of Cabagan were included in the selection process.

2.2. Data Collection

A pre-tested questionnaire adopted from the study of Yago (2022) was used to collect primary data through house-to-house interviews. The questionnaire administered is composed of basic information about the respondent's background; it includes the socio-economic profile of the farmers such as age, gender, marital status, household size, educational attainment, tenurial status, years of farming experience, income levels, and other sources of income. It is also accompanied by significant information like corn farming cultural and management practices. Additionally, the agricultural inputs and others were added such as land (in hectares), labor (in man-days), seeds (in kilograms), fertilizers (in kilograms), pesticides (in liters), and herbicides (in liters); as well as on output (in kilograms) and output price (in Php/Kg) gathered from the respondents. Including the years of engagement of corn farmers in monoculture and diversified farming were collected.

2.3. Profitability Analysis

To determine the net return (profit) from monoculture and diversified corn farming in Cabagan, Isabela, a cost and return analysis was used. In acquiring this, the net return was equal to the total revenue after subtracting all the production costs. The equation is given below:

$$\Pi = TR - TC$$
$$= TR - [TVC + (TFC - DC)]$$

Where:

Π= Net Return.

TR= Total Revenue.

TC= Total Cost.

TVC= Total variable cost.

TFC=Total Fixed cost.

DC= Depreciation cost.

Total revenue is the sum of financial gains from the sales of the farmer. On the other hand, the total cost is the expenditure incurred by farmers in the agricultural field; specifically, it is the sum of total variable costs and total fixed costs. While total variable costs are the expenditures that vary with the amount of output, total fixed costs are the costs that remain constant regardless of how the amount of output changes.

2.4. Gross Profit Margin

To evaluate how well the farm business gathers revenue from its direct expenses, the study used gross profit margin. Shown as below:

$$\textit{Gross profit margin} = \frac{\text{Gross profit}}{\text{Total revenue}}$$

$$\textit{Operating profit margin} = \frac{\text{Operating profit}}{\text{Total revenue}}$$

2.5. Statistical Analysis

The study applied descriptive analysis to assess the mean, frequency, and percentage to draw the respondents' socio-economic characteristics, as well as their cultural and management practices.

The profitability of monoculture and diversified production systems was compared using a t-test. Specifically, the t-statistic was computed using the following formula:

$$tc = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{\sqrt{sp^2(\frac{1}{n_1} + \frac{1}{n_2})}}$$

$$sp^2 = \sqrt{\frac{(n_1 - 1){s_1}^2 + (n_2 - 1){s_2}^2}{n_1 + n_2 - 2}}$$

Where:

$\bar{X}_1$= Mean, monoculture corn farmers.

$\bar{X}_2$= Mean, diversified corn farmers.

μ_1 = Population of monoculture corn farmers.

μ_2= Population of diversified corn farmers.

s_p^2= Pooled variance.

n_1 = Sample size.

n_1 = Population of monoculture corn farmers.

n_2= Population of diversified corn farmers.

The following hypotheses was tested for the analysis:

H_0: $\mu_1 = \mu_2$, the mean levels of profitability of diversified and monoculture small-scale yellow corn farmers are equal.

H_1: $\mu_1 \neq {}_2$ the mean levels of profitability of diversified and monoculture small-scale yellow corn farmers are not equal.

3. RESULTS AND DISCUSSION

3.1. Socio- Demographic Profiles of Yellow Corn Farmers Engaged in Monoculture and Diversified Production Systems

3.1.1. Age

In a monoculture production system, there is a noticeable age (Table 1) distribution among respondents. Among them, 6.67% fall within the younger age bracket (32-39), while 23.33% are aged between 40-47. The group aged 48-55 constitutes 30.00% of respondents, with 20% falling between 56-63, and 16.67% between 64-71. The oldest group (72-79) represents 3.33% of respondents. In contrast, for diversified farming, the younger age group falls within the range of 32 to 39 years old, with 9 respondents, representing 30% of the total respondents. Following this, the age bracket of 40 to 47 years old includes 11 respondents, accounting for 36.67% of the total respondents. Subsequently,

there are 9 respondents aged between 48 and 55 years, constituting 30.00% of the total respondents. The age group of 56 to 63 years old encompasses 1 respondent, making up 3.33% of the total respondents.

The result of the T-test indicates that there is no significant difference (P> 0.05) in terms of age between monoculture and diversified farmers. The older age groups tend to dominate both the monoculture and diversified production systems, and due to their advanced age, they are less inclined to embrace new agricultural methods currently being promoted. Musaba and Bwacha (2014) suggest that as farmers age, their efficiency decreases. Moreover, older farmers are more resistant to adopting new farming techniques, preferring to adhere firmly to traditional practices. Several factors dissuade younger individuals from entering farming, including high input costs and parental reluctance to see them follow in their agricultural footsteps. Instead, many young people opt for urban or overseas employment opportunities. In the Philippines, farmers perceive farming as a challenging livelihood, leading them to discourage their children from pursuing it. According to a report in The Manila Times (2023), farmers in the Philippines tend to belong to the older age group, typically aged 55-60.

Table 1. Age profile of small-scale yellow corn farmers in Cabagan, Isabela.

Classification of respondents						
Characteristic	**Monoculture (n=30)**			**Diversified (n=30)**		
	Class interval	**Frequency**	**Percentage**	**Class interval**	**Frequency**	**Percentage**
Age	32-39	2	6.67	32-39	9	30.00
	40-47	7	23.33	40-47	11	36.67
	48-55	9	30.00	48-55	9	30.00
	56-63	6	20.00	56-63	1	3.33
	64-71	5	16.67	64-71	0	0.00
	72-79	1	3.33	72-79	0	0.00
Average	54.37			51.1		
Mean difference	3.27					

3.1.2. Sex

The data suggests that among monoculture farmers, a substantial majority of 76.67% are male, with females accounting for 23.33% of the total (Table 2). In contrast, in diversified farming, data indicate a slight predominance of females, with approximately 53.33% of participants being female, while males make up 46.67% of the total respondents.

Research has shown that in many agricultural communities, traditional gender roles influence participation in farming activities. Historically, farming has been perceived as a male-dominated occupation, with men primarily responsible for crop cultivation and land management. This could explain the higher proportion of male monoculture farmers (Musaba & Bwacha, 2014). Moreover, access to resources such as land, finance, and agricultural inputs can also contribute to gender differences in farming. Studies have found that women often face barriers to accessing these resources compared to men, limiting their participation in certain types of farming activities, such as monoculture farming, where substantial resources may be required (Food and Agriculture Organization of the United Nations, 2011).

Diversified farming systems, which often involve a mix of crops, livestock, and other income-generating activities, may offer more opportunities for women's participation. Research suggests that women are more likely to engage in diversified farming as it allows them to utilize their diverse skill sets and contributes to household food security and income generation (Doss, 2001).

Table 2. Gender profile of small-scale yellow corn farmers in Cabagan, Isabela.

Classification of respondents				
Characteristic	**Monoculture (n=30)**		**Diversified (n=30)**	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Sex				
Male	23	76.67	14	46.67
Female	7	23.33	16	53.33

3.1.3. Marital Status

Table 3 illustrates notable differences in marital status between monoculture and diversified farmers. Among monoculture farmers, a significant majority (86.66%) are married, reflecting a traditional farming model where families work together in agricultural endeavors (Musaba & Bwacha, 2014). Conversely, a smaller proportion of monoculture farmers are single (3.33%), suggesting that unmarried individuals are less commonly engaged in this type of farming. Additionally, the presence of widowed/widower individuals (10%) among monoculture farmers indicates that some individuals continue farming even after experiencing the loss of a spouse, possibly influenced by economic necessity or a strong connection to farming as a way of life.

In contrast, among diversified farmers, a majority (80%) are married, signaling the importance of family involvement in agricultural activities across different farming systems. However, a higher percentage of diversified farmers are single (16.66%) compared to monoculture farmers, suggesting a greater prevalence of independent farming pursuits or engagement outside traditional family structures. The similar presence of widowed/widower individuals (3.33%) among diversified farmers indicates a continuation of farming activities even after the loss of a

spouse, underscoring the resilience and dedication of individuals within the agricultural sector, regardless of marital status.

Table 3. Marital status of small-scale yellow corn farmers in Cabagan, Isabela.

Classification of respondents				
Characteristic	**Monoculture (n=30)**		**Diversified (n=30)**	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Marital status				
Single	*1*	*3.33*	*5*	16.67
Married	*26*	86.67	*24*	80.00
Widowed/ Widower	*3*	10.00	*1*	*3.33*
Separated	*0*	0.00	*0*	0.00

3.1.4. Household Size

In monoculture farming, households (Table 4) with 2-4 members and those with 5-7 members each represented 50% of the total, averaging 6 persons per household. Conversely, among diversified yellow corn farmers, households with 2-4 members and 5-7 members each accounted for 40%, while those with 8-10 members made up 16.67%, and those with 14-16 members constituted 3.33%, averaging 5 persons per household.

Household size can influence farming practices and decision-making within agricultural households. Larger households may have more labor available for farm work, potentially allowing monoculture farmers to manage larger farms or undertake more intensive farming practices. In contrast, smaller household sizes among diversified farmers may necessitate different approaches to farm management and labor allocation.

Since the level of significance is greater than (P>0.10), the T-test result indicates that there is no significant difference between monoculture and diversified farmers. The household size of farmers does not affect the level of on-farm performance; however, family labor can contribute to on-farm activities. Family labor is more prevalent in monoculture farming compared to diversified farming. Household size cannot directly affect the level of profitability of farms; however it can lessen the cost of hired labor through the additional contribution of family members on farms, according to Agbugba, Christian, and Obi (2020).

Table 4. Household size of small-scale yellow corn farmers in Cabagan, Isabela.

Classification of respondents						
Characteristic	**Monoculture (n=30)**			**Diversified (n=30)**		
	Class interval	**Frequency**	**Percentage**	**Class interval**	**Frequency**	**Percentage**
Household size	2-4	*15*	50	2-4	*12*	40
	5-7	*15*	50	5-7	*12*	40
	8-10	*0*	0	8-10	*5*	16
	11-13	*0*	0	11-13	*0*	0
	14-16	*0*	0	14-16	*1*	*3.33*
Average	*6*			4.67		
Minimum	*2*			*2*		
Maximum	*14*			7		
Mean difference	1.33					

3.1.5. Educational Attainment

In monoculture farming (Table 5), 26.67% of respondents have completed elementary education, while another 10.00% are elementary undergraduates. Similarly, 26.67% have graduated from high school, while only *3.33%* hold a college degree.

Additionally, *3.33%* are college undergraduates, and 6.67% have had no formal schooling. These findings suggest that a significant portion of monoculture farmers have attained education levels ranging from elementary to high school, with fewer individuals having pursued higher education.

Conversely, among diversified farmer respondents, *23.33%* have completed elementary education, while 26.67% are elementary undergraduates. Additionally, *33.33%* have graduated from high school. Furthermore, only *3.33%* hold a college degree, and there are no respondents with no formal schooling. These results indicate a similar pattern of educational attainment among diversified farmers, with a notable proportion having completed elementary and high school education. However, compared to monoculture farmers, a slightly lower percentage of diversified farmers hold college degrees.

The result of the T-test indicates that there is no significant difference (P> 0.05) in terms of educational attainment between monoculture and diversified farmers. The educational background of farmers can influence their farming practices, decision-making abilities, and the adoption of new technologies and techniques. Understanding the educational profile of farmers is crucial for designing targeted agricultural extension programs and initiatives aimed at enhancing productivity, sustainability, and resilience in farming communities.

According to the study of Bayacag and Rola (2001), educational attainment is an important factor affecting the technical efficiency of farmers.

The study indicates that the majority of corn farmers in Bukidnon have the same level of educational attainment, and their efficiency also depends on the support they receive from their spouses.

Table 5. Educational attainment of small-scale yellow corn farmers in Cabagan, Isabela.

Characteristic	Classification of respondents			
	Monoculture (n=30)		Diversified (n=30)	
	Frequency	Percentage	Frequency	Percentage
Elementary graduate	8	26.67	7	23.33
Elementary undergraduate	3	10	8	26.67
Highschool undergraduate	7	23.33	2	6.67
Highschool graduate	8	26.67	10	33.33
College undergraduate	1	3.33	2	6.67
College graduate	1	3.33	1	3.33
No formal schooling	2	6.67	0	0

3.1.6. Tenure Status

Among monoculture farmers (Table 6), the majority (73.33%) are share tenants, while a minority (26.67%) operate as owner-operators. Conversely, among diversified farmers, the highest proportion (43.33%) are owner-operators, indicating a larger presence of independent farm owners within this group. Additionally, 40.00% of diversified farmers are share tenants, suggesting a significant reliance on shared agricultural resources or land. The remaining 16.67% are lessees, indicating a smaller but still notable presence of farmers who lease land for agricultural purposes within diversified farming systems. These findings highlight differences in land ownership and tenure arrangements between monoculture and diversified farming practices, potentially influencing factors such as decision-making autonomy, resource access, and long-term sustainability within each farming system.

The composition of farmers, particularly in terms of land tenure, plays a crucial role in shaping agricultural practices and outcomes. Barrett, Bellemare, and Hou (2016) highlights the significance of land tenure arrangements in influencing agricultural productivity and sustainability. Share tenancy, common among monoculture farmers, often entails limited decision-making power and access to resources for tenants compared to owner-operators. This may lead to inefficiencies and challenges in implementing sustainable farming practices, as tenants may prioritize short-term gains over long-term investments in land stewardship (Jayne, Chamberlin, & Headey, 2018).

Conversely, diversified farming systems, where owner-operators dominate, may offer greater autonomy and incentives for sustainable land management practices. Studies by Shiferaw, Prasanna, and Hellin (2014) emphasize the positive impact of owner-operated farms on agricultural productivity and environmental sustainability. Owner-operators are more likely to invest in soil conservation, crop diversification, and other sustainable practices, leading to improved resilience and long-term viability of farming systems. The presence of share-tenants and lessees among diversified farmers underscores the diversity of land tenure arrangements within this group. This diversity may reflect varying access to capital, land availability, and local agricultural policies (Ali & Byerlee, 2002).

Table 6. Tenurial status of small-scale yellow corn farmers in Cabagan, Isabela.

Characteristic	Classification of respondents			
	Monoculture (n=30)		Diversified (n=30)	
	Frequency	Percentage	Frequency	Percentage
Owner-operator	8	26.67	13	43.33
Lessee	0	0	5	16.67
Share-tenant	22	73.33	12	40

3.1.7. Years of Farming Experience

The data (Table 7) indicate that in monoculture farming, 5 respondents (16.67%) have been engaged in farming for 4-13 years. Additionally, 10 farmers (33.33%) have 14-23 years of farming experience. Eight farmers (26.67%) have been farming for 24-33 years. Both the 34-43 and 44-53 year intervals have 3 farmers each, representing 10% of the total respondents per interval. Lastly, 1 respondent (3.33%) has 54-63 years of farming experience.

In comparison, among diversified farmers, 30% have 4-13 years of farming experience. The 14-23 year interval includes 36.67% of the respondents. Another 30% have been farming for 24-33 years. Only 3.33% of respondents have 34-43 years of experience, and none have 44-53 or 54-63 years of experience. Both monoculture and diversified households have an average of 30 years of farming experience. The minimum farming experience is 4 years for monoculture and 1 year for diversified farming. The maximum experience is 50 years for monoculture farmers and 38 years for diversified farmers.

From this data, both groups have a similar average number of years of farming experience, with some differences in the distribution across different intervals. Diversified households have slightly more respondents with fewer years of farming experience (4-13 years), while monoculture households have a more even distribution across the various intervals. Farmers with greater years of experience are said to have more acquired knowledge and expertise in managing farms, as specified by Mayo et al. (2023).

The result of T-test showed that there is a significant difference ($P<0.05$) in terms of years of farming experience between the two farming systems. Since both farming practices majorly belonged to the older age group, this indicates that most of the farmers have been farming for long years. However, this long year of experience made them unwilling to adapt to new farming practices, leading them to stick to the old farming practice, which is monoculture. Agbugba et al. (2020) state that years of experience in corn farming can affect farmers' performance and yield output in cultivating corn. This shows that farmers have greater knowledge through their primary experiences in planting corn.

Table 7. Years of farming experience of small-scale yellow corn farmers in Cabagan, Isabela.

Characteristic	Classification of respondents					
	Monoculture (n=30)			Diversified (n=30)		
	Class interval	Frequency	Percentage	Class interval	Frequency	Percentage
Years of farming experience	4-13	5	16.67	4-13	9	30
	14-23	10	33.33	14-23	11	36.67
	24-33	8	26.67	24-33	9	30.00
	34-43	3	10.00	34-43	1	3.33
	44-53	3	10.00	44-53	0	0
	54-63	1	3.33	54-63	0	0
Average	26.03			19.2		
Minimum	4			1		
Maximum	50			38		

3.1.8. Attended Training Seminars

In monoculture farming (Table 8), 13 respondents (43.33%) attended training sessions, while 17 farmers (56.67%) did not participate in any training or seminars. Similarly, among diversified farmers, 13 respondents (43.33%) attended seminars, and 17 respondents (56.67%) did not. According to Kilpatrick (1997), farmers who attend training and seminars are more likely to adopt new farming practices when they see clear opportunities and potential profits. Cabangbang and Quicoy (2019) recommend that both government and non-government agencies should continue to offer training programs and seminars to help farmers, whether practicing monoculture or diversified farming, enhance their farming skills.

Table 8. Attendance to trainings and seminars of small-scale yellow corn farmers in Cabagan, Isabela.

Characteristic	Classification of respondents			
	Monoculture (n=30)		Diversified (n=30)	
	Frequency	Percentage	Frequency	Percentage
Attended	13	43.33	13	43.33
Did not attend	17	56.67	17	56.67

3.1.9. Income Levels

The data (Table 9) shows that in monoculture farming, most respondents fall within the lower income ranges of 200-8,500 and 8,600-16,800, representing about 46.67% and 40% of the total respondents, respectively. Additionally, 10% of respondents (3 people) had incomes between 16,900-25,100, and none were in the 33,500-41,700 range. Only one respondent fell within the 41,800-50,000 income bracket. For diversified farming, 15 respondents (50%) earned between 200-8,500, and 13 respondents (43.33%) earned between 8,600-16,800. There was one respondent each (3.33%) in the 25,200 to 33,400 and 33,500 to 41,700 income ranges.

The T-test result indicates no significant difference (P>0.10) in monthly income between the groups, suggesting that both monoculture and diversified farmers have similar income levels. The average income for monoculture farmers is Php 9,353.33, which is slightly higher than the Php 9,163.33 for diversified farmers.

Table 9. Income levels of small-scale yellow corn farmers in Cabagan, Isabela.

Characteristic	Classification of respondents					
	Monoculture (n=30)			Diversified (n=30)		
	Class interval	Frequency	Percentage	Class interval	Frequency	Percentage
Income level	200-8500	14	46.67	200-8500	15	50
	200-8500	14	46.67	200-8500	15	50
	8600-16800	12	40	8600-16800	13	43.33
	16900-25100	3	10	16900-25100	0	0
	25200- 33400	0	0	25200-33400	1	3.33
	33500-41700	0	0	33500-41700	1	3.33
	41800-50000	1	3.33	41800-50000	0	0
Average	9353.33			9163.33		
Minimum	200			500		
Maximum	23000			35000		
Mean difference			190			

3.1.10. Credit Availment

Among diversified farmers (Table 10), 20 respondents (67%) availed themselves of credit, while 10 respondents (33.33%) did not. In contrast, 60% of monoculture farmers have used credit, while 40% have not. This data suggests that credit usage is more common among diversified farmers, who grow a variety of crops (such as corn, tomatoes, mung beans, and squash) and need credit for fertilizers and other inputs. Monoculture farmers, however, primarily use credit for seedlings and fertilizers.

Access to credit significantly impacts the technical efficiency of farmers in yellow maize (corn) farming, as highlighted by Cabangbang and Quicoy (2019). This is particularly important because farmers in the Philippines often belong to poor households; without access to credit, they would struggle to cultivate their lands due to rising prices of farm inputs and decreasing prices of local agricultural products.

Table 10. Credit availment of small-scale yellow corn farmers in Cabagan, Isabela.

Characteristic	Classification of respondents			
	Monoculture (n=30)		Diversified (n=30)	
	Frequency	Percentage	Frequency	Percentage
Availed	18	60	20	67
Did not availed	12	40	10	33

3.2. Cultural Management Practices of Small-scale Yellow Corn Farmers of Cabagan, Isabela

The comparative cultural management practices of small-scale yellow corn farmers in Cabagan, Isabela, are presented in Table 11.

3.2.1. Land Preparation

The use of the traditional plow (araro) is more common among diversified farmers, with 7 respondents, compared to only 1 in monoculture farming. In contrast, tractor usage is significantly higher in monoculture farming, with 28 farmers compared to 16 in diversified farming. Additionally, the mixed usage of araro and tractor is more prevalent in diversified farming, with 7 respondents, while only 1 respondent in monoculture farming uses this mixed approach. Diversified farmers, on the other hand, tend to cultivate different crops with the help of family members to reduce the need for hired labor and lower the costs of land preparation and planting. This indicates that since diversified farmers have the availability of animal power, they are dependent on araro. Meanwhile, monoculture farms cultivate corn for commercial purposes, which demands them to use tractors for faster land preparation.

3.2.2. Planting

For planting methods, the data shows that the majority of monoculture farmers use mechanical seeders, with 29 respondents, while only 1 monoculture farmer uses a combination of seeder and manual planting. In contrast, among diversified farmers, 9 use mechanical seeders, 11 practice manual planting, and 10 use a combination of both seeder and manual methods.

Manual planting is more common in diversified farming, with 11 respondents, compared to none in monoculture farming. The use of both manual and seeder methods is also more prevalent in diversified farming, with 10 respondents, while only 1 monoculture farmer uses this combined approach.

In comparing the two farming systems, monoculture farmers are more likely to use mechanical seeders, as they typically plant a single crop, making the use of machinery more efficient and time-saving. Diversified farmers, who plant multiple crops, often find it unsuitable to rely solely on seeders, as some crops require manual planting.

A study by Mesfin, Fufa, and Haji (2011) recommends promoting diversified farming by providing access to affordable rented machinery, as well as improving access to market roads and irrigation systems, to meet the needs of diversified farmers who rely more heavily on manual planting methods.

3.2.3. Water Management

In general, farmers primarily rely on rain to supply water for their crops. The data indicate that only 2 respondents in monoculture farming use pump wells to irrigate their farms. In contrast, among diversified farmers, 11 respondents use pump wells, and 5 also irrigate their crops. The use of water in diversified farming exceeds that of monoculture farming. Given that diversified farming involves cultivating various types of crops, it necessitates higher water usage. Conversely, monoculture farmers mainly rely on rainfall to meet their farms' water needs.

3.2.4. Weed Management

In both monoculture and diversified farming, the use of synthetic herbicides to control weeds is prevalent. Among monoculture farmers, 29 respondents apply herbicides using sprayers, while only one respondent applies them manually. Similarly, in diversified farming, a total of 28 respondents apply herbicides with sprayers, while 2 respondents opt for manual application.

While crop diversification aims to incorporate functional biodiversity, thus potentially reducing weed emergence, diversified farms still experience negative impacts on weed seed emergence, as noted by Sharma, Shrestha, Kunwar, and Tseng (2021).

3.2.5. Fertilizer Application

Manual fertilizer application is a common practice in both monoculture and diversified systems. All respondents from both groups reported using fertilizers, including basal and side-dressing applications, which are essential for corn farming. However, this widespread use of fertilizers contributes to the environmental concerns associated with corn farming, as highlighted in the study by Abbas et al. (2022). The emissions of nitrogen-based chemical fertilizers, both on and off farms, significantly contribute to global warming. This not only poses risks to human health but also leads to other environmental issues. Therefore, despite its agricultural importance, corn production is often criticized for its environmental sustainability challenges.

3.2.6. Pesticide Application

For pesticide application, 10 farmers under monoculture have applied pesticide using a sprayer, while in diversified farming, 16 farmers also apply pesticide using a sprayer. The data implies that diversified farmers used pesticides more than monoculture farmers. A study stated that crop diversification is promoted to lessen pesticide usage, highlighted by Thomine, Mumford, Rusch, and Desneux (2022). However, the majority of farmers in Cabagan, Isabela, are not knowledgeable enough in pest management. Instead of adapting crop diversification to reduce synthetic pesticide usage, they tend to use more of it due to their diverse crops, as stated by Sharratt and McWilliams (2005).

Table 11. Cultural management practices of monoculture and diversified small-scale corn farmers respondents in Municipality of Cabagan, Isabela.

Production activity	Cultural management practices	
	Monoculture	**Diversified**
Land preparation	Araro (1)- (Manual plow of the soil) Tractor (28)- (Plowing with mechanical) Araro/ Tractor- 1	Araro (7)-Manual plow of the soil) Tractor (16) (Plowing with mechanical) Araro/ Tractor- 7
Seed preparation	Selecting high quality seed	Techniques such as seed priming or coating
Planting	Sowing seeds, used machinery such seed drills or planters. Seeder- 29 Manual- 0 Seeder/ Manual- 1	Direct seeding and transplanting Seeder- 9 Manual- 11 Seeder/ Manual- 10
Water management	Rainfed Pumpwell- 2 Irrigation- 0	Irrigated (Pumpwell) Pumpwell- 11 Irrigation- 5
Weed management	Herbicides and mechanical methods such as tilling or cultivation. Herbicide/ Sprayer-29 Herbicide/ Manual-1	Cultural, mechanical, and biological approach Herbicide/ Sprayer-28 Herbicide/ Manual-2
Fertilizer	Synthetic fertilizer Manual-30	Organic fertilizer such as compose or manure along with synthetic fertilizer. Manual-30
Pesticide	Not practiced chemical pesticides. Sprayer- 10	Sprayed chemical pesticide. Sprayer- 10
Harvesting	Manual and mechanized Combine harvester -19 Manual- 11	Manual/Mechanized Combine harvester -19 Manual-11
Drying	Sun drying and mechanical drying method (Grain dryers or dehydrators).	Combination of sun drying and air-drying methods

3.3. Profitability Analysis of Small-scale Yellow Corn Farmers in Cabagan, Isabela

3.3.1. Labor Utilization Per Hectare of Monoculture and Diversified Small-Scale Yellow Corn Farmers

Table 12 presents the labor utilization per hectare of monoculture and diversified small-scale yellow corn farmers. To prepare one hectare of land for planting, monoculture farming requires an average of 2.31 man-days, which represents 13.45% of the total man-days needed for the entire production period. In comparison, diversified farming requires 2.94 man-days, accounting for 12.55% of the total production days.

In seed preparation and planting, monoculture farming requires an average of 1.85 man-days, which accounts for 10.77% of the total man-days. In contrast, diversified farming demands an average of 6.19 man-days, making up 26.42% of the total production days. This indicates that labor utilization is higher in diversified farming due to the additional time needed to prepare and plant the various seeds used in this approach.

For water management, monoculture farmers depend entirely on rainfall. In contrast, diversified farming requires additional water supply for some crops, particularly in regions with distinct wet and dry seasons like Isabela, as noted by Lansigan, De los Santos, and Hansen (2007).

For fertilizer application, monoculture farming utilizes an average of 4.01 man-days, accounting for 23.35% of total production man-days, while diversified farming utilizes an average of 4.78 man-days, corresponding to 20.40% of total man-days. In terms of pesticide application, monoculture farming requires an average of 0.95 man-days, making up 5.53% of the total man-days. In comparison, diversified farming uses an average of 0.57 man-days, representing 2.43% of the total production days.

Lastly, in terms of harvesting and drying, monoculture farming requires an average of 5.84 days, accounting for 34.01% of the total production man-days. Conversely, diversified farming takes 5.40 days on average, representing 23.05% of the total man-days. In summary, the average labor utilization per hectare in monoculture farming is 17.17 man-days, whereas in diversified farming, it is 23.43 man-days. The result of the T-test indicates a significant difference ($P<0.01$) between monoculture and diversified farming. This suggests that the two farming systems differ significantly in terms of labor requirements per hectare, with diversified farming requiring more labor compared to monoculture farming. Labor plays a crucial role in farming; a lack of labor or manpower affects the overall

productivity, profitability, and long-term sustainability of all agricultural commodities. Labor requirements are a crucial aspect of both monoculture and diversified farming methods. In a diversified system, the efficiency of labor is positively affected by diversification and involvement in agroecological networks (Ferguson & Lovell, 2019).

Table 12. Labor utilization per hectare of monoculture and diversified small-scale yellow corn farmers.

Production activity	Classification of respondents			
	Monoculture		Diversified	
	Man- day	Percentage	Man- day	Percentage
Land preparation	2.31	13.45	2.94	12.55
Seed preparation and planting	1.85	10.77	6.19	26.42
Water management	0.00	0.00	0.61	2.60
Weed management	2.21	12.87	2.94	12.55
Fertilizer application	4.01	23.35	4.78	20.40
Pesticide application	0.95	5.53	0.57	2.43
Harvesting and drying	5.84	34.01	5.40	23.05
Total	17.17	100.00	23.43	100.00

3.3.2. Input Utilization per Hectare of Monoculture and Diversified Small-Scale Yellow Corn Farmers

The majority of farmers (Table 13) cultivate an average farm size of 0.84 hectares in monoculture and 0.92 hectares in diversified farming. In terms of seed usage (kg/ha), monoculture farmers use an average of 24.87 kg/ha, while diversified farmers use 17.74 kg/ha on average. Diversified farmers apply synthetic fertilizer with an average of 259 kg/ha, which is less than the average of 331.98 kg/ha in monoculture. The result of T-test shows that there is no significant difference (P>0.05) in terms of farm size between monoculture and diversified farming.

Regarding pesticide application, monoculture farms apply pesticides less frequently with an average of 2.48L/ha, while diversified farms have an average pesticide application of 3.8 L/ha. According to Afari-Sefa, Asare-Bediako, Kenyon, and Micah (2015), monoculture farmers tend to not used pesticide due to a lack of knowledge in managing pest and they disregard the potential harmful effects of these chemicals on human health and the environment specified. In terms of hired labor (man-days/ha), monoculture farmers hire on-farm laborers with an average of 14.46 man-days/ha, slightly more than the average of 14.17 man-days/ha in diversified farming.

Table 13. Input utilization per hectare of monoculture and diversified small-scale yellow corn farmers.

Material inputs	Classification of respondents	
	Monoculture	Diversified
	Quantity	Quantity
Average farm size (ha)	0.84	0.92
Seed (kg/ha)	24.87	17.47
Fertilizer (kg/ha)	331.98	259
Pesticide (l/ha)	2.48	3.8
Herbicide (l/ ha)	4.18	3.89
Labor Hired labor (manday/ha)	14.46	14.17

3.3.3. Breakdown Cost per Hectare of Monoculture and Diversified Small-Scale Yellow Corn Farmers

Table 14 presents the breakdown of cash costs per hectare for monoculture and diversified small-scale corn farmers in Cabagan, Isabela. Monoculture farmers incurred a total cash cost of Php29,251.16, while diversified farmers spent less at Php23,020.90. In terms of labor, monoculture farmers spent Php7,925 (27.09%) on hired labor and Php241.11 (0.82%) on family labor, whereas diversified farmers allocated Php7,259 (31.53%) for hired labor and Php1,141.67 (4.95%) for family labor, indicating a higher reliance on unpaid household labor. Seed expenses were slightly higher in monoculture farms at Php7,107.93 (24.29%) compared to Php5,918.25 (25.71%) in diversified systems. Fertilizer accounted for the largest share of monoculture cash costs at Php10,591.61 (36.20%), while diversified farms spent Php5,513.89 (23.95%) in this category. Pesticide and herbicide costs were also slightly higher in diversified farms, with Php530.42 (2.30%) and Php2,658.29 (11.54%) respectively, compared to Php476.47 (1.62%) and Php2,908.84 (9.94%) in monoculture systems. These figures indicate that monoculture farming generally involves higher cash expenditures across most input categories.

Table 14. Breakdown of cash cost per hectare of monoculture and diversified small-scale corn farmers respondents in Cabagan, Isabela.

Costs	Classification of respondents			
	Monoculture		Diversified	
	Amount (PhP)	Percentage	Amount (PhP)	Percentage
Labor				
Hired	7925	27.09	7259	31.53
Family	241.11	0.82	1141.67	4.95
Seed	7107.93	24.29	5918.25	25.71
Fertilizer	10591.61	36.20	5513.89	23.95
Pesticide	476.47	1.62	530.42	2.30
Herbicide	2908.84	9.94	2658.29	11.54
Total cash cost	29251.16	100	23020.9	100

Non-cash costs (Table 15) show that all monoculture farmers (100% of respondents) reported using family labor (unpaid), valued at Php 762.78. In contrast, diversified farmers reported a higher non-cash cost for family labor, amounting to Php1,787.78, representing 48.09% of the respondents. Additionally, diversified farmers received seeds from the Department of Agriculture (DA) valued at Php822.22, accounting for 22.11%. They also benefited from non-cash fertilizer inputs worth Php648.88 (17.45%), pesticide support worth Php443.33 (11.92%), and herbicides valued at Php15.00 (0.40%).

Table 15. Breakdown of non-cash cost per hectare of monoculture and diversified small-scale corn farmers respondents in Cabagan, Isabela.

Costs	Classification of respondents			
	Monoculture		Diversified	
	Amount (PhP)	Percentage	Amount (PhP)	Percentage
Family labor (Unpaid)	762.78	100	1787.78	48.09
Seeds (DA) Hybrid seeds OPV seeds vegetable seeds	0	0	822.22	22.11
Fertilizer	0	0	648.88	17.45
Pesticide	0	0	443.33	11.92
Herbicide	0	0	15	0.40
Total non-cash cost	762.78	100	3717.21	100

Table 16 compares the fixed costs incurred by monoculture and diversified corn farmers per hectare. Monoculture farmers had a total fixed cost of Php1,113.02, while diversified farmers spent significantly more at Php2,589.39. The distribution of fixed cost items shows differences in farming practices and resource use between the two systems.

Monoculture farmers allocated the largest portion of their fixed costs to tractor use (Php 480), accounting for 43.12% of their total fixed expenses. In contrast, diversified farmers spent less on tractor use (Php 277.78), representing only 10.72% of their fixed costs. This suggests that diversified farms rely less on mechanized land preparation.

For knapsack sprayers, diversified farmers incurred a higher cost (Php 732.15 or 28.27%) compared to monoculture farmers (Php 535.85 or 48.14%), indicating a greater reliance on manual or semi-mechanized spraying methods.

A key distinction lies in the cost of water machines (e.g., water pumps). Diversified farmers invested significantly more in this category—Php1,549.39, comprising 59.83% of their fixed costs compared to only Php97.17 (8.73%) for monoculture farmers. This implies that diversified farms may use more controlled or varied irrigation practices.

Table 16. Fixed cost and total cost per hectare of monoculture and diversified small-scale corn farmers respondents in Cabagan, Isabela.

Costs	Classification of respondents			
	Monoculture		Diversified	
	Amount (PhP)	Percentage	Amount (PhP)	Percentage
Tractor	480	43.12	277.78	10.72
Knapsack sprayer	535.85	48.14	732.15	28.27
Machine for water	97.17	8.73	1549.39	59.83
Total fixed costs	1113.02	100	2589.39	100

3.3.4. Yield per Hectare of Monoculture and Diversified Small-Scale Yellow Corn Farmers

The yield (Table 17) for monoculture farming ranged from 200 kg/ha to 8,000 kg/ha, with an average yield of approximately 4,034.34 kg/ha. For diversified farming, the yield ranged from 300 kg/ha to 7,700 kg/ha, but with a lower average yield of approximately 3,091.13 kg/ha. Despite these ranges, both monoculture and diversified farmers generally achieve higher average yields per hectare.

Table 17. Yield per hectare distribution of monoculture and diversified small-scale yellow corn farmers in Cabagan, Isabela.

Yield (kg/ha)	Classification of respondents			
	Monoculture		Diversified	
	Number of farmers	Percentage	Number of farmers	Percentage
Interval				
200-1500	4	13.33	8	26.67
1600-2900	10	33.33	7	23.33
3000-3300	2	6.67	1	3.33
3400-4700	2	6. 67	7	23.33
4800-6100	8	26.67	3	10.00
6200-7500	2	6.67	2	6.67
7600-8900	2	6.67	2	6.67
Average	4034.34		3091.13	
Mean difference	943.21			
Minimum	200		300	
Maximum	8000		7700	

The results of the T-test indicate that there is no significant difference (P>0.10) in yields between monoculture and diversified farming systems. This indicates that aside from farming practices, there are other factors that determine the yield of crops. According to Hapinat (2023), both farming practices face rapid insect pest population growth, rendering control measures ineffective. Additionally, changes in weather patterns due to climate change threaten corn production, particularly for open-pollinated varieties. Unpredictable droughts and excessive rainfall have disrupted traditional planting and harvesting schedules, as discussed by Perez, Smith, and Johnson (2020).

3.3.5. Cost and Return Per Hectare of Monoculture and Diversified Small-Scale Yellow Corn Farmers

Monoculture farmers obtained (Table 18) a total return of Php 98,779.31 per hectare, consisting of Php 82,906.69 in cash income and Php 15,872.62 in non-cash income. In contrast, diversified farmers generated a total return of Php 57,825.90 per hectare, with Php 50,679.73 from cash income and Php 7,146.17 from non-cash income. The results of the T-test indicate a significant difference (P<0.05) between the total returns of monoculture and diversified farming systems. This data suggests that, strictly from a financial perspective, monoculture farming is more profitable than diversified farming. However, factors like soil health, biodiversity, sustainability, and risk management might also play a crucial role in deciding the farming approach, which is not captured by monetary returns alone.

Table 18. Cost and return per hectare of monoculture and diversified small-scale yellow corn farmers in Cabagan, Isabela.

Item	Classification of respondents	
	Amount (PhP)	
	Monoculture	Diversified
Income		
Cash income	82906.69	50679.73
Non- cash income	15872.62	7146.17
Total returns	98779.31	57825.9
Cash costs		
Labor		
Hired	7925	7295
Family	241.11	1141.67
Seed	7107.93	5918.25
Fertilizer	10591.61	5513.89
Pesticide	476.47	530.42
Herbicide	2908.84	2658.29
Total cash cost	29251.16	23020.96
Non- cash costs		
Family labor (Unpaid)	762.78	1787.78
Seeds (DA)	0	822.22
Fertilizer	0	648.88
Total non- cash costs	762.78	3717.21
Fixed cost		
Tractor	480	277.78
Knapsack sprayer	535.85	732.15
Manual weeding	0	30
Machine for water	97.17	1549.39
Total fixed costs	1113.02	2589.39
Total costs	31126.96	29327.56
Net return	67652.35	28498.34
Mean difference	39127.01	

3.3.6. Gross and Operating Profit Margin Ratios per Hectare of Monoculture and Diversified of Small-Scale Corn Farmers

The gross profit margin ratio (Table 19) measures the money a business makes after accounting for the cost of doing business, specifically the cost of goods sold (COGS). In contrast, the operating profit margin ratio reflects the earning power of a farm business from its operations, taking into account operating expenses such as rent, utilities, wages, and depreciation costs.

Monoculture farmers have a higher gross profit margin ratio compared to diversified farmers. For every peso of income generated, monoculture farmers retain 0.82 centavos, with 0.18 centavos going towards the cost of goods sold. Diversified farmers, on the other hand, retain 0.67 centavos per peso of income, with 0.33 centavos allocated to COGS. This suggests that monoculture farming leaves farmers with a larger portion of their income after covering the direct costs of production.

Similarly, the operating profit margin ratio is higher for monoculture farmers than for diversified farmers. Monoculture farmers have an operating profit margin of 0.68, while diversified farmers have a ratio of 0.57. This means that monoculture farmers retain 0.68 centavos per peso of income after accounting for operating expenses, whereas diversified farmers retain 0.57 centavos per peso. This indicates that monoculture farmers are more efficient in converting their income into operating profit, even after covering their operational costs.

However, the data also suggests that monoculture farming typically requires more inputs, such as fertilizers and pesticides. This is because growing the same crop over large areas can lead to increased susceptibility to pests and

diseases, as well as nutrient depletion in the soil. These factors necessitate the use of more chemical inputs to maintain crop health and yields. In contrast, diversified farming can offer savings on labor and machinery costs. Different crops have varied needs and maintenance schedules, which can complement each other. For instance, certain crops may fix nitrogen in the soil, reducing the need for synthetic fertilizers for subsequent crops. This interdependence can lead to more efficient use of resources and lower overall input costs.

Monoculture farming appears to offer higher gross and operating profit margins, it also entails higher input costs due to the need for intensive management practices. Diversified farming, although having lower profit margins, can benefit from reduced input costs and more sustainable practices that improve long-term farm viability.

Table 19. Gross and operating profit margin ratios per hectare of small-scale corn farmers in municipality of Cabagan, Isabela.

Item	Farming method		
	Monoculture	Diversified	Mean difference
Total returns (PhP)	98779.31	57825.9	40953.41
Total costs (PhP)	31126.96	29327.56	1799.4
Net return (PhP)	67652.35	28498.34	39154.01
Gross profit margin ratio	0.82	0.67	0.15
Operating profit margin ratio	0.68	0.57	0.11

4. CONCLUSION

Older farmers dominate both monoculture and diversified systems. Monoculture farms are predominantly male, whereas diversified farms have more females, with most farmers in both systems being married and having elementary to high school education. Both groups have similar income levels and farming experience, but diversified farmers avail themselves of credit more.

Monoculture farming relies more heavily on tractors, whereas diversified farms utilize a combination of tractors and traditional plows. Monoculture farms primarily employ mechanical seeders, while diversified farms tend to use manual seeding methods. Diversified farms make greater use of pump wells and irrigation systems, in contrast to monoculture farms, which mostly depend on rainwater. Both farming systems use herbicides, with monoculture having a slightly higher usage. Pesticide use is minimal in both systems.

Monoculture farming utilizes more man-days for land preparation and fertilizer application. In contrast, diversified farmers have higher family labor participation and more man-days for seed preparation, planting, and water management. Monoculture incurs higher total cash costs compared to diversified farming. Monoculture spends more on labor and other farm inputs such as fertilizer and pesticides.

Monoculture farmers earned a significantly higher total return per hectare (Php 98,779.31) compared to diversified farmers (Php 57,825.90). While monoculture farming appears more profitable financially, non-monetary factors such as sustainability, soil health, and risk management are also important considerations when choosing a farming system.

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