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# Factors Influencing Agricultural Land Management Practices in Misamis Occidental, Philippines

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Gaining insights into prevailing land management practices and discerning the factors influencing their adoption is important since it can help pinpoint areas that require enhancement and help formulate targeted strategies to optimize existing agriculture support services in the province. This paper aims to identify the determinants that can influence the implementation of different land management practices among the farmers in Misamis Occidental, Philippines. Descriptive statistics were employed to describe the socio-demographic and farm characteristics of the farmers, while a logistic regression model was used to determine correlations between these characteristics and the adoption of different management practices. Results of the analysis indicate that farmer's age, monthly income, family size, farm ownership, farm size, farm age, education, and association membership can influence the implementation of different practices in various ways. Since farm age (p=0.03) and organization membership (p=0.01) emerged as significant influencing factors, it is recommended to strengthen and support these organizations so more new farm owners can be engaged to participate in land conservation efforts within Misamis Occidental watershed.
**Keywords:** Sustainable land management practices, tilling, organic fertilizer, inorganic fertilizer, organic farming, agroforestry, Logit Regression Model.

## INTRODUCTION

Agriculture holds significant importance in the Philippines, especially in rural regions where a considerable portion of the population depends on farming as their main livelihood. In the province of Misamis Occidental, located in the Northern Mindanao region of the Philippines, agriculture plays a vital role in the local economy and supports the livelihoods of numerous residents. Misamis Occidental is renowned for its diverse agricultural production, with crops such as sugarcane, rice, coconut, and bananas making significant contributions to the local agricultural output. These crops not only ensure food security but also contribute to the province's economy through trade and export (SAAD, 2021). However, farmers in Misamis Occidental encounter various challenges in effectively managing their lands. These challenges include limited access to modern agricultural technologies, insufficient capital for farm investments, and the impact of environmental factors such as climate change and land degradation (Salvador-Canceran *et al.,* 2015). Exposure to extreme weather conditions can make some agricultural areas susceptible to erosion and landslides. Soil infertility exacerbated by poor irrigation systems was blamed for being the persistent cause of low production. The local government in the province had provided agricultural support services to address the identified needs of the farmers. These services include the provision of irrigation materials, distribution of planting materials, assistance in the prevention and control of pests and diseases, and transfer of appropriate technologies. However, most farmers are not aware of these offered services (Villanueva *et al.,* 2019). Demographic information on the farmers who actively manage their plantations can be helpful to tailor-fit program campaigns related to these agricultural services optimizing the use of free and available resources. Understanding the current land management practices and the determinants of their implementation are crucial to identifying areas for improvement and developing strategies to optimize available agricultural services in the province's local governments.

Perennial cropping systems inherently serve dual or multi-use purposes, contributing to both ecosystem services and the bioeconomy (Sprunger *et al.,* 2024). The longevity of perennial crops allows for continuous ecosystem services, such as soil conservation, water retention, and biodiversity enhancement. Simultaneously, these crops become valuable resources for the bioeconomy, offering a renewable source of

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raw materials for various industries. The synergy between ecological and economic functions makes perennial cropping systems an integral component of sustainable and resilient agricultural practices. The benefits of incorporating perennial crops in annual crop farms (agroforestry) have been recognized as an effective tool for combating the impacts of climate change and promote environmental benefits. For example, in Bangladesh, nationwide agroforestry programs have been implemented to diversify production, enhance soil health, and maintain groundwater levels (Shoyama *et al.*, 2020). In northwest and southwest China, soil loss rates are comparatively higher compared to other countries because of the prevalence of conventional tillage (Guo *et al.*, 2015). The implementation of ridge tillage, where seedlings are planted on raised beds, was proven to reduce erosion rates of farmlands in China significantly (Dai *et al.*, 2018) and Indonesia (Satriawan *et al.*, 2015). Tillage operations combined with mulching techniques (such as straw returning) can also prevent soil loss in agricultural farms (Wang *et al.*, 2019). Besides enhancing soil fertility, the application of organic matter, such as animal manure, can reduce erosion rates as it makes the soil more resistant to detachment (Wang *et al.*, 2017). The application of manure when utilized together with contour tillage and mulching can improve the efficiency of the soil erosion control measure (Zhang *et al.*, 2016). (Wang *et al.*, 2018) also measured the efficiency of grass cultivation to reduce soil erosion in China. They noted a decrease in surface runoff by 27-72% by integrating grass hedges (Melilotus and Pennisetum grass) on a maize field. The grass hedges prevented not only soil erosion but also reduced the amount of atrazine that leaches the deeper soil layers.

The adoption of sustainable land management practices can be influenced by multiple factors. According to (Nelson *et al.*, 2019), higher levels of education positively contribute to the comprehension of organic agriculture (OA) and environmental aspects. In a study conducted in the mountainous and coastal regions and the Mekong delta in Vietnam, household income was identified as having a significant impact on the adoption of sustainable land management practices (Dung, 2022). This is because adoption of SLM can be costly compared to regular agricultural practices. Farm households that have access to extension services were also found to adopt SLM practices than those with no access in the regions. In Thailand, the common reasons for the non-adoption of SLM are the shortage of labor, absence of resources (e.g. water, financial budget, materials, and ingredients), and lack of knowledge (Salaisook, 2019).

In general, the implementation of land management practices by rural households was also found to be influenced by factors such as wealth status/income (Turyahabwe *et al.*, 2022; Uddin *et al.*, 2014), educational attainment (Agidew and Singh, 2019; Deressa *et al.*, 2009), farm size (Bekele and Drake, 2003; Etsay *et al.*, 2019), and other multiple factors (Table 1). The purpose of this work is to describe the existing socio-demographic and farm characteristics among perennial plantation farmers and to determine how these characteristics influence the adoption of various land management practices. This work describes the existing socio-demographic and farm characteristics among perennial plantation farmers and determines how these characteristics influence the adoption of various land management practices.

**Table 1. Influence of various factors on the implementation of land management practices.**

| Factors | Influence | Supporting References |
|---|---|---|
| Educational attainment | Positive | Deressa *et al.*, 2009<br>Agidew and Singh, 2019<br>Turyahabwe *et al.*, 2022<br>Uddin *et al.*, 2014 |
| Age | Positive | Turyahabwe *et al.*, 2022 |
| | Negative | Uddin *et al.*, 2014 |
| Income | Positive | Turyahabwe *et al.*, 2022<br>Uddin *et al.*, 2014 |
| Family Size | Negative | Bekele and Drake, 2003<br>Uddin *et al.*, 2014 |
| Farm ownership | Positive | Turyahabwe *et al.*, 2022<br>Atiyong *et al.*, 2020 |
| Farm Size | Negative | Etsay *et al.*, 2019<br>Bekele and Drake, 2003<br>Uddin *et al.*, 2014 |
| | Positive | Turyahabwe *et al.*, 2022 |
| Farm Age | Positive | Kreitzman, 2020 |
| Membership on a farmer association | Positive | Turyahabwe *et al.*, 2022<br>Uddin *et al.*, 2014 |

## MATERIALS AND METHODS

Study Area: The study area is in Misamis Occidental, Philippines, which is situated in the northern part of the island of Mindanao (Figure 1). Misamis Occidental is a province known for its diverse ecosystems, encompassing both terrestrial and marine environments. The province is bordered by the Mindanao Sea to the north and the provinces of Zamboanga del Norte and Zamboanga del Sur to the west and south, respectively. The sampling area covered the falcata, banana, mango, and coconut plantations in Oroquieta, Jimenez, and Aloran Misamis Occidental.

Study Population and Research Instrument: A master list of farmers who are actively engaged in managing banana, mango, coconut, and falcata plantations was obtained from the Department of Agriculture and respondents were randomly chosen from the list. These farmers were from three municipalities recommended by the department: Jimenez, Aloran, and Oroquieta. From this master list. A total sample of 86 farmers (10% of the registered farmer population) were chosen to participate in this research. A semi-structured survey questionnaires were distributed among the

respondents. For ease of understanding, the questionnaire was created in a local dialect (Cebuano/Bisaya). Prior to the conduct of data collection, a pre-test was conducted first to ensure the validity and completeness of the questionnaire. Results of the pre-test survey were integrated into the questionnaire.

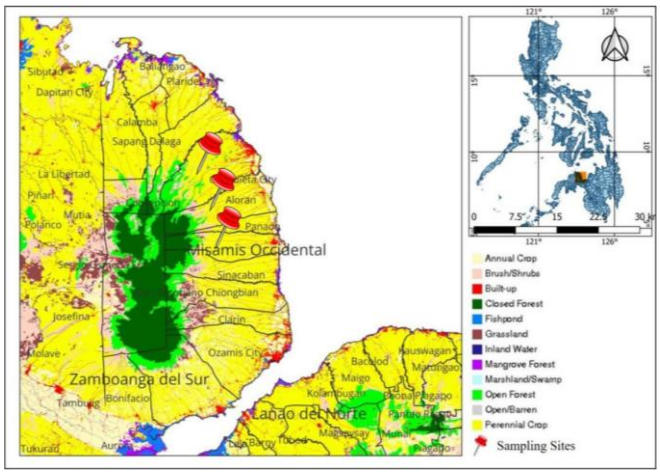


**Figure 1. Map of Misamis Occidental showing sampling areas.**

***Data Analysis*:** This study involved regressing the socio-demographic and farm characteristics against the various land management practices. The socio-demographic and farm characteristics, as well as the land management practices, were chosen based on a review of diverse literature and actual on-the-ground practices. The land management practices selected in this study included soil tillage (ST), plant compost application (PC), organic fertilizer (i.e. manure) application (OF), inorganic fertilizer application (IF), mixing of other tree species (MT), and clearing of understory vegetation (CU). The socio-demographic and farm characteristics that influence the land management practices were considered the independent variables. These variables included age, income, family size, farm ownership, farm size, farm age, membership to a farmer association, and education.

Statistics such as the mean, standard deviation, and percentages were used to describe the different socio-demographic and farm characteristics. Since the outcome or the dependent variable is binary (Yes = 1; No = 0), logistic regression model was employed to identify the influencing factors of the adoption of various land management practices among the farmers. The logit regression model has a few assumptions. Besides having binary response variables as mentioned, the model assumes that observations are independent from each other and no multicollinearity should exist among explanatory variables. Since the logistic regression model is designed for binary outcomes, it is not suitable for modeling variables with more than two categories, otherwise, multinomial logistic regression is more appropriate. The model is also sensitive to outliers which can disproportionately affect the resulting coefficients. The same model was also used in various studies (Atiyong *et al.*, 2020; Etsay *et al.*, 2019; Mebrate *et al.*, 2022; Uddin *et al.*, 2014). The logit model was utilized to discern the socio-economic factors impacting farmers' adoption of diverse farm management practices. The functional form of the logit model, as derived by Gujrati and Porter (Gujrati and Porter, 2009) and employed by (Uddin *et al.*, 2014) is expressed as follows:

$$P_i = 1/1 + e^{-zi}$$

where, Pi is equal to the probability of adoption of the ith respondent, Ezi represents the irrational number e raised to the power of Zi.

Zi refers to the function of N-explanatory/dependent variables and expressed as:

$$Zi = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_n x_n + \mu_i$$

where, β0 = constant term; β1,…,βn = regression co-efficient

Therefore,

$$Zi = \beta_0 + \beta_1\,(\text{Age}) + \beta_2\,(\text{Monthyincome}) + \beta_3\,(\text{Familysize}) + \beta_4\,(\text{Farmownership}) + \beta_5\,(\text{Farmsize}) + \beta_6\,(\text{Farmage}) + \beta_7\,(\text{Membershiptoanassociation}) + \beta_8\,(\text{Education}) + \mu$$

Before the conduct of regression analysis, the independent variables were subjected to a contingency coefficient test and variance inflation factor (VIF) to identify the presence of multicollinearity. Statistical analysis was performed using STATA MP17.

## RESULTS

Socio-demographic Characteristics: Results of socio-demographic and farm characteristics descriptive analysis were reflected in Table 2. Farmers involved in the management of their plantations span a wide age range, ranging from 25 to 89 years old. A significant proportion of 5% hails from the 51-70 age group, while only 4.65% is represented by farmers aged 18-30. Additionally, a segment of the farming population (18.60%) comprises individuals who are more than 70 years old. On average, the farmers have an age of approximately 57 years. Regarding income, the survey results indicate a range from ₱1,200.00 to ₱85,000.00 per month for the farmers. The majority (49%) of farmers report a monthly income of less than ₱5,000.00. A substantial portion (34%) falls within the income bracket of ₱5,001.00 to ₱15,000.00. A smaller percentage of farmers fall into the income categories of ₱15,001.00 to ₱25,000.00 (6%), ₱25,001.00 to ₱35,001.00 (7%), and greater than ₱35,000.00 (4%). Many of the interviewed farmers, however, do not solely depend on their plantations. They also have alternative sources of income beyond farming, such as holding positions

as barangay officials, owning "sari-sari" stores, and receiving financial support from other family members, among others. Household sizes in the surveyed population range from 1 to 10 individuals. A significant portion (50%) of farmers have households composed of 4 to 6 people. In contrast, 42% of farmers have smaller households, consisting of 1 to 3 individuals. These families predominantly comprise elderly couples who have been left behind by their children to work or start their own families in other locations. Larger households with 7 to 9 people account for only 7% of the respondents, while those with 10 people are the least common among the surveyed farmers. The majority of farmers, comprising 27%, have completed high school, indicating a significant portion of the farming community has at least a secondary education. The next highest percentage, at 21%, consists of college graduates, highlighting a noteworthy presence of individuals with higher education within the farming population. The distribution of the remaining percentage (52%) was evenly spread across different educational categories (elementary level, elementary graduate, high school level, and college level).

**Table 2. Descriptive analysis of socio-demographic and farm characteristics.**

| Variables | N | Min. | Max. | Mean | SD |
|---|---|---|---|---|---|
| Age | 86 | 25 | 89 | 57 | 15 |
| Monthly income (₱) | 84 | 1,200 | 85,000 | 10,915 | 12,885 |
| Family size | 86 | 1 | 10 | 4 | 2 |
| Farm size (ha.) | 86 | 0.25 | 9.00 | 1.36 | 1.40 |
| Farm age (years) | 86 | 3 | 65 | 19 | 18 |
| Education | | | Frequency | Percentage | |
| Elementary Level | | | 11 | 12.79 | |
| Elementary Graduate | | | 11 | 12.79 | |
| High School Level | | | 11 | 12.79 | |
| High School Graduate | | | 23 | 26.74 | |
| College Level | | | 12 | 13.95 | |
| College Graduate | | | 18 | 20.93 | |
| Total | | | 86 | 100.0 | |
| Farm ownership | | | | | |
| Owned | | | 51 | 59.30 | |
| Renting/Tenant | | | 35 | 40.70 | |
| Total | | | 86 | 100.0 | |
| Membership to an association | | | | | |
| Member | | | 49 | 56.98 | |
| Non-member | | | 37 | 43.02 | |
| Total | | | 86 | 100.0 | |

Farm Characteristics and Farm Ownership: A significant portion (66%) of farmers manage a farm area falling within the range of 0.01 to 1.00 hectares. Additionally, 17% of the farmers manage farms with an area between 1.01 and 2.00 hectares. A smaller percentage of the farmers are managing farm sizes ranging from 1.10 to 1.5 hectares (7%) and more than 3 hectares (9%). In terms of farm age, a proportion (29%) of the farms under investigation are aged five years or younger. This percentage does not significantly differ from the proportion of farms exceeding 25 years of age. In general, the majority of farms (50%) fall within the bracket of ten years or younger. The majority (59%) of the farmers have direct ownership and control of the land they cultivate, while 41% reported that they are just renters or tenants of the land they manage. Among the surveyed population, 57% are members of a farmer association. This membership in this certain group suggests a substantial presence of social capital among these farmers.

Factors Influencing Land Management Practices: The following figure (Figure 2) depicts the land management practices applied by the surveyed farmers across the three municipalities. Most farmers (86%) are involved in vegetation clearing, using tools such as mechanical grass cutters or the traditional bolo. A substantial portion (77%) of farmers integrate various tree species into their plantations. Almost equal percentages of farmers adopt the use of plant residues, organic fertilizers, and non-organic fertilizers (28%, 26%, and 31%, respectively). In contrast, among the six practices, tilling emerges as the least utilized land management practice, with farmers typically implementing it only during the planting stage.

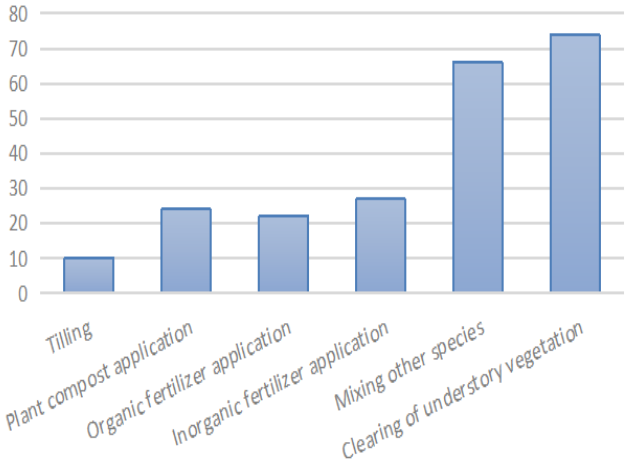


**Figure 2. Frequency of land management adoptions.**

Testing for Multicollinearity: Prior to undertaking a logistic regression analysis, the independent variables underwent a contingency coefficient test to assess the presence of multicollinearity between the independent variables. Contingency coefficient can determine whether two variables are dependent or independent of each other. Multicollinearity, if present, can inflate the variance and potentially lead to type II errors. The results of the test in STATA revealed very low (less than 0.75) contingency coefficients, indicating the absence of multicollinearity between the independent variables being tested.

Another diagnostic test to confirm the presence of multicollinearity is through the variance inflation factor

**Table 3. Multicollinearity through contingency coefficient test.**

| | Age | Education | Income | Fam.Size | Ownership | FarmSize | FarmAge | Membership |
|---|---|---|---|---|---|---|---|---|
| Age | 1.0000 | | | | | | | |
| Education | -0.2447 | 1.0000 | | | | | | |
| Income | -0.1238 | 0.3907 | 1.0000 | | | | | |
| Fam.Size | -0.2717 | 0.1326 | 0.1447 | 1.0000 | | | | |
| Ownership | 0.1327 | 0.0384 | -0.1302 | -0.0696 | 1.0000 | | | |
| FarmSize | 0.0987 | 0.1518 | 0.0357 | 0.3042 | -0.2170 | 1.0000 | | |
| FarmAge | 0.3194 | -0.1620 | -0.0534 | -0.0534 | 0.0091 | 0.2762 | 1.0000 | |
| Membership | 0.0579 | 0.1175 | 0.1435 | 0.1435 | -0.0984 | -0.0560 | 0.0132 | 1.0000 |

**Table 4. Multicollinearity through VIF test.**

| | VIF | Tolerance (1/VIF) |
|---|---|---|
| Education | 1.38 | 0.726338 |
| Income | 1.32 | 0.760342 |
| Family Size | 1.26 | 0.790973 |
| FarmOwnership | 1.19 | 0.843402 |
| FarmSize | 1.18 | 0.848670 |
| FarmAge | 1.12 | 0.892659 |
| Assoc.Membership | 1.10 | 0.911657 |
| Mean VIF | 1.22 | |

**Table 5. Results of Logit Regression Model.**

| | ST | PC | OF | IF | MT | CU |
|---|---|---|---|---|---|---|
| Age | -0.0169 | -0.0073 | -0.0147 | -0.0200 | 0.0073 | 0.0118 |
| | (0.0275) | (0.01983) | (0.0234) | (0.0186) | (0.0207) | (0.0260) |
| Income | 3.80e-06 | 0.00005 | 0.00006 | 0.00002 | -0.00002 | 0.00003 |
| | (0.00003) | (0.00003) | (0.00003) | (0.00002) | (0.00002) | (0.00004) |
| Fam.Size | 0.0058 | 0.1802 | 0.0423 | -0.1645 | -0.0428 | -0.0690 |
| | (0.2374) | (0.1652) | (0.2032) | (0.1570) | (0.1608) | (0.2083) |
| FarmOwnership | -0.6553 | -0.4430 | -0.2647 | -0.6790 | -0.8027 | -0.7843 |
| | (0.7613) | (0.5485) | (0.6218) | (0.5212) | (0.6122) | (0.7827) |
| FarmSize | 0.2728 | -0.4388 | 0.5126 | -0.1422 | -0.0937 | -0.0070 |
| | (0.2695) | (0.3215) | (0.2723) | (0.2341) | (0.2165) | (0.2882) |
| FarmAge | -0.0228 | -0.0010 | -0.0558* | 0.0092 | -0.0113 | 0.0057 |
| | (0.0259) | (0.0154) | (0.0251) | (0.0142) | (0.0150) | (0.0197) |
| Assoc.Membership | -0.2331 | 0.3627 | 1.8915* | 0.5923 | 0.3285 | 0.7993 |
| | (0.7527) | (0.5705) | (0.7367) | (0.5316) | (0.5577) | (0.6849) |
| Education | -0.0720 | -0.2485 | -0.1381 | 0.1666 | -0.0772 | -0.1218 |
| | (0.2413) | (0.1901) | (0.2145) | (0.1755) | (0.1939) | (0.2405) |

Source: Field Survey 2022, *Significant at p 0.01, Enclose in parenthesis are the standard error

(VIF). The VIF can be calculated using the following formula:

$$VIF_i = \frac{1}{1 - R_{i^2}}$$

where $R_{i^2}$ denotes the unadjusted coefficient of determination for regressing the ith independent variable on the remaining ones. Upon conducting the test in STATA, the Variance Inflation Factor (VIF) yielded a mean value of 1.22. Multicollinearity may be identified when the VIF value exceeds 5 or 10 (Kim, 2019). Consequently, in these variables, multicollinearity is not present. The tolerance level (1/VIF) measures the level of estimator's sensitivity to changes. A serious collinearity problem is indicated by values lesser than 0.10 (Marcoulides and Rakov, 2019; Kim, 2019). Result of the VIF and tolerance level (1/VIF) test (table 4) indicates the absence of collinearity.

***Logistic Regression Analysis:*** The outcomes derived from the logit models presented in Table 5 illustrate how farmers' socio-demographic factors and farm characteristics impact the adoption of diverse land management strategies. Various factors exert distinct influences on implementation. While age, farm size, ownership, age of the farm, and education

exhibit negative correlations with most management practices, both income and membership in a farmer's association are positively correlated with the adoption of the majority of land management practices. Farm age and association membership also demonstrate significant influences ($p<0.05$) on the adoption of a land management practice, particularly with organic farming implementation. The negative correlation coefficient indicates that the intensive practice of inputting organic substances typically occurs during the early stages of plantation establishment and eventually decreases as the plantation ages.

## DISCUSSION

The result suggests that age does not have a significant impact on the adoption of various land management practices, aligning with the findings of Barman and Das (Barman and Das, 2010). The mean age of the participants is comparable to the average age of farmers in the country, which is 57 (UNO, 2013). Almost 24% of the respondents are 50 years old and above. This is comparatively lower than the results in the socio-demographic characteristics of farmers in Camarines Sur and Cawayan, Masbate, Philippines where 77% and 47% of the farmers, respectively, are 50 years old and above (Paladan, 2019; Velza et al., 2023) but is almost comparable to the farmers in Sugpon, Ilocos Sur where 28% belongs to the age group of 50 and above (Roa *et al.*, 2022). This indicates a greater participation of older individuals in agriculture compared with the youth. The relatively low engagement of young people in farming may stem from a perception of agriculture as unappealing, leading them to seek alternative employment in other sectors. This has been apparent in the data on family size range in which 41% of the surveyed population are composed of one to three family members, predominantly, elderly couples. The prevalence of older farmers, however, brings advantages in terms of accumulated wealth, experience, and social capital within the agricultural system (Abegunde *et al.*, 2019). By examining the coefficient estimates, it appears that older farmers are more inclined towards traditional and less labor-intensive approaches like agroforestry and vegetation clearing rather than embracing modern techniques such as tilling and application of inorganic fertilizers (Atiyong *et al.*, 2020; Uddin *et al.*, 2014). This generational shift in the agricultural sector can be considered an opportunity to promote sustainable agricultural practices within the province. Younger farmers have the vitality and enthusiasm to participate in educational initiatives and practical training programs. Additionally, they are more open to adopting digital technologies (such as drones, satellite imagery, etc.) that can allow more precise management of water, fertilizer, and pesticide applications on their farms. This can allow resource optimization, waste reduction, and the mitigation of environmental pollution. Younger farmers can also leverage existing data analytic available on the internet to forecast weather patterns, monitor market trends, and assess resource availability to enhance productivity and mitigate risks.

Over 80% of the surveyed population have incomes that are below the monthly poverty threshold (for a family of five) in the country, which is ₱12,030.00 in 2021 (PSA, 2022). Given that a significant portion of farmers belong to families that are below the poverty threshold, the establishment of a financing scheme tailored to this population would enhance the adoption of sustainable practices throughout the province. Income also exhibits an extremely weak positive influence on the adoption of land management practices. Farmers with considerable off-farm income may tend to prioritize alternative activities with potentially higher returns than conservation investments, leading to reduced investment in soil conservation practices (Kerr and Sanghi, 1992). The majority of the management practices such as tilling, fertilizer application, and understory vegetation clearing require initial investment except for agro-forestation as farmers can simply cultivate their seedlings and integrate them into their plantations. This result implies that with better access to financial resources, the farmers are willing to adopt sustainable practices in their farming operations. In line with this need, the Philippine government has intensified its lending programs to address the financial constraints in the agricultural sector and help farmers boost their productivity (Bayudan-Dacuycuy *et al.*, 2022). Besides financial access, the government also provided various agricultural services, such as the distribution of planting materials, prevention of agricultural pests and disease and transferring of appropriate technology. However, many farmers in the province are not aware of these agricultural support services offered by the local governments (Villanueva *et al.*, 2019).

The analysis of demographic characteristics revealed that nearly 27% of the participants had graduated high school. This value is comparatively higher than the farmers in Masbate where only 17% have finished high school or have pursued tertiary education (Velza *et al.*, 2023) and the majority (58%) of the farmers were not able to complete elementary education. While a significant portion of the respondents have graduated college (21%), many of the farmers (25%) barely finished elementary level. This implies that communication can be problematic if the language used in educational campaigns is too technical. Visual and practical demonstrations using simplified training materials and local language can be effective in conveying information to this group. There is an expectation that the level of education could influence the adoption of land management decisions because of the assumed connection between education and knowledge. While several studies have reported a significant positive association between education and land management decisions (Badal *et al.*, 2006; Deressa *et al.*, 2009; Uddin *et al.*, 2014), the current study's results do not align with this claim. Most of the coefficient estimates tend toward negative

relationships, a trend that was also observed in a separate study conducted in the Tigrai region of Ethiopia (Etsay *et al.,* 2019). This could be explained by the possibility that the execution of these practices may not demand higher education and technological expertise (Atiyong *et al.,* 2020). Alternatively, it might be due to highly educated farmers having more opportunities outside farming, which could contribute to their lower involvement in the implementation of these practices, particularly the labor-intensive ones (Aryal *et al.,* 2021). The use of inorganic fertilizer, on the other hand, may need some degree of literacy as most often, these fertilizers come with instructions regarding rates, timing, and safety precautions.

The mean household size in the study is 4, which can indicate division of labor in farm activities. Women in the family are often considered as supplemental family labor for farm activities such as harvesting and selling of harvested products. Meanwhile, men who are often the household head, lead the decision-making process on all farm activities of the household (Deluna, 2023). Additionally, the maximum family size is 10. This indicates that there is a potential for inter-generational knowledge transfer within the family and ensures the continuity of sustainable farming techniques. Large family sizes can promote resource sharing and collaboration among family members to optimize access to land, water, tools, and equipment. The findings from the regression analysis indicate that family size does not emerge as a significant factor influencing the adoption of various land management practices. The same insignificant yet positive impact was also identified by (Deressa *et al.,* 2009) in their study in the Nile Basin of Ethiopia. However, the coefficient estimates of the current study's data suggest that households with larger family sizes may be inclined to adopt certain labor-intensive practices, such as tilling and the application of plant residues and organic fertilizers. This aligns with the results supported by (Atiyong *et al.,* 2020), who identified a strong positive correlation between household size and these management practices. Families are recognized as valuable sources of labor for farm operations and are often considered advantageous for farm productivity, especially in tasks that require significant labor input.

From the sampled population, a significant portion of farmers (59%) owned the land they managed. The influence of land tenure on the choice of land management practices appears to be statistically insignificant, as per the results. However, the negative coefficient values suggest that farmers who are sharers and renters adopt these practices more frequently than landowners do. This inclination might be attributed to tenants prioritizing short-term economic gains, potentially leading to the over-exploitation of soils, as noted by (Eder *et al.,* 2020). A similar insignificantly negative relationship was also identified in the study concerning various practices such as tilling, organic farming, and mixed cropping (Atiyong *et al.,* 2020). Furthermore, corroborating studies by (Barman and Das, 2010) affirm that ownership is significantly associated with the adoption of beneficial measures, but not the use of unbeneficial ones. Given that a significant percentage of farmers are landowners, policies should promote responsible land stewardship and incentivize land owners who adopt sustainable land management practices. Some incentive approaches may include access to credit, grants for implementing conservation measures, and subsidies for purchasing inputs or equipment that facilitate sustainable land management. The existing agricultural extension services should promote participation among landowners in the decision-making processes related to land tenure and agricultural development. This can be done by encouraging dialogue, collaboration, and knowledge sharing of the adoption of sustainable land management practices. Tenants, on the other hand, often lack decision-making authority over land management practices, as they must adhere to the preferences and directives of landowners. Policies should be designed to provide them legal protection for their rights and ensure that they have a recourse mechanism to address grievances or violations of their rights pertaining to land use. Policies can also prioritize measures to secure land rights for example highlighting land titling programs and land regularization initiatives. This can be beneficial especially since many farmers in the province believe that land title security can address their problem of the lack of livelihood resources (Salvador-Canceran *et al.,* 2015). The size of the farm is another factor that can influence decisions related to land management. Findings from the current study reveal both positive and negative relationships between farm size and the adoption of various land management practices, although these relationships are not statistically significant. A similar lack of conclusiveness was observed in the study by (Bradshaw *et al.,* 2004). Nevertheless, the coefficient estimates suggest that farmers with larger farms may show a preference for investing in soil tillage. The negative pattern of coefficient estimates for practices such as plant compost and inorganic fertilizer application, as well as the integration of multiple tree species and clearing of understory vegetation, could be attributed to the increased difficulty in implementing these methods as the land size grows. These practices often require more labor and incur higher costs (Takele *et al.,* 2023; Uddin *et al.,* 2014).

The findings also indicate that farm age does not significantly impact the majority of the specified management practices, except for the application of organic fertilizer ($p = 0.03$). Organic fertilizers can promote plant growth (Ye *et al.,* 2022), the reason why they are usually applied during the early stage of plantation establishment. According to the coefficient estimates, activities like soil tillage, plant compost application, and the integration of multiple tree species (agroforestry) may be more prevalent during the earlier phases of plantation establishment. This is significantly true ($p = 0.03$) for the application of organic fertilizer. However,

as the plantation ages, maintenance activities such as the clearing of understory vegetation may intensify, most likely for aesthetic reasons. The application of inorganic fertilizer, on the other hand, may intensify as the plantation ages to enhance desirable plant qualities and traits (Ganeshamurthy *et al.,* 2019).

Membership in an association positively influences the implementation of various management strategies. Additional benefits along with an organization membership such as training and visitation of extension workers can motivate farmers in participating conservation programs and the implementation of conservation practices in their respective farms (Badal *et al.,* 2006). The significantly positive influence of association membership ($p = 0.01$) in the adoption of organic fertilizer implies that farmers who are members of agricultural associations are more likely to adopt the use of organic fertilizer compared to those who are not members. This correlation suggests that being part of such groups provides farmers with access to information, resources, or shared knowledge that encourages the adoption of sustainable and organic farming practices. To enhance the effectiveness of the farmers' association, it is advisable to introduce workshops and training initiatives. A knowledge-sharing platform must be established to encourage interaction and exchange of ideas pertaining to agricultural innovations. Since many farmers are not aware of the agricultural services offered by local governments in the province (Villanueva *et al.,* 2019), these social groups can be utilized to effectively improve information dissemination. To reach more farmers, the government can support the association in various means such as providing financial support and technical assistance to promote capacity-building initiatives, facilitating access to resources such as equipment and transportation services, developing supportive policies that enable the associations to thrive effectively such as land tenure and credit access, and ensuring legal recognition through appropriate legal frameworks to enhance accountability, legitimacy and address any bureaucratic barriers.

***Conclusion*:** The current study could pinpoint the areas that need to be considered in designing the overall land management programs in the province. While the majority of the farmers are 50 years old or above, younger farmers are identified to be more engaged when it comes to the implementation of various land management practices. This reflects a promising trend among younger farmers who display a greater inclination toward adopting modernized techniques. This shift in attitude among younger farmers suggests a positive trajectory for the adoption of advanced farming methods. Furthermore, income was found to have a positive influence on the implementation of various management practices. Thus, the provision of access to finances or incentives is a pivotal motivator for the adoption of sustainable farm management practices. Besides promoting environmental conservation, these incentives may encourage the younger generation to be actively involved in farm management instead of looking for other opportunities outside farming. Aligning financial incentives with environmental goals can become a multifaceted strategy with economic, environmental, and generational engagement benefits. It is also important to highlight the indispensable role of associations and extension services in the implementation of sustainable farming practices. Financial constraints and the lack of resource availability among farmers can be addressed by policymakers by allocating budgetary resources to support the associations' capacity-building initiatives and infrastructure development. To optimize agricultural services offered, the local government should work collaboratively with the existing farmers' association to reach and attract more farmers.

To promote the implementation of sustainable land management practices, it is also imperative to intensify programs and campaigns targeted at populations without formal degrees, as they show a higher level of involvement in this study. Extension materials, guides, and toolkits should be specifically designed for them to convey information more effectively. These can include the use of interactive and attractive brochures that are communicated in the local dialect.

Moreover, collaboration with research institutions, private sectors, and civil society organizations (such as NGOs) can be helpful to leverage complementary strengths and resources. The research institutions can help conduct localized studies and provide technical expertise to identify appropriate sustainable farming practices that allow soil, water, and biodiversity conservation while minimizing the environmental impact. The private companies can help in the provision of additional resources such as seeds, fertilizers, and pesticides. Furthermore, they also play a crucial role in connecting farmers to markets and adding value to agricultural products. Civil social organizations, such as NGOs, can also promote community development, social cohesion, and empowerment by facilitating the formation of cooperatives and self-help organizations that allow farmers to collectively address common challenges for sustainable land management and access support services.

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***Availability of data and material*:** We declare that the submitted manuscript is our work, which has not been published before and is not currently being considered for publication elsewhere.

***Code availability*:** Not applicable.

***Consent to participate*:** All authors participated in this research study.

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***SDG's Addressed*:** Zero Hunger.

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