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Ethnofarming Practices of Mandaya Ginger Farmers in Andap, New Bataan, Davao De Oro, Philippines

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Abstract

The study aimed to determine the socio-demographic profile and document existing practices and problems related to ginger farmers' soil fertility, diseases, and insect pest management practices. Also, to analyze the agro-ecological situation using SWOT analysis. The enumerators conducted one-on-one interviews with the ginger farmers with participative field transects from November 2017 to June 2018 to identify the Ethno farming practices of Mandaya ginger farmers with 44 key participants. The result shows that the majority of the ginger farmers are old (36%), male (80%), married (85%) with 5 to 6 children (32%), with more than 25 years of ginger farming experience (77%) in less than 0.25 hectare (50%), and have low educational attainment (48%). The Mandaya ginger farmers use soil color and texture, the presence of *Ageratum conyzoides*, and crop income from the previous cropping as indicators to identify fertile and infertile soils. Fewer Mandaya farmers still practice indigenous knowledge including magical, factual, and traditional practices on ginger production. Although most farmers use new technologies, some tend to combine their indigenous knowledge with new technologies for ginger farming. It has been identified that the Mandaya farmers had limited knowledge of controlling insect and disease infestations, soil fertility management, and commodity price fluctuation, which are significant constraints for them. Mandaya ginger farmers and government agencies are encouraged to develop technologies that will utilize their indigenous knowledge of ginger and other crops while promoting, preserving, and protecting their cultural identity anchored to a scientific way of farming to help attain food security and sustainability for the country.

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Introduction

Indigenous groups in Mindanao often use celestial bodies or the stars as their basis or guide for their farming, hunting, fishing, and other livelihood activities, beliefs, practices, and traditions.[1] One of the most famous indigenous tribes in New Bataan, Davao de Oro, is the Mandaya. Mandaya means the first people upstream, “man” means people, and “daya” refers to the upper portion of the river.[2]

The primary source of living for Mandaya people in Barangay Andap is agriculture. They cultivate coconuts, tubers, other cultigens, and along with bananas, vegetables, and root crops. In addition, Mandaya farmers living in remote places follow traditional methods for ginger cultivation, which are generally eco-friendly, less expensive, and utilize local resources, knowledge, and labor. However, most of these traditional cultivation sites and fallow areas have now been degraded and are further threatened by the influx of migrant farmers introducing unsustainable ginger commercial farming practices. According to the Philippine Statistic Authority, in 2019, the production of ginger went down to 26.93 thousand metric tons or by -3.6 percent, from 27.93 thousand metric tons in 2018.

Farmers' experience of several generations with soil and land, in production and management practices to post harvest operation could be of tremendous benefit to agriculture scientists. This knowledge should be developed with scientific knowledge in formulating research strategies and interventions to create effective and efficient agriculture farming to improve and sustain the country's food security. A participatory research approach involving farmers is essential for developing technologies and management innovations.[3,4,5] Ethno farming practices of Mandaya fall under the level of ethno science. Thus, ethnoscience is ethnic or “native science," the indigenous scientific practices or the "science" practiced by ethnic or indigenous groups.[6]

To achieve this, it is necessary to document the indigenous practices of Mandaya ginger farmers since their indigenous farming practices are not documented so far. With the advent of government modernization programs, indigenous farming practices could be replaced by new technological knowledge. Also, available scientific literature on the ethnofarming of Mandaya ginger farmers is hard to find. Perhaps it has prompted the researchers to document the existing ethno farming practices of Mandaya ginger farmers in Andap, New Bataan, which could help them preserve their indigenous farming knowledge and maintain cultural integrity. Thus, this study was initiated to determine the socio-demographic profile and document the existing practices and problems related to and limited to soil fertility, insect pest, and diseases management practices of Mandaya ginger farmers. Also, to analyze the agro-ecological situation using Strength, Weaknesses, Opportunities, and Threats (SWOT) analysis of Mandaya ginger farmers in Andap, New Bataan, Davao de Oro, Province.

Methodology

Research Environment

The study was conducted at the Barangay Andap, New Bataan, Davao de Oro Province, Philippines located at 7° 31' north and 126° 9' east coordinates. The barangay, headed by Cequina B. Dante and the chieftain of Mandaya residence in the Barangay Andap New Bataan is Matikadong Daniel Belayo. The study was conducted from November 2017 to June 2018.

Research Design and Methods

This research utilized the qualitative-descriptive analysis survey design using ethnographic techniques to accurately capture the Mandaya ginger farmers' perspectives in understanding the ethnoscience, particularly their ethnofarming practices.

Purposive sampling was used to identify Mandaya ethnic groups engaged in ginger farming at Andap, New Bataan. The selection criteria of participants were based on the: (1) willingness of the farmer to share indigenous knowledge, (2) the peace and order situation, (3) the socio-economic profile, (4) the accessibility, and (5) the cultural integrity. The selection of farmers was based on the list given by the chieftain. Enumerators were brief one week before the interview, and the prepared survey questionnaire was distributed to the enumerators (on-site). A semi-structured interview questionnaire with participative field transects was used to elicit information on ginger farming production and management practices of 44 Mandaya ginger

farmers in New Bataan, Davao de Oro. Furthermore, all selected key participants agreed to share their ginger farming practices and be documented.

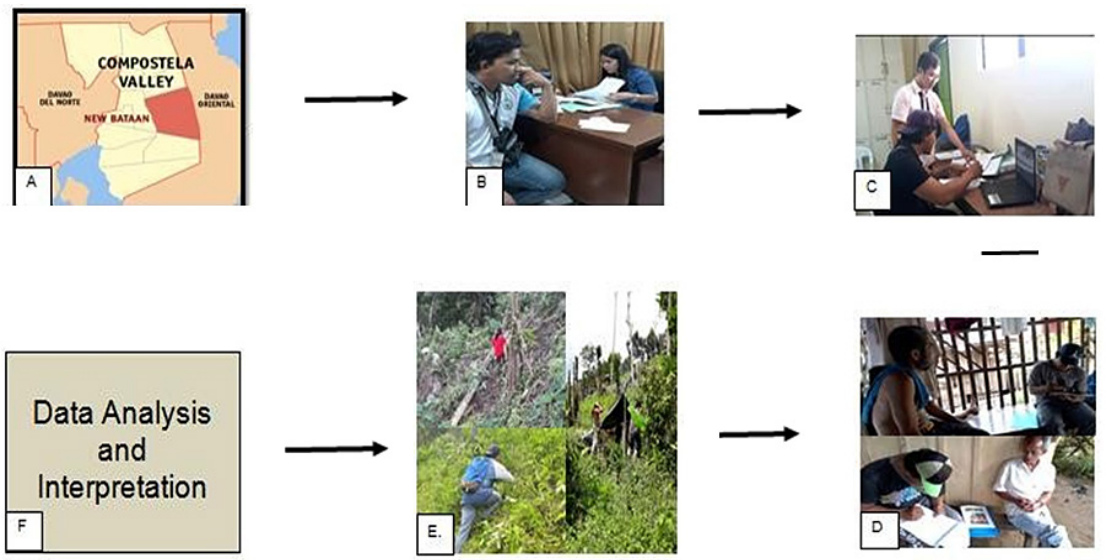
Before the enumerators conducted the one-on-one interview with the ginger farmers with participative field transects, this study was properly communicated to the Office of the Governor, Office Municipal Mayor, Barangay Captain, and the Chieftain of the tribe in Andap, New Bataan, Davao de Oro. Courtesy calls of the researcher in said offices were also done for proper etiquette of conduct and orientation of the survey questionnaire (Figure 1).

The research instruments used for this study were a field notebook, video camera, digital recording, and semi-structured interview guide questionnaire containing the socio-demographic profile of the participants with the name, age, sex, civil status, number of children, years of farming experience, educational attainment, annual income, and the land area planted for ginger. Also, the soil characteristics, soil fertility, cultural management, insect pest, disease management, and the farmers' problems were properly documented.

The processes of collecting data were flexible, that is, emerging from the circumstances encountered in the field, and typically involved a contextual response to the lived realities that arouse unpredictably in the course of the field works during individual interviews, observations, and immersion in the community.

Data Analysis

All data variables elicited from the survey were analyzed using descriptive statistics using SPSS version 24[7], and frequency graphs were created using Microsoft Excel software[8] and SWOT analysis. SWOT analysis was undertaken to identify its internal strengths, weaknesses, and external opportunities and threats.



Source: Hilario H. Casol Jr. and Wikipedia

Fig. 1: Survey flow for the assessment in documenting indigenous knowledge in ginger production and management of Mandaya farmers in New Bataan, Davao de Oro Province: A. Selection of the study area; B. Courtesy callfor Province, Municipal, Barangay, and tribal leader; C.Briefing of Enumerators; D. One-on-one interview with the farmers; E. Transect walked with the farmers; F. Data interpretation and analysis

Results and Discussion

Socio-Demographic Profile of Mandaya Ginger Farmers

The study revealed that the mean age of Mandaya ginger farmers is 45.07 years, and the age of majority of the farmers ranged from 53 to 63 years. The ginger farmers are dominantly male (80%) and were married (85%) with a mean of 3.33 children, and the majority of families have 5 to 6 children (Figure 2). They have over 25 years of ginger farming experience (70%). Most farmers are elementary undergraduates (46%), followed by no formal education (22%). These findings are similar to Valdez and Hansel[9] on the Mansaka, Subanen farmers, and other ethnic groups in Mindanao that have a low level of educational attainment. Most farmers were aged 65 or above, and most of them were not able to go to school. This result also implies that the Mandaya ginger farmers are already old, and no younger or youth farmers are engaged in ginger cultivation. This might be why indigenous knowledge in ginger production could vanish. Most indigenous knowledge is transferred from one generation to generation through oratory means. When young Mandaya was not involved in farming, it could be the start of the degradation of their indigenous knowledge, particularly in ginger production and management.

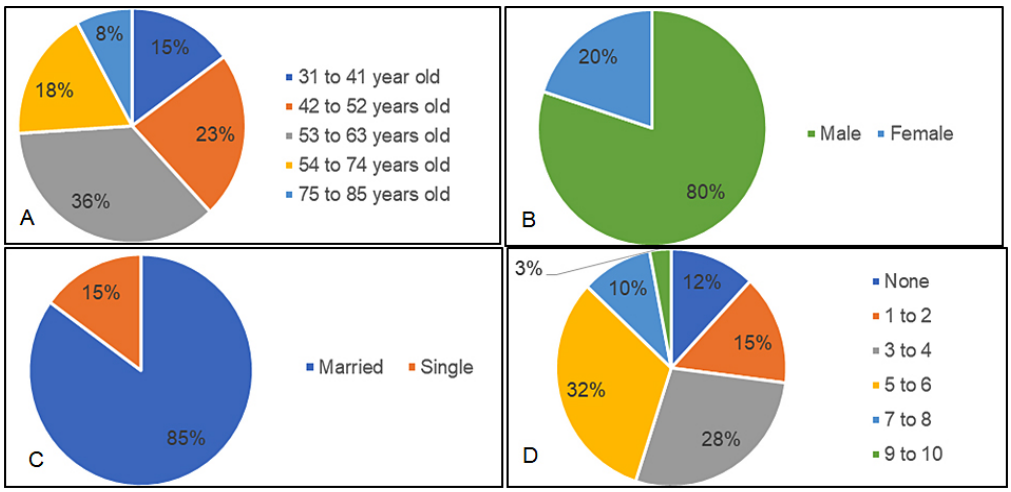


Fig. 2: Socio-demographic profiles of Mandaya gingerfarmers: A. Age Distribution; B. Sex Distribution; C. CivilStatus;D.Number of Children

This result support Palis[10] findings that youth participation in farming is declining because parents who are farmers want to send their children to college so they can get non-farming jobs in cities or abroad. The desire of parents for their children not to work in agriculture could pose a severe threat to the industry. According to the study's findings, most farmers are getting older, which could negatively impact the nation's capacity to produce food and its pool of skilled agricultural workers. The study's findings about aging farming are consistent with an IRIN[11] report that the Philippines may experience a severe shortage of farmers in just 15 years due to the farmers being already old, and the country farmer's average age is 57-year-old. However, the Philippines is not the only country where farmers are aging. It is a global phenomenon. This is especially true among small holder farmers in Asia.[12] In Thailand, farmers are 52 years old on average.[13] A third of the farmers in China are over 50 years old. Chinese farmers are 55 in its three modern cities. Africa, Indonesia, Korea, Vietnam, the United States, Japan, and the European Union have all seen an increase in the aging population.[15,16]

Moreover, it was observed that most ginger farmers were males rather than female. Maybe it assumes most of the work related to land and seedbed preparation, ploughing, irrigation, and harvesting required strength. According to the Food and Agriculture Organization (FAO), as cited by CIAT; DA-AMIA,[17] states that most men are involved

in raising, cultivating, and harvesting fodder crops as well as the watering, grazing, and milking of cattle. Despite making up less than a third of the entire agricultural workforce, women's contribution to food production is probably understated in official statistics because they have less access to resources for production than men do.[17] This finding suggests that men still outnumber women in the agricultural workforce.

On the other hand, the average annual income of the farmers is Php 42,850.00, and 50% of the participants have an annual income ranging from Php 10,000.00- to 30,000.00 and with less than 0.25 ha (55%) of land for ginger production (Figure 3). This finding confirms the reports of PSA[18] that the average farm size decreased from 2.84 ha per farm in 1980 to 1.29 ha per farm in 2012. Land holdings and parcels have been dispersed to new generations, contributing to a significant, continuously increasing fragmentation of farmland,[17] which conforms to the study's findings.

Furthermore, a quarter of the population still lives below the national poverty line despite efforts to reach the Millennium Development Goals targets. Due to decreasing agricultural investments, which have resulted in low productivity at the expense of growth in the service and manufacturing sectors, farmers and fishermen continue to be the groups most impacted by poverty.[17] This smaller area of agricultural land could lead to shorter food production and income for farmers. However, proper and appropriate farming technologies would improve food production and help attain food security.

Soil Characteristics and Topography

The result shows that the production site of Mandaya ginger farmers is mostly found in mountainous areas (97%) (Figures 4). The production site has direct sunlight (95%), a loamy type of soil texture (49%), a darker soil color (67%), and good drainage (100%) at the production site (Figure 4).

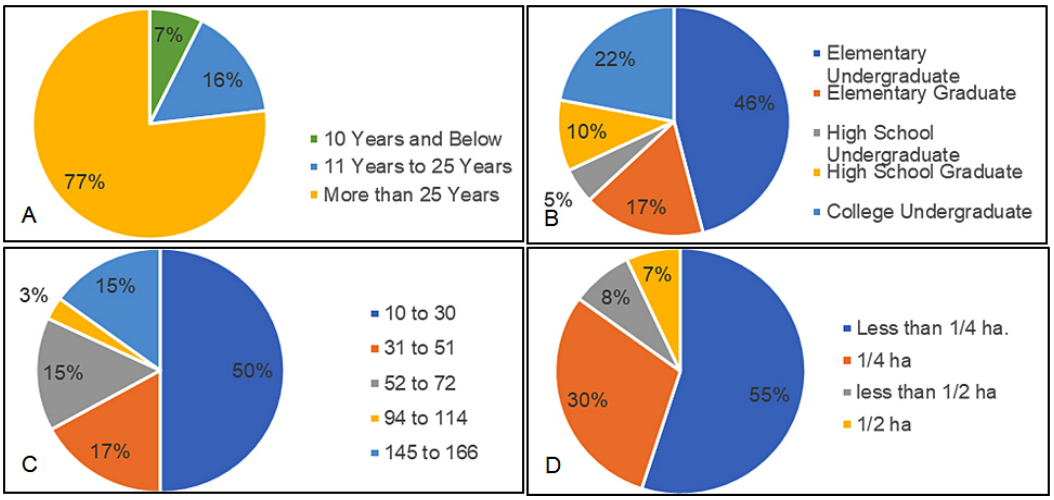
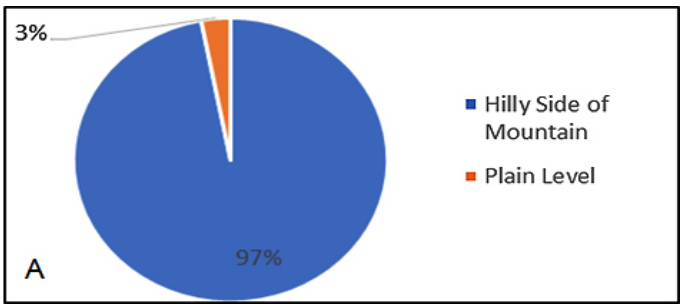


Fig. 3: Socio-demographic profiles of Mandaya gingerfarmers: A. Years of Farming Experience; B. Educational Attainment;C. Annual Income;D. Area Planted



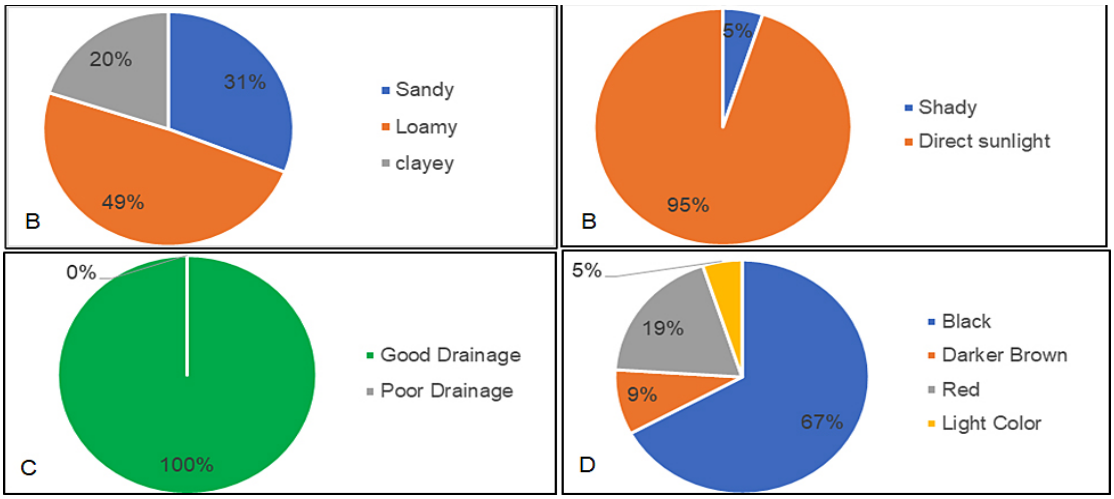


Fig. 4: Percentage distribution of soil characteristics and topography of the area: A.Topography of Collection Site; B. Light of Collection Site;C. Soil Texture;D. Soil Drainage; E.Soil Color

According to the tribal chieftain, all mountainous areas in New Bataan are placed for the Mandaya people. The early ethnographic accounts by Cole[19] and Garvan,[20] as cited by Yengoyan[21] that formerly Mandaya were seldom found residing higher than 750 m above sea level. However, the nature of Mandaya on the slash-and-burn cultivation of crops pushed them to more elevated areas,[19] which conforms to the present study. Furthermore, the government provided the authority to manage and cultivate the land as their ancestral domains. However, some of the Mandaya people sold their piece of land to others. According to the National Commission on Indigenous Peoples (NCIP), approximately 7.7 m ha, or 26% of the country's total land area of 30 m ha, are occupied by indigenous peoples (IPs). As of 2019, with a total land area of 5.7 m ha and 1.3 m IPs holding rights, the NCIP has issued 243 certificates of ancestral domain titles.[22]

It shows that the forestland was converted into agricultural production. This result is incongruent with Stibig *et al,*[23] as cited by CIAT; DA-AMIA,[17] that most of the lowland forests in Southeast Asia are also being converted to cash crop plantations. This has caused significant soil erosion in the uplands and a loss of biodiversity. As a result of stringent policies regulating logging operations, deforestation rates have been slowly decreasing in recent years.[24]

Soil Fertility Management Practices

The soil fertility management practices of Mandaya ginger farmers are presented in Table 1. The table provides information that Mandaya ginger farmers did not practice and perform soil sampling, identify soil properties and conduct nutrient analysis (100%) as the basis for fertilization. Farmers only used inorganic fertilizers (100%) to sustain the nutrient requirement for ginger growth and development. The most common inorganic fertilizers used are Complete (14-14-14), Urea (46-0-0), Ammonium Phosphate (16-20-0), and Muriate of Potash (0-0-60). Their fertilization practice was done in two splits application. The first fertilization application is applied at the seedling stage, where plants have two to three stalks, and the second period of fertilizers is done at the flowering stage. The mode of fertilization application is basal, were putting small amounts of fertilizers are placed beside the plants or "*vinitsin*" in the Mandaya dialect. Even though the Mandaya ginger farmers did not practice soil sampling, soil properties, and nutrient analysis for fertilization guide, they have a unique way of determining the soil fertility based on their indigenous knowledge.

Accordingly, Mandaya farmers decided the soil fertility on the topsoil color (41%), vegetation present in the area (27%), income from the previous cropping season (18%), and soil texture (14%) (Figure 5). These criteria given by the key participants were

also similar to the indigenous knowledge criteria of selecting fertile in the study of Desbiez[4] and Dawoe.[3] According to Mandaya ginger farmers, the darker to black color of the topsoil is fertile soil, while the red color of soil represents infertile soil (Figure 7). This means that Mandaya ginger farmers based on the fertility of soil color. Furthermore, they classify darker soil colors as fertile soil while lighter to red colors as infertile soil. This indigenous practice of Mandaya ginger farmers is similar to indigenous knowledge practice in the Ashanti Region of Ghana[3] and Upper Eastern Kenya,[25] where darker soils were considered more fertile than lighter or red ones.[3] Generally, darker soils are rich in organic matter, contain high nitrogen levels, have good aeration and drainage, and pose a low erosion risk.

Table 1: Soil fertility management practices of Mandaya ginger farmers

Fertilizers Used	Rate of Application	Period of Application	Method of Application
Complete(14-14-14) mixed with Urea (46-0-0)	10gper hill	Rhizomes with two to three stalks developed	Basal application or "*Vinitsin*" in Mandaya ginger farmers' dialect
Muriate of potash (0-0-60) mixed with Ammonium Phosphate (16-20-0)	10gper hill	Flowering stage	Basal application/ *Vinitsin*

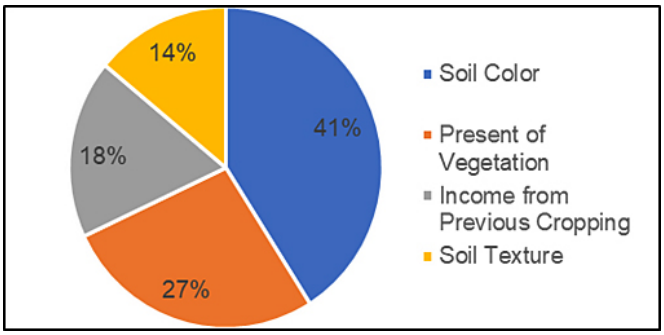


Fig. 5: Percentage distribution of soil fertility management practices

Red soil has iron-containing soil minerals that undergo oxidation and reduction reactions that can provide helpful information on the hydrologic condition of a soil.[26] This darker soil of Mandaya ginger farmers' site could be due to high organic stocks before the forest land was converted to agricultural land. This finding is in accordance with the study of Frye and Blevins[27] that a darker colored surface horizon is normal for soils formed under forest vegetation, and it was noted that 68% of the production site of the Mandaya ginger farmers has darker soil color (Figure 4.D), indicating fertile soil. However, 42% of the production site is infertile soil which is based on their soil fertility indicators. Moreover, most of the production areas are found on the hilly side of the mountain, which also affects the soil's physical and chemical nutrients of the cultivated land. Generally, soil in the hilly areas tends to undergo more weathering, resulting in much poorer soil quality.

According to Akhtaruzzaman *et al,*[28] hill soils face severe degradation due to intensive leaching, soil acidification, biotic activity, and improper land-use systems. Moreover, most ginger production areas are found on the hilly side of the mountain, which has a higher elevation than plain areas. This is also incongruent with Akhtaruzzaman

et al.[28] that higher topography enhances the removal of base cations through leaching and runoff processes, and forest hills soil becomes gradually acidified. To assess the soil fertility of the production site, it is suggested to perform soil sampling, soil properties identification, and conduct nutrient analysis so that the ginger farmers can fertilize adequate essential nutrients and save production costs.

The presence of *Ageratum conyzoides* Linn. or "*Gapas-gapas*" in the Mandaya dialect in the area also indicates fertile soil. According to the farmers, the soil is fertile when A. *conyzoides* Linn is abundant in the area. According to them, when A. *conyzoides* are dominant in the production site, it indicates fertile soil, otherwise, infertile soil. This indigenous knowledge of Mandaya ginger farmers is the same perception of the farmers in mid-hill of Nepal[4] that they also used the A. *conyzoides* Linn as an indicator of fertile soil. According to Marnotte[29] reports, A. *conyzoides* Linn. grows well, mainly where soil fertility is high. Furthermore, this species thrives best in rich, moist mineral soils and will not grow in the shade.[30] It grows particularly well where soil fertility is high, with dense populations developing when fertilizer is used.[29] There is a report that this species can alter soil properties by releasing all elochemicals that could inhibit the growth of other species,[31] dominating the other species.

On the other hand, when the farmers have a higher or comparable income to the previous cropping season, they also indicate that the soil is still fertile. This indicator of Mandaya ginger farmers is similar to the indicators reported by Dawoe[3] and Wawire.[25] The darker soil color, presence of A. *conyzoides* Linn in the area, and income of the previous cropping are their indigenous knowledge used by the Mandaya ginger farmers as indicators of soil fertility. This indigenous knowledge of the farmers has been used to indicate fertile soil. Thus, scientists and Mandaya ginger farmers must work together to have a meaningful and substantial result on soil fertility while preserving and protecting the indigenous knowledge of Mandaya ginger farmers. Furthermore, the United Nations[32] stresses that indigenous knowledge must be protected, preserved, and encouraged.

Cultural and Management Practices

Table 2 presents the cultural and management practices of Mandaya ginger farmers in Andap, New Bataan, Davao de Oro Province. The result shows that the Mandaya Ginger farmers have different ways of propagation techniques. Most used rhizomes with three to five bud eyes as their planting materials (40%). Other farmers used rhizome with two to three bud eyes and had no specification on the planting material size (38%), while 17% used rhizome with two to three bud eyes in big toe size. Moreover, according to the ginger farmers, using two or more bud eyes on rhizomes would ensure a higher chance of germination.

Meanwhile, few farmers only practiced rhizomes soaked in N-Methyl Carbamate solutions before planting. Generally, this N-Methyl Carbamate is an active insecticide ingredient that kills many insect pests in their larvae and adult form. Furthermore, exposure to carbamate can disrupt mitochondrial metabolism by targeting multiple receptors and transporters at low specificity (i.e., promiscuously), thereby disrupting energetics and redox signaling in developing cells,[33] resulting in the death of insect pests.

The result has been noted that Mandaya ginger farmers are using rhizomes with more than two bud eyes as planting materials. They believed that having more than two more bud eyes on rhizomes would ensure a higher chance of germination. Meanwhile, ginger farmers used to combine their indigenous practice with modernized technology. This indigenous factual practice by the Mandaya farmers on the number of bud eyes combined with empirical knowledge in selecting planting materials is noted.

On the other hand, most farmers practice synthetic herbicides to eradicate the weeds present in the area before land preparation (68%). Some of them used slashing bolo with a curved tip and improvised wooden rakes and burning of the unwanted weeds (10%). It was noticed that most Mandaya ginger farmers used empirical knowledge in controlling weeds. However, few farmers still practiced the slash and burned in controlling weeds, their early ethnographic nature of cultivation, as cited by Cole.[19]

Meanwhile, it also reveals that most Mandaya Ginger farmers start their cultivation activity in the wet season from February to April by digging the land allocated for ginger production.

It was observed that Mandaya ginger farmers have different indigenous practices on planting techniques (Table 2). The majority of the ginger farmers plant ginger based on the planting season (42%) during the end of the rainy months (February to April), the 22% of the farmers plant their ginger at any time of the year (22%), and the remaining percentage distribution of planting techniques is based on the date ending with the numbers zero and eight because they believe that zero and eight represent abundant harvest (Table 2). This means that 50% of the Mandaya ginger farmers used empirical knowledge on planting ginger. Interestingly, 23% of the key participants still practice the traditional and magical procedure of planting ginger, which is based on the planting on the lunar phase, the shape of dates, and uttering or reciting magical words and prayers to the unseen spirits. These traditional and magical procedures are similar to the traditional and magical practices of Mansaka and Subanen farmers.[9]

Table 2: Cultural and management practices of Mandaya ginger farmers in Andap, New Bataan, Davao de Oro Province

Cultural and Management Practices	Mandaya Farmers Practices	Percentage (%)
A. Propagation	1. Rhizomes that contain 2 to 3 bud eyes in big toe size	17.0
	2. Use of fully matured rhizomes that are firm and glossy	2.0
	3. Rhizomes that contain 3 to 5 bud eyes	40.0
	4. Rhizomes that contain 2 to 3 bud eyes, air-dried for three days inside the sacks, after incubation for three days, it was planted in the area	38.0
	5. Rhizome soaked in N-Methyl Carbamate solution (5 glannate per 20 lof water) for 3 to 5 min	3.0
		100.0
B. LandPreparation	1. Herbicide application before planting	75.0
	2. Slashing and digging	10.0
	3. Herbicide application and burning	10.0
	4. Slash and burned	5.0
		100.0
C. Planting	1. Planting anytime	22.0
	2. Based on the planting season	42.0
	3. Based on the date which ended in 8 and 0 (e.g.,8,10,18,28)	15.0
	4. Based on the lunar phase	5.0
	5. Basedon the radio announcement	8.0
	6. Based on planting season and based on the date which ended in 8 and 0 (e.g., 8,10, 18,28)	5.0
	7. Planting will be done in March with prayers to God	3.0
		100.0
D. Harvesting	1. Harvest was done at nine months to 1 year AP	12.0
	2. Mandaya farmers will harvest only when the rhizomes are fully matured, or it will be harvested when it reaches one year above	38.0
	3. Harvest was done at 6 to 7 months after planting and depending on the market price	50.0
		100.0

Moreover, it can be noted that there is a lesser number of Mandaya ginger farmers practicing their indigenous knowledge regarding their planting techniques for ginger production. This lesser inclination of Mandaya ginger farmers to their indigenous knowledge could be due to programs and technologies promoted by the government agencies or learned from Christian and Non-Christian farmer settlers in Andap, New Bataan, and other nearby places. Similar findings were made by Camacho,[34] who noted that the Ifugaos' indigenous knowledge systems are slowly vanishing as a result of the indigenous peoples' shifting needs and interests as well as the proliferation of government initiatives to advance agricultural technology.

Mandaya ginger farmers harvest their commodity six to seven months after planting (50%) (Table 2). This means the rhizomes are tender and low in pungency and fiber content. This reason for harvesting early is to save the rhizomes from the disease outbreak, which can seriously affect the farmer's income. However, some farmers still harvest at harvest maturity (38%). Others harvested it nine months after planting (12%). Moreover, harvesting was still dependent on the market price, so Mandaya farmers did not harvest the entire crop. They keep a portion of rhizomes for the next cropping as planting materials. Harvested ginger from the field was directly sold to the middlemen. It was observed that Mandaya farmers have a poor post harvest operation. The harvests from a mountainous area are transported using of rattan basket or “Bukag" in the Mandaya dialect and carried by the farmer to the public market in Poblacion, New Bataan, and other nearby market places.

The postharvest operation practiced by Mandaya ginger farmers is poor, affecting the ginger quality and may cost additional expenses. This inappropriate handling of ginger may have resulted in huge postharvest losses and affected the value chain. Similar findings of Adewoyin[35] show that indigenous postharvest handling practices of fruits often involve improper handling techniques that lead to significant postharvest losses due to a lack of information among all involved parties in the postharvest food chain for fruits. Produce quality will be significant losses due to wounding, bruising, and physical injury caused by rough and abusive harvesting techniques and postharvest handling techniques, which will also increase postharvest decay. The postharvest operation of Mandaya ginger must be noted since their practice is poor. Concerned government agencies must look into this and may provide training and assistance on improving their postharvest operation while maintaining their cultural integrity.

Disease and Insect Pest Management Practices

Table 3 summarizes the disease and disease management, and Table 4 presents the insect pest and insect pest management practices of Mandaya ginger farmers.

Soft Rot

Pythium spp. causes soft rot.[36] The symptom initially appears as the water soaking the collar region of the pseudostem. In Mandaya, this soft rot disease is locally called as “*Lata*”. They are named based on the appearance of the infected plants. Most participants have no action to control this disease infestation (76%). However, others also use chlorine solution (5%) to control soft rot disease; sometimes, they uproot the infected plants and dispose them off (17%). The rhizomes infected with *Pythium* spp. were secluded as planting material. They selected planting material with no sign of *Pythium* spp. for the next cropping.

Selecting uninfected planting material can help minimize the soft rot infestation. However, *Pythium* spp. is a soil-borne pathogen still present in the soil, which still affects the productivity of ginger. In addition, most farmers have no action to control this disease since they do not know how to control this disease. Also, improper management of diseases, such as using chlorine solution, is ineffective in controlling soft rot. According to Rai *et al,*[36] the effective method to control soft rot is by applying a chemical fungicide. However, extensive fungicide use poses a serious threat to the environment and human health.[36]

Considering the negative impact of synthetic chemicals such as fungicides for soft rot is essential. Mandaya ginger and non-ginger farmers must consider using eco-friendly and economically viable options. As Rai *et al*[36] mentioned, developing eco-friendly and economically viable alternative approaches for effective management of soft rot of ginger is essentially required.

Bacterial Wilt

Bacterial wilt is caused by *Ralstonia solanacearum*, also known as one of the most destructive diseases in ginger.[37] The symptoms of this disease are drooping and wilting of leaves in the early morning, and the leaves turn yellow by the collapse of the pseudostem. In the Mandaya dialect, bacterial wilt is called "*Lata*." Most of them have no action to control this disease (73%). Participants repeatedly said they do not know how to control and treat this disease. However, others are uprooting the infected plants and cordoning the infected area (22%), and using fungicide (3%) and chlorine solution (2%) was the practice to prevent the infestation.

Based on Mandaya ginger farmers' practice, it can be observed that fungicide was used to treat bacterial wilt. This result suggests there was a mismatching of technology applications. This is incongruent to Guji *et al*[38] that this disease is hard to control because of its wide host range, prolonged survival in the soil, modes of spread, and survival potential as latent infection. There are reports that were using toxic and volatile chemical gases,[39] applying potassium fertilizer,[40] and soil solarisation[41] help to manage this disease.

However, it was emphasized by Lemesa and Zeller[42] that there is no single effective measure against this pathogen. Farmers must consider using combination of biological, cultural, and chemical control, but must consider the practices that would not harm the environment and human food safety.

Leaf Spot

Leaf spot caused by *Phyllostica zingiberi*. Spots develop as a white papery center and dark brown margin with a yellowish halo surrounding it. In Mandaya farmers, leaf spot is commonly called “Dab-dab". Most farmers took no action to control leaf spots (75%). On the other hand, they uprooted the infected plants and cordoned the infected area (20%). Other farmers use a fungicide (3%) and chlorine solution (2%) to control leaf spot disease. This result suggests that fewer Mandaya ginger farmers practice the use of synthetic chemicals.

It can be observed that farmers have no action to control this disease. However, fewer farmers practice cultural management, such as uprooting the infected plant. However, this strategy can effectively control the infestation of *Phyllostica zingiberi*. Some reports suggest spraying of carbendazim as effective means of controlling leaf spot.[43] Thamburaj[44] reported that two sprays of carbendazim (0.2% concentration) at the time of the disease onset, twice more at 15 d intervals offered the most effective control of leaf spots.

Shoot Borer

Shoot borer is scientifically known as *Conogethes puncteiferalis*. The presence of a bore hole on the pseudostem by yellowing the central shoot is a sign of pest infestation. In Mandaya, this Shoot borer is called “*Olud*." Most Mandaya farmers (70%) have no action to control this insect pest, but other farmers use synthetic insecticides to control shoot borer larvae (25%), and sometimes they practice physical control by handpicking of shoot borer (5%).

It can be noted that the majority of farmers have no idea how to control this shoot borer, but lesser farmers use chemical approaches to control this insect pest. This result indicates that farmers may not know what chemical to use or insect pest management approach to control this shoot borer. This insect pest is a polyphagous insect that eats shoots, buds, flowers, and other ginger plant parts. Malathion at a concentration of 0.1% has been recommended to control the pest.[45] However, biopesticide control is an alternate chemical to control this significant insect pest. Spraying Dipel at a concentration of 0.3% during the months from July to October was found effective.[46] Entomopathogenic nematodes, such as *Steinernema* sp. and *Heterorhabditis* sp., were found promising in controlling C. *punctiferalis* (infesting chestnut) in a laboratory bioassay conducted in Korea.[47]

Leaf Roller

Leaf roller is scientifically known as Udaspes *focus* Cram. It is an olive green caterpillar with a distinct black head that folds the leaves. It folds the leaves, remains inside the fold, and defoliates leaves from the tip and margins. Leafroller is called “*Luko-luko*" in the Mandaya dialect. Most of them have no action to control leafroller (70%). However, some farmers used synthetic insecticides to control the leafroller (8%). Sometimes they practice physical control by handpicking to terminate (8%) the insect pest.

It can be observed that the majority of the Mandaya ginger farmers have no action on this leaf roller. Spraying a 0.1% solution of carbaryl or a 0.05% solution of dimethoate may be used to control this insect pest, depending on how bad the infestation is.[45] Also, spraying a branded insecticide is recommended to control this minor pest.[48] However, synthetic chemicals must be the last option in integrated pest management. The ecological sound insecticide must be considered in controlling this insect pest.

White Grub

This insect is scientifically known as *Holotrichia* spp. The grub feeds on the newly formed rhizomes, which leads to the leaves yellowing. In Mandaya this white grubs were called "*Tandayan*". Mandaya farmers have no action to control (75%). However, some farmers used synthetic pesticides to control a white grub (12%). Sometimes, they practice physical control by handpicking (13%).

This insect pest eats away roots, feeds on rhizomes, and makes holes inside them. Probably it paves the way for the infection of fungi to develop rhizomes rot. The damage becomes evident only when the entire plant dries up due to feeding by grubs on roots and rhizomes.[49] Results have shown that the majority of the Mandaya ginger farmers have no action on controlling this insect pest, indicating that farmers have no idea on how to control this insect pest. According to Gautom,[49] using Chloropyrifos as a chemical insecticide can reduce the white grub-infected rhizome yield. However, excess or uncontrolled uses of chemical pesticides have spoiled the balance of the insect population. Besides causing severe environmental threats, resistance, resurgence, and persistency problems can also not be denied.[49] Appropriate technology must be considered in controlling this insect pest since chemical, environmental impact and adverse effect on human health is critical.

Table 3: Summary of disease and disease management of Mandaya ginger farmers in Andap, New Bataan, Davao de Oro, Philippines

English Name	Scientific Name	Mandaya Term	Management Practice	Percentage (%)
Soft rot	*Pythium* spp.	"*Lata*"	1. Uproot the infected plant and dispose	78.0
			2. Use of chlorine solution	17.0
			3. No Action	5.0
				100.0
Bacterial Wilt	*Ralstoniasola nacearum*	"*Lata*"	1.Up root the infected plants and cord on the infected area	22.0
			2. Use of chlorine solution	2.0
			3. Using fungicide	3.0
			4. Noaction	73.0
				100.0
Leafspot	*Phyllostica zingiberi*	"Dab-dab"	1. Uproot the infected p lant and dispose	0. 2 0
			2. Use of chlorine solution	2.0
			3. Using insecticide	3.0
			4. No Action	75.0
				100.0

Problem Identified

Age and Educational Attainment

Farmers are at the average age of 45, ranging from 53 to 63 years old. This implies that farmers are mostly old, and fewer young Mandaya is engaged in farming, especially ginger cultivation. This could be a determining factor in declining of the new farmers' generation. According to them, their

daughters and sons mostly take a degree unrelated to the agriculture program. Most Mandaya farmers in ginger production are elementary undergraduates. It might cause a limited range in the interpretation of new technologies on using and managing them.

Table 4: Summary of insect pest and insect pest management of Mandaya ginger farmers in Andap, New Bataan, Davao de Oro, Philippines

English Name	Scientific Name	Mandaya Term	Management Practice	Percentage (%)
Shoot Borer	*Conogethespunc teiferalis*	*"Olud"*	1. Applying of Insecticides	25.0
			2. Hand Picking	5.0
			3. No Action	70.0
				100.0
Leaf Roller	*Udaspesfolus*	*"Loko-loko"*	1. Applying of Insecticides	22.0
			2. HandPicking	8.0
			3. NoAction	70.0
				100.0
White grub	*Holotrichiaspp.*	"Tandaya"	1. Applying of Insecticides	12.0
			2. Hand Picking	13.0
			3. No Action	75.0
				100.0

Soil Fertility and Fertilization

Farmers do not perform the soil properties and nutrient analysis as bases for fertilizer application, and most of them usually use synthetic fertilizers, herbicides, insecticides, and fungicides. These synthetic chemicals and inorganic fertilizers are primarily used to manage ginger production. These chemicals can harm soil health and soil microorganisms, the health of the consumers and farmers, and the ecosystem biodiversity.

Topography and Location

The topography sites where the Mandaya farmers cultivate their ginger are almost found in mountainous areas. This is risky for Mandaya farmers for their health and safety. This mountainous area where they plant their ginger might be prone to landslides due to heavy rains, low tropical depressions, typhoons, and deforestation. Moreover, forest land is converted into the agricultural production site.

Cultural and Management

Farmers have different ways of propagation, planting techniques, land preparation, and harvesting operations. Farmers did not use recent advanced technologies in ginger production. They used "*bolo*" with a curved tip and an improvised wooden rake to slash weeds instead of a mechanical machine for land preparation and harvesting operation. However, mechanical machines and tools might be complicated because the production area is located on the mountains' hilly side.

Postharvest Operation

Farmers harvest their commodity from mountainous areas, which was transported using a rattan basket or "*Bukag*" in the Mandaya dialect, and it was carried manually by the farmers themselves. There are no modernized technologies for ginger harvesting, transportation, handling, and other postharvest operations; however, these technologies might not be applied because of the situation mentioned on the production site. This poor postharvest operation by the farmers might affect the quality of the product and may cause lower income.

Insect Pest and Disease Management

Farmers have no proper way of insect pest and disease diagnosis, and they have limited knowledge in pest and management strategies, resulting in less harvest and faster disease infestation in the ginger production area.

SWOT Analysis

Table 5 presents the strength, weaknesses, opportunities, and treats of the ginger production of Mandaya farmers at Barangay Andap, New Bataan, Davao de Oro Province.

Table 5: SWOT analysis on ginger production of Mandaya farmers

Strength

1. Mandaya ginger farmers have a large-scale area for ginger production.
2. They still practice a traditional way of ginger cultivation.

Weaknesses

1. No data on the number of Mandaya farmers engaged in ginger production.
2. Farmers have limited knowledge of advanced technology in insect pest and disease management strategies.
3. Mandaya ginger farmers have limited advanced information on technologies for crop management to postharvest operation on ginger production and management.
4. Fewer Mandaya ginger farmers are practicing their indigenous knowledge.
5. The indigenous knowledge is still present but could be threatened by the advent of technologies and programs implemented by the government, eliminating appropriate indigenous knowledge on farming.

Opportunities

1. Markets are available locally.

Threats

1. The production sites are mostly found in mountainous areas. This is risky for Mandaya farmers for their health and safety.
2. Soil-borne diseases are present at the production site.
3. The price of the produce fluctuates and varies every time.
4. Ginger production is affected by unfavorable climatic conditions.
5. Biodiversity is affected by turning forestal lands for agricultural usage.

Conclusion

The Mandaya ginger farmers are still practicing their indigenous knowledge in ginger production. They rarely used advanced technologies for land preparation to postharvest operation. In addition, some ginger farmers are struggling because of disease infestation. The limited knowledge to control insect and disease infestation, soil fertility management, and commodity price fluctuation are significant constraints for these farmers. Farmers also need the training to enhance their indigenous knowledge and hone their skills in producing ginger and other crops. The responsible government agencies must assess the need for capability enhancement of ginger farmers. Also, provide a technical guide on land preparation to postharvest operation, including insect and disease management while preserving cultural integrity.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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