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DETERMINING THE PRODUCTIVITY AND POVERTY LEVEL OF QUEEN PINEAPPLE FARMERS IN CAMARINES NORTE, PHILIPPINES

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ABSTRACT

Purpose- Queen pineapple production is a small-scale farming acitivity in Camarines Norte Philippines. Despite its production potential, pineapple farmers report of low productivity as the price of input increases and the net income decreases. This paper compares the productivity level relative to the poverty threshold of Queen pineapple farmers who use traditional and innovative production practices.

Methodology- Data was gathered from January to March 2022 in Camarines Norte, where Queen pineapple production is highly concentrated. A total of 96 farmers were interviewed using a semi-structured questionnaire. Productivity was measured based on the cost and revenue analysis of traditional practices, the use of innovative production, and the input and output ratio in terms of land labor and capital.

Findings- Results revealed that innovative production increased land, labor, and capital productivity. The poverty threshold is influenced by educational status, household size, and pineapple cultivation area. Thus, 56 percent of the farmers live with less than the basic food requirements, 17 percent live below the poverty threshold, and only 27 percent live above the poverty threshold.

Conclusion- To earn more than the poverty threshold the decision point may be based on area planted or based on farming system. The former suggest that a Queen pineapple farmer must utilize 1.6 hectares (ha) using traditional practices but only 0.68 ha using innovative production practices while the latter suggest that based on farming system, expanding production areas through mixed or integrated cropping or adopting production innovations for single cropping is recommended.

Keywords: Traditional practices, cost of production, farming system.
JEL Codes: D24, D31, O31

1. INTRODUCTION

The Philippine economy is the 36th largest economy in the world, the 12th largest in Asia, and the third largest in the ASEAN. The Philippines contributes 0.18 percent to the world's total gross domestic product (GDP). Its main economic drivers include the service (61.05%), industry (28.89%), and agriculture, forestry, and fishing (AFF) sectors (10.07%). The Philippines is regarded as an emerging economy, according to UNIDO (2020), because of its competitive workforce comprising 65 percent of its population. By the end of 2022, the Philippine population was around 115 million, about a quarter of which depended on agriculture for livelihood.

With rapid urbanization and the younger generation more interested in the service and industry sector, the agriculture sector needs more government support and intervention to create more jobs and opportunities in the rural areas, ensure food security, and reduce hunger and poverty in the country. Based on the Philippine poverty threshold, Mapa (2022) wrote that a family of five requires PHP 12,030 per month for necessities and at least PHP 8,379 to meet basic food requirements. In 2006, around 32.9 percent of the population was poor, meaning one out of four Filipinos were poor. In 2020, the figure was slightly reduced to 30 percent; hence, around 30 million Filipinos remained poor after over a decade. In rural areas, the ratio is expected to be higher since poverty incidence is much higher in rural areas (36%) than in urban areas (13%) (IFAD 2022).

The Philippines is considered one of the leading exporters of pineapple globally (Reinhardt and Rodriguez 2009; Balito 2010; Hossain 2016), which makes the pineapple industry one of the most significant contributors to the country's GDP. In 2021,

the pineapple industry's share in the AFF sector is 7.2 percent. The Philippines exported fresh pineapples worth USD 281 million in 2021, with a total volume of around 546.11 thousand metric tons (Statista 2021). Production grew at an average of 1.2 percent while the acreage remained constant. The lack of growth in the industry is attributed to the high incidence of small fruits (up to 40%), poor cultural management and postharvest practice, and lack of available appropriate storage areas, among others.

Pineapple is a perennial herb in the Bromeliaceae family (Bartholomew 2003; Tewodros et al. 2018). Four varieties thrive in the country, namely: (1) Hawaiian, (2) MD2, (3) Red Spanish, and (4) Queen. Hawaiian and MD2 are produced heavily in Mindanao by giant companies such as DOLE and Del Monte, mainly for export. Red Spanish is popularly grown in Aklan for fiber production. Queen pineapple is primarily produced in South Luzon to address domestic demand.

A tapering shape, deep eyes, and fresh yellow color widely characterize the Queen pineapple variety. It is known for its characteristic aroma, crisp flesh, and sweet juice, and it is popularly served as table fruit or dessert. The fruit contains Vitamin C and A, calcium, phosphorus, fat, sugar, and carbohydrates. It is generally smaller, ranging from 0.7 to 1 kg in medium to large classification (Philippine National Standard 2004), but sweetest at 14 degrees Brix. The average fruit weight without the crown varies from 600–800 grams (g). In addition, it has strong fiber, which is excellent for cloth material and an alternative to animal leather. Pineapple has a high domestic demand and has the potential for an international market niche.

Queen pineapple is a typhoon-resilient crop. It has been one of the primary sources of income for smallholder farmers in rural areas in the Philippines, especially in Camarines Norte, a province in Region V, where typhoons occur around 20 times a year. Despite the production potential of pineapple, low productivity has remained a considerable problem for Queen pineapple farmers for decades.

Previous research focused on enhancing cultural management practices. However, no accurate data can be found as to the existing cost of production for Queen pineapple compared to the cost and income of adopting recommended technologies. Lubis et al. (2014) believed that low productivity in horticulture is mainly due to the inability of the farmers to exploit available technologies, resulting in lower production efficiencies.

This paper aims to assess the economic characteristics of farmers in the study area, determine the productivity level of traditional practices compared to innovative production, and assess the poverty level of pineapple farmers based on their income sources.

2. LITERATURE REVIEW

The economic landscape of the Philippines is characterized by a strong service sector, a significant industrial base and ongoing reliance on agriculture. The country's emerging economic status presents both opportunities and challenges espifically in the agriculture sector, which calls for sustainable practices to harness its full potential. The need for increased government intervention in agriculture is underscored by its dual role in job creation and food security.

Poverty remains a critical issue in the Philippines, with the poverty threshold indicating that a family of five requires PHP 12,030 monthly for necessities, and PHP 8,379 for basic food needs. Canlas et al. (2006) noted that in 2006, 32.9% of the population lived in poverty, a figure that slightly decreased to 30% by 2020. This stagnation in poverty reduction highlights systemic issues, particularly in rural areas, where poverty incidence is significantly higher (36%) compared to urban areas (13%) as reported by IFAD (2022).

Research indicates that income levels among pineapple farmers can vary significantly based on farm size, access to markets, and production practices. Many smallholder farmers struggle with low profit margins due to high production costs and limited market access. This contributes to ongoing financial strain among farmers which limit their economic mobility.

The production costs of pineapple farming in the Philippines encompass various factors including land preparation, labor, inputs, and post-harvest handling. Land preparation is a significant initial investment. Labor is a major cost component in pineapple production, given the labor-intensive nature of activities such as planting, weeding, and harvesting.

According to the findings of Balogun, Adewuyi, and Disu (2018), that pineapple production is dominated by farmers who are of active age. The findings imply that, given proper training, pineapple growers can still adopt new technologies. Esiobo and Onubuogo (2014) reported that farmers aged 41–50 are still in active age, more receptive to agricultural innovation, and could withstand the stress and strain involved in agricultural production.

To increase bragaining power, farmers often turned to cooperatives to pool resources and negotiate better prices and avail of government interventions as a group. While the benefits of cooperatives are free training and production loans with low interest, the cooperative manager complained of low payment rates. In the long run, members' share capital and savings are used to pay their loans, and membership becomes null and void. Most respondents lack an appreciation of the benefits of cooperatives and prefer to farm as individual farmers. Falling out of members may also threaten the cooperative's very existence. Dimas, Lyne, and Bailey (2022) cited that despite financial support from various sources, many cooperatives need help to remain viable.

To augment income farmers diversify and adopt mixed cropping practices. Mixed cropping refers to a farming system where multiple crops are grown in a single field simultaneously (CGIAR, 2002). Growing additional crops alongside pineapple provide farmers with multiple source of harvest throughhout the year creating diverse income streams. Ryschawy et al. (2019) believed that crop-livestock integration is an agroecological way of farming as it reduces negative environmental impacts and could improve resilience and production efficiency (Stark et al. 2018). In the study area, chicken, swine, and carabao were the usual animals raised while cultivating pineapple. Carabao was used for hauling agri-products and inputs and in land preparation for manual plowing and harrowing. Chicken was raised for meat, primarily for personal consumption, while swine was grown mainly on a backyard basis with 3–5 heads. Crop-livestock integration requires additional capital and labor but increases land productivity by providing added income without expanding the area.

To increase income, farmers are also encourage to transitioned from traditional farming practices and slowly adopt mechanization and other farming technologies. Limiting factors such as lack of access to capital, cultural and social factors, and limited training and low level of education causes poor adoption. In the study of Uematso and Mishra (2010), a lack of formal education hindered technology adoption, especially for smallholder farmers who tend to work off-farm. In rural Ethiopia, the study of Weir (1999) concluded that at least four years of primary schooling can have a significant impact on productivity. The association of the poverty threshold of Queen pineapple farmers to socioeconomic factors, such as education and number of household members, is also similar to the findings of Adekoya (2014) that the chance of being poor is higher among non-educated farmers and farmers with large households.

Improving productivity of farmers requires several strategies and series of training to enhance adoption of modern farming practices. However, a closer look at the micro level may provide detailed insights for deeper understanding and may provide customized solutions similar to the goal of this study. Further policy makers can make more informed decisions leading to better outcomes that are both effective and sustainable

3. DATA AND METHODOLOGY

A survey was conducted from January to March 2021 in Camarines Norte, where 7 percent of the total pineapple production in the country is produced. A total of 96 farmers responded to the survey using a semi-structured questionnaire. Secondary data were gathered from local government unit offices and the Department of Agriculture, RFO 5.

Sample respondents were chosen by location based on the number of pineapple growers in the municipality. Descriptive statistics, such as frequency, percentage, and average, are used to present the socioeconomic characteristics of the respondents.

A partial productivity analysis was used to measure productivity levels to relate input, such as land, labor, and capital, to a single output—productivity. Productivity refers to the amount of added value per unit of input factor. Value added is obtained by subtracting the material costs from the output. Labor productivity was computed by labor input versus output. Labor input is the number of working days put into one cycle of pineapple cultivation multiplied by the wages per day. Labor productivity was generated by dividing the added value by the labor input. The added value refers to the gross income minus variable costs.

Since it takes 14 months to cultivate pineapples, the added value per land area obtained in one cycle of pineapple cultivation was converted to one year's worth. Input capital consists of variable capital and fixed capital. For productivity analysis, the following formulas were used:

Labor Productivity

Labor input = number of working days × average farm wage per day
Added value = gross income − material cost
Labor productivity = added value/labor input

Capital Productivity

Capital input = variable capital + actual fixed capital
Capital productivity = added value/capital input
Land productivity = added value × 12 months/months per cropping

4. FINDINGS AND DISCUSSIONS

4.1. Socioeconomic Condition of Queen Pineapple Farmers

Pineapple farmers in Camarines Norte are mostly smallholders cultivating on a limited scale at an average area of 1.2 ha. Farms are dispersed, and farmers mix pineapple with short-term crops for personal consumption and as a source of added income. There were cooperatives active in the area and an active pineapple farmers' association in most of the municipalities in the province. These associations benefit farmer members through production loans, training on processing, and product development. Pineapple farmers' key challenge is the source of capital in sustaining the long-term cycle of pineapple

cultivation, which can take up to 14 months before harvesting and another four months to get the planting materials from the mother plant.

Both males and females participate in pineapple production (Table 1). However, due to the labor-intensive and time-consuming activities involved in pineapple production, there was more participation by male (68%) than female (32%) farmers. The majority (66%) were 41–60 years old, with a mean age of 48, which is younger than the average age of farmers at 57 years.

Table 1: Socioeconomic Characteristics of Farmers

Variable	Frequency	Percentage	Average
Gender			
Male	65	68	
Female	31	32	
***Age**			48
21–30 years old	5	5	
31–40 years old	16	17	
41–50 years old	29	31	
51–60 years old	33	35	
61–70 years old	10	11	
Civil Status			
Single	4	4	
Married	81	85	
Widow	4	4	
Separated	6	6	
Educational Level			8.5
Elementary	29	31	
High School	47	50	
College	16	17	
Masteral	2	2	
Household Size			5
1–3	21	24	
4–6	56	62	
7–9	9	12	
10–12	3	2	
Tenurial Status			-
Owned	39	42	
Tenant	26	28	
Leaseholder	28	30	
Coop Membership	32	34	-
Member	62	66	
Non-member			

The mean household size is five persons. The result of this study implies a higher participation of middle-aged farmers than younger and elderly farmers in pineapple cultivation. Most (62%) respondents have an average of 4–6 family members. Coop membership is low at 32 percent. This result implies that the household size in the study area is enough to provide the required family labor for a small parcel of land. Before the pandemic, some households experienced a labor shortage since young family members preferred off-farm jobs in urban areas. During the pandemic, massive termination of contractual works in the cities forced the unemployed to return home and provide assistance in on-farm jobs. However, this movement, which resulted in increased available labor, may be temporary and must be studied if the situation remains after the pandemic.

Most farmers have an average farming experience of 22 years, while the average pineapple cultivation experience is 17 years. Most of these farmers grow coconut prior to planting pineapple. A coconut tree bears fruit after 6–10 years, but the peak of production is at 15–20 years. Respondents have an average land area of 3 ha planted with mixed crops such as coconut, rice, pineapple, and lowland vegetables. Out of 57 percent of the respondents with an area ranging from 2–5 ha, 52 percent allotted 1–2 ha to pineapple cultivation, implying that if one crop is more profitable, expanding the area is also feasible at the expense of low-income crops (Table 2)

Farmer respondents had three types of tenurial status. The first type is landowner, which refers to a person with the legal right to the land by inheritance or deed of sale. The owner can enjoy and dispose of the land without limitations other than those established by law (Article 435). The second type is the tenant, who is entrusted to manage the land while the owner

is either busy or away working in other areas in the Philippines or abroad. Some tenants live on the owner's farm and, depending on the trust and confidence of the owner, may decide which crops to plant. Profit-sharing arrangement varies depending on the agreement. The third type is the leaseholder, which either rents the land for pineapple production or borrows the land in exchange for labor, such as cleaning the land area and doing other farm jobs as payment. Of the 57 percent of the farmers cultivating an area ranging from 2–5 ha, 48 percent were owned, and 24 percent were tenants. The average area cultivated by owner and tenant respondents was larger than the leaseholders. This means these farmers can decide on crop prioritization and adopt new practices. Hence, these groups must be the target for the orientation of innovative production.

Table 2: Tenurial Status of Farmers by Total Land Area

Tenurial Status	Land Area (ha)							
	–1	**1–2**	**2–3**	**3–5**	**5–10**	**10–**	**%**	**Average**
Owned	2	2	13	13	7	2	42	4.12
Tenant	1	9	4	9	2	1	28	3.02
Leaseholder	9	1	7	8	3	-	30	2.50
Total	12	12	24	30	12	3	100	

4.2. On-Farm and Off-Farm Income of Farmers

The on-farm income of farmers varies based on the farming system used. There were three commonly practiced farming systems in Camarines Norte, namely, (1) single-crop farming, (2) multi-crop farming, and (3) integrated farming with livestock raising. Coconut, combined with other crops planted underneath, is the most dominant crop in the study area.

Single-crop farming refers to a farming system that solely plants pineapple in a production area. However, in this paper, single-crop refers to farmer respondents solely planting pineapple in an open area or under coconut. It implies that some farmers rent or borrow the land on a special arrangement to plant pineapples. Farm activities are solely focused on Queen pineapple production, which includes preparation of inputs and land, planting, fertilizer application, weed control, pest management, application of growth regulators (optional), and harvesting.

On the other hand, mixed cropping refers to a farming system where multiple crops are grown in a single field simultaneously (CGIAR, 2002). In this case, pineapple was planted under coconut while growing other crops. In this study, 44 percent, or almost half of the respondents, preferred a multi-crop farming system. This is similar to the findings of Stark et al. (2018) that the multi-crop farming system accounts for almost half of the world's food production, often in the context of smallholder agriculture. Pineapple is a long-duration crop that can be grown in a rice-based cropping system after rice harvest in Eastern India (Verma et al. 2020). Coconut-based cropping system is also one of the sustainable cropping pattern models to enhance economic viability (Thomas et al. 2018). Other activities are conducted, such as harvesting coconut, de-husking, and hauling to the nearest road.

In an integrated farming system, cropping activities are simultaneously conducted with growing animals, like fattening pigs. Crop-livestock integration refers to a farming system that plants pineapple simultaneously with other crops like coconut, vegetables, rice, and banana while raising animals.

To augment the on-farm and household financial budget, 62 percent of the farmers had off-farm jobs (Figure 1). Off-farm jobs vary by educational status; respondents with college degrees have secured formal jobs as government employees or barangay officials, with an average wage of PHP 600 per day. In comparison, less educated farmers can only engage in informal jobs such as driver, construction worker, and miner, with an average daily wage of PHP 365.

Figure 1: Sources of Income of Queen Pineapple Farmers

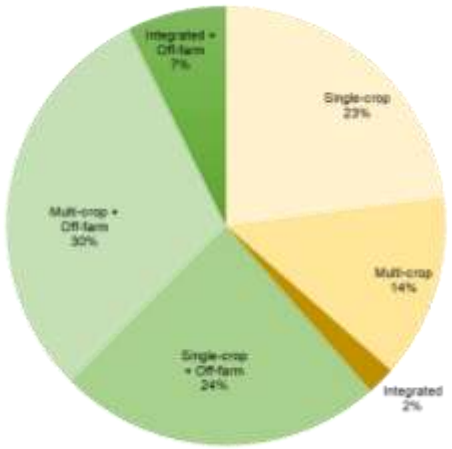


Figure 1 shows that aside from farming systems, farmers' sources of income are classified into two: on-farm and off-farm. Those relying solely on on-farm income practice single-crop, multi-crop, or integrated farming systems. This group can provide added hours of labor and focus only on farming but tends to need more capital to sustain the financial requirements of pineapple production. The second group, which combines on-farm and off-farm jobs, also practice either single-crop, multi-crop, or integrated farming system in combination with work outside the farm. When farm activities require additional labor, off-farm income was utilized to pay for hired labor to do farm activities. Further, this group earns more and provides more investment in pineapple cultivation than farmers without off-farm jobs.

The respondents' income sources were on-farm, off-farm, or a combination (Table 3). The first group solely relied on on-farm income using different farming systems (38%), while the second group combined off-farm income and on-farm income from different farming systems (62%). In terms of the farming system, almost half of the farmers use single crop (47%), followed by multi-crop (44%). The least preferred was integrated (9%). In terms of income, those without off-farm jobs have low incomes below the poverty threshold. Only multi-crop and integrated farming systems generated income sufficient for farmers' basic food requirements.

On the other hand, those with off-farm jobs have a higher income, as expected, because of combined sources of income. It can be deduced that this group also has higher capital invested in pineapple cultivation, which can be seen in the on-farm income of the multi-crop and integrated farming systems, which is almost enough for the food basic requirement threshold. Combining on-farm and off-farm income generated an income above the food requirement for a single-crop farming system and above the poverty threshold for a multi-crop and integrated farming system.

Table 3: On-Farm and Off-Farm Average Annual Income per Household Member

Source of Income	Frequency	Average Pineapple Area (ha)	Ave. Farm Income (PHP)	Ave. Off-farm Income (PHP)	Ave. Total Income (PHP)
Without off-farm job					
Single-crop	22	1.23	5,444		5,444
Multi-crop	13	0.95	11,324		11,324
Integrated	2	0.63	16,779		16,779
With off-farm job					
Single-crop	23	1.10	13,524	8,885	20,886
Multi-crop	29	1.24	19,999	14,657	32,083
Integrated	7	1.30	20,399	13,151	33,551
Total/Average	96	1.16	15,633	10,579	23,574

The socioeconomic factors strongly associated with the poverty threshold of Queen pineapple farmers in Camarines Norte were household size, educational attainment, and land area. Expectedly, the number of household members affects the farmers' entire budget for personal and on-farm expenditures. The higher the number of household members, the higher the

financial requirement for basic needs, such as shelter, food, and education, eventually affecting the budget allotted for pineapple production. In effect, higher household expenditures reduce the production capital. The lower the production capital, the less likely farmers will harvest quality fruits and sell them at higher prices. It should be noted, however, that the baseline data used is intended for a household of five. This was then divided into the individual requirement to consider the different household sizes of the respondents. It must be kept in mind that individuals within the household have different needs and expenditures; thus, if one is looking at a holistic view of poverty, it is best to convert the values back to the household level.

Moreover, cross-tabulation of educational level and economic status showed that most respondents with income below the poverty threshold finished elementary and high school. As shown in Table 1, the combined percentage of elementary and high school respondents was 76 percent.

Table 4: Socioeconomic Factors Associated with the Poverty Threshold of Queen Pineapple Farmers

Variable	Fisher's Exact Test	Significance
Age	4.174	0.378
Gender	0.127	1.000
Civil status	1.660	0.487
Educational attainment	10.904	0.022**
Number of household members	14.403	0.003***
Coop membership	2.093	0.383
Tenurial status	2.848	0.610
Years in farming	3.875	0.433
Years in pineapple growing	3.830	0.422
Total land area	1.727	0.454
Pineapple land area	6.553	0.033**

Note: *, **, and *** indicate significance at p≤.10, p≤.05, and p≤.01, respectively

More than half of the respondents planted pineapple on 1–2 ha of land, around 70 percent of whom are living below the poverty threshold. The association of land area with the socioeconomic status of Queen pineapple farmers can imply two things: to maximize productivity, the land area must be expanded, or farmers must adopt innovative production practices.

The cross-tabulation results (Table 5) reflect the socioeconomic factors of the farmers relative to the poverty threshold. It can be noted that the poor farmers living in poverty are those with larger family household sizes using a cultivation area of 1 hectare or less for pineapple and finished elementary or high school. The number of household members affects the overall budget for personal and on-farm needs. To live above the poverty level based on existing income, households must have a maximum of only four members. Meanwhile, if using traditional practice, the pineapple cultivation area must be at least 1.5 ha to generate income above the poverty line. Most farmers who finished elementary or high school live below the poverty line and earn less than the basic food requirements. The data implies that farmers require capability training to improve practical knowledge that can help them increase their income.

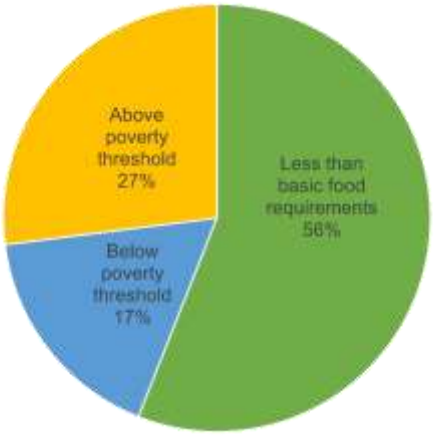
Table 5: Cross-Tabulation of Socioeconomic Factors of the Respondents Relative to Poverty Threshold

Variable	Less than Basic Food Requirements	Less than Poverty Threshold	More than Poverty Threshold
Average household size (persons)	5.5	3.9	3.8
Average pineapple area (ha)	1.07	0.77	1.48
Educational status			
Elementary	17		4
High school	11	8	8
College	8	2	4
Total	36	10	16

The poverty threshold is based on the amount for a family of five members. To calculate the standard amount for families with fewer or more household members, this standard amount was divided by five to calculate the amount per household

member. Thus, the individual poverty threshold in the Philippines in 2022 was PHP 2,406 per month or PHP 28,872 per year, while the individual food requirement is PHP 1,675 per month or PHP 20,110 per year. Multiplying this amount by the number of household members calculated the estimated income per household. As a result of this estimation, 36 (56%)pineapple farmers earned less than the basic food requirements, 11 (17%) earned less than the poverty threshold, and 17 (27%) earned more than the poverty threshold.

Figure 2: Economic Status of Queen Pineapple Farmers based on the Poverty Threshold



4.3. Traditional Production Practices

Pineapple cultivation is a laborious and long-term undertaking. Activities include land preparation, hauling/preparation of planting materials, planting, weed control through herbicide and manual weeding, fertilizer application, fruit induction, harvesting, and marketing. Production practices vary depending on the farmers' exposure to traditional practices, training, and ability to adopt recommended technologies.

Pineapple is considered a drought-tolerant plant. Land preparation is best done from January to September to avoid the heavy rains from October to December. Most farmers use manual preparation by clearing the area of grasses and weeds. If a farmer uses a tractor, plowing the land to eliminate debris follows the clearing activity. Plowing is the initial breaking of the soil, usually in large clods. After two weeks, harrowing will be done to allow the weeds to decompose. Harrowing breaks soil clods, incorporates plant materials, and levels the soil. If the area is idle for a long time and the weeds are thick, the land is harrowed one month after plowing. The most common practice is manual land preparation, clearing all the bushes and weeds using bolo and planting pineapple without tillage.

Asexually-propagated planting materials are the crown, slip, and sucker. Farmers in Camarines Norte mostly use suckers because it takes about 16–18 months from planting to harvest, compared to suckers from the crown, which takes 22–24 months until harvest (Philippine Recommends, 2008). Using non-uniform planting materials can bring about early or late plant maturity, resulting in a high percentage of small fruits and low economic performance. Cooperatives and individual farmers sell uniform-sized suckers at PHP 1.5–3, while uneven-sized suckers are sold at PHP 1 per piece.

The fertilizer application for Queen pineapple is based chiefly on traditional practices or the recommendations of fellow farmers. The most common types of fertilizers used are complete (14-14-14) and urea (46-0-0) at four bags each per hectare (Table 6). Pineapple planting is done based on the farmer's preference regarding plant spacing, open or intercropped areas, alleyways for harvesting, and walking trails for humans and carabaos. Farmers often used the single row at 60 × 30 centimeters (cm) or 100 × 30 cm as the estimated distance between plants.

Weed control can be done manually or by spraying herbicides. Most farmer respondents control weeds using herbicides, and only eight practiced manual weeding. Farmer's application of herbicides varies depending on their budget. Some apply herbicide every three months after planting or at three and seven months after planting. Manual weeding is done as the need arises. The quality and weight of pineapple fruit highly depend on the amount of fertilizer and the application timing.

For soil analysis, extension workers conduct orientation on collecting soil samples and submitting these to the DA Regional Field Office 5 soil laboratory for analysis. Farmers may also refer to the pineapple compendium book distributed through the municipal agriculture offices to pineapple farmers. Soil samples and the soil analysis report may also be submitted to the local municipal agriculture office so that farmers do not need to travel to the regional office. Plants applied with fertilizer recommendation based on soil analysis had 14 percent increased fruit weight and a moderate sweetness of 16 Brix compared to farmers' practice and recommended application for pineapple without soil analysis (Campita and Dipasupil 2020). Hence, if capital is available for the additional cost of fertilizer and labor, applying fertilizer based on the soil analysis result is

recommended. However, despite extension efforts, only some farmers submitted samples or followed the recommended fertilizer application rate. Instead, most used their fellow farmers' recommendations in applying fertilizer.

Table 6. Traditional Production Practices of Queen Pineapple Farmers

Activity	Sample Period	Practice	Problem
Land preparation	Early May	Manual clearing of weeds	Plants are prone to fungal diseases due to plant and weed residue in the soil.
Preparation of planting materials	Early May	Hauling of suckers/sun-drying	Planting all suckers without sorting and eliminating small sizes results in the non-uniform size of fruits.
Planting	Early May	Single spacing based on estimates, usually 100 × 30 cm	Lower number of plants and fruits
Weed control using herbicide	3 months after planting	Herbicide application using a sprayer	Plants compete with weeds while establishing roots, which hinders optimum growth.
Manual weeding	Every 2 months as needed	Manual pulling of weeds using bolo	Weeds are massive and harder to pull out without tillage
Fertilizer application	3 and 7 months after planting	Complete - 1.6 g/plant Urea – applied at 1.6 g/plant	Insufficient amounts and the wrong type of fertilizer limit plant growth
Flower induction	7 months after planting	Apply per plant	Early induction results in a high percentage of small fruits
Harvesting and marketing	13 months after planting	Trader facilitates harvesting	Low profit share

Fruit induction is done between 7–10 months. After seven months of spending money on inputs, financial pressure gets heavy, and farmers often rush to induce the plants and harvest earlier than their natural fruiting schedule. If untreated, insect pests and diseases can cause severe crop losses on Queen pineapple production.

Proper timing is crucial in harvesting to prolong shelf life. For the local market, fruit is harvestable at maturity index one or when the first line of eyes is tinted with yellow. For export, fruits are harvested still green and just about to turn yellow. Queen pineapple is usually harvested at 4.5–5 months after flower induction. Around PHP 130,000 is needed to finance the cost of one hectare of pineapple production. A net income of around PHP 100,000 per cycle equals a monthly income of around PHP 8,333.

The cost of production of Queen pineapple using traditional practices is composed of variable and fixed costs (Table 7). Variable costs comprised planting materials, fertilizer, herbicides, and ethrel for flower induction. Planting materials (60%) and fertilizer (34%) are the major cost drivers for materials. Farmers use suckers as the planting material and typically space pineapple suckers at 100 × 30 cm. Each sucker occupies 0.3 square meters (m^2) per plant, with around 33,333 plants per hectare. A typical pineapple area is planted under coconut at irregular spacing. Using the recommended space for coconuts at 10 × 10 meters (m), with each tree occupying 2 × 2 m^2, a hectare is ideally planted with 100 coconuts at a total area of 400 m^2. With the remaining space of 9,600 m^2, 32,000 pineapples can be planted. However, the population of pineapple varies depending on the available suckers and the farmers' budget.

Most of the farmers practiced zero tillage and manually prepared the land by clearing the area of grasses and weeds. After clearing, the suckers are planted using a bolo. Application of fertilizer was often based on information from fellow farmers and/or personal estimates of the farmer. Since 2022, the price of fertilizer increased by 25–30 percent, and farmers reduced dosage (at about 3.2 g per plant) to two applications at 3 and 7 months after planting.

Herbicide application was made at 2 months and 6 months after planting. Farmers apply 2 kg of herbicide (Karmex or Diuron) per hectare at 130 g per sprayer load with 16 liters of water. Manual weeding is done alternately or depending on the budget. Farmers induced pineapple to flower at 7–9 months after planting. Induction is done by adding 5 milliliters (ml) of ethrel and 250 g of urea to 16 liters of water in a sprayer. The solution is applied to the whorl of the plant. Flowering starts after 30 days,

and fruit can be harvested 4–4.5 months after spraying. Hence, if the farmer induced at 9 months, the harvest will be 13 months after planting.

Table 7: Costs of Pineapple Production for a 1-Ha Farm Using Traditional Practices

Item	Quantity	Unit	Price/Unit	Total (PHP)
Variable cost				120,421.93
Materials				70,050.00
Suckers used	30,000	piece	1.50	45,000.00
Fertilizer		bag		21,000.00
Complete	4	bag	2,700	10,800.00
Urea	4	bag	2,550	10,200.00
Herbicide	4	kg	850	3,400.00
Leadthrel	1	liter	650	650.00
Labor				40,289.20
Land preparation	5	man-days	500	2,500.00
Planting	30,000	piece	0.50	15,000.00
Weeding	15	man-days	500	7,500.00
Fertilizer application	6	man-days	500	3,000.00
Herbicide application	4	man-days	500	2,000.00
Transport from farm to road	25,723	piece	0.40	10,289.20
Interest on variable cost*	0.087	14 months		10,082.73
Fixed Cost				8,722.00
Depreciation on Bolo	4	piece	233	932.00
Depreciation on pail	2	piece	117	234.00
Depreciation on Sprayer	2	piece	778	1,556.00
Land Rental	1	ha/cycle	6,000	6,000.00
Total Cost				129,143.93

Note: *Prices of fertilizer were adjusted as of December 2022

The primary cost driver in pineapple production are suckers (35%), fertilizer (16%), and labor (31%). The average labor cost increased from PHP 400 to PHP 500 per day after the pandemic due to inflation. Land rental comprised a considerable portion of the fixed cost at PHP 6,000 per hectare. Farmers prefer to use something other than heavy equipment (i.e., tractors) in land preparation. The fixed cost was limited to small farm tools such as pail, bolo, and sprayer.

The revenue of pineapple farming depends on two things: the number of fruits and their price. Pineapple is resilient to typhoons and has only an average mortality rate of 5 percent unless other problems arise, such as insect and pest infestation, although these are uncommon. In traditional practice, farmers connect to the market via an agent or trader; once the agreement is made, the trader facilitates harvesting the pineapple and other marketing activities until the product reaches the market. Hence, the trader also estimates the sizes and their corresponding prices. The farmer can negotiate during this process, but the decisions mainly rely on traders. Pineapple fruits are not sorted but rather priced based on estimates before harvest. Table 8 shows the number of pineapples harvested in one hectare based on size classification and their corresponding price based on the agreement between trader and farmer, which often takes place two weeks before harvest.

Table 8: Revenue of Pineapple Production Using Traditional Practices

Item	Quantity	Unit	Price/Unit	Total (PHP)
Sales				
Large	20,167	piece	9	181,503.00
Medium	5,556	piece	7	38,892.00
Small	1,667	piece	5	8,335.00

Given Free	556	piece	5	2,780.00
Self-consumption	556	piece	5	2,780.00
Gross income	28,502	piece	-	234,290.00
Net income				100,799.40
Net income per piece				3.54
Added value				156,837.00

4.4. Innovative Production for Pineapple

Innovative production was also analyzed (Table 9). It involved using a tractor for harrowing and plowing, double row plant spacing, fertilizer application based on soil analysis, application of pre-emergence herbicide, and induction of plants at 10 months. The innovative production innovations mentioned here are not new scientific breakthroughs but rather a package of technologies that are already there but need to be used or adopted by most farmers.

Land preparation using a tractor is recommended but not traditionally practiced. In some areas, it may be impossible to mechanize land preparation due to slope and hilly terrain, but there are also areas where it can be done. The tractor is recommended for conducting one-time plowing to break huge chunks of soil and remove weeds. Harrowing twice is recommended to break the soil further into arable land and mix the weeds into the soil for faster decomposition. There should be a two-week break between plowing and harrowing to allow the weeds to decompose. Suckers should be exposed to sunlight to prevent fungal diseases. Suckers with symptoms of diseases or are short and dry should be removed. The site can be laid out using a bamboo stick, plastic straw, tape measure, and bolo.

Table 9: Recommended Production Innovations for Pineapple Farmers

Activity	**Period**	**Practice**	**Merit**
Land preparation	Early to the middle of May	Use a tractor for one-time plowing and two times for harrowing	Improve soil medium to increase yield
Preparation of planting materials	Early to the middle of May	Hauling, sun-drying, and sorting of suckers	Quality planting materials produce bigger fruits
Planting	Middle of May	Use double row spacing at 100×50×30 cm	Increased number of plants
Weed control using herbicides	10 days after planting and 6 and 9 months after planting	Herbicide application using a sprayer	Pre-emergence application minimizes weed competition during plant establishment
Manual weeding	Every 2 months or as needed	Spot weeding	Spot weeding as the need arises after the chemical spray is more economical.
Fertilizer application	1 and 7 months after planting	Complete at 2.85 g/plant	Application of the correct dosage of fertilizer is correlated to an increase in fruit size.
	3, 5, and 7 months after planting	Urea - at 1 g/plant	
	1 and 7 months after planting	Muriate of potash At 2.15 g/plant	
	4 and 10 months after planting	Amotash at 3.2 g/plant	
Flower induction	10 months after planting	apply per plant at 10 MAP	Ensure uniform ripening
Harvesting	14 months after planting	Harvest by 4–6 laborers	Same as traditional

Marketing	14 months after planting		Multiple channels

Recommended spacing is a double row at 100 × 50 × 30 cm. To get the number of planting materials needed, get the length by dividing 10,000 cm (100 m^2) by 30 cm to come up with the 333.3 number of hills. Add 100 cm and 50 cm for the width and divide it by 2 to get 75 cm. Then, get the width by dividing 10,000 cm by 75 cm to get the value of 133.33 hills. Then, multiply the value of length and width to get the total number of plants of around 44,443. Allotting 400 m^2 for coconut, the remaining space of 9,600 m^2 can be planted with 40,900 pineapples.

Table 10: Costs of Pineapple Production Using Innovative Production

Item	Quantity	Unit	Price/Unit	Total (PHP)
Variable Cost				235,132.31
Materials				111,900.00
Suckers used	40,000	piece	1.5	66,600.00
Fertilizer				34,200.00
Complete	5	bag	2,700	13,500.00
Urea	2	bag	2,550	5,100.00
Muriate of potash	3	bag	2,450	7,350.00
Amotash	5	bag	1,650	8,250.00
Leadthrel	1	liter	800	800.00
Herbicide (diuron)	8	kg	850	6,800.00
Pest control (lorsban)	1	liter	950	950.00
Face mask	2	set	25	50.00
Boots	3	pairs	500	1,500.00
Gloves	20	piece	50	1,000.00
Labor				80,500.00
Clearing	20	man-day	500	10,000.00
Land preparation				
Tractor rental	1	day	2,000	2,000.00
Operator	1	man-day	500	500.00
Hauling of planting materials	40,000	piece	0.15	6,000.00
Lay outing	5	man-day	500	2,500.00
Planting	40,000	piece	0.50	20,000.00
Weeding	16	man-day	500	8,000.00
Fertilizer application	12	man-day	400	4,800.00
Herbicide application	4	man-day	500	2,000.00
Harvesting	38,000	piece	0.25	9,500.00
Transport from farm to road	38,000	piece	0.40	15,200.00
*Interest on variable cost	0.108	14 months		21,366.15
Fixed cost				8,534.00
Depreciation on bolo	4	piece	200	800.00
Depreciation on pail	4	piece	100	400.00
Depreciation on sprayer	2	piece	667	1,334.00
Land rental	1	ha/cycle	6000.00	6,000.00
Total cost				243,666.31

*Prices of fertilizer were adjusted as of December 2022

Herbicide application can be done four times: 10 days before planting and 3, 6, and 9 months after planting. Manual weeding is done as the need arises. The frequency of weeding proved to control the competition of weeds for nutrients. Fruit induction can be done 10 months after planting, so harvest is at 14 months. The average labor cost per day is PHP 500. Land rental comprised a considerable portion of the fixed cost at PHP 6,000 per hectare.

The advantages of innovative production also come at a cost. Added planting materials, other agriculture inputs, and labor costs increased the production capital requirements to around PHP 250,000.

For fertilizer application, soil sample analysis is recommended. Compared to traditional practice, recommended fertilizer was applied at 1, 3, 4, 5, 7, and 10 months after planting, depending on the type and volume per plant. Similar to traditional practice, the primary cost drivers in applying farm innovations were planting materials (27%), fertilizer (14%), and labor costs (33%).

Applying the recommended innovations enhances the overall harvest quality in terms of size. However, the difference in the degree of sweetness is negligible in the domestic market. On the positive side, good-sized pineapples can be sold to different channels and still command a reasonable price. Traders buy pineapple at a higher price when most of the pineapples are premium in size (Table 11). Pineapples can also be sold at the local trading center or in the cooperative for processing.

Table 11: Revenue of Pineapple Production Using Innovative Production

Sales	Quantity	Unit	Price/Unit	Total (PHP)
Extra large	14,198	piece	15	212,972.97
Large	17,568	piece	13	228,378.38
Medium	4,775	piece	9	42,972.97
Small	1,459	piece	6	8,756.76
Gross income	38,000			493,081.08
Net income				248,080.77
Net income per piece				6.53
Added value				350,987.33

5. PRODUCTIVITY ANALYSIS

Productivity depends on using resources such as land, labor, and capital. The efficient use of these resources is correlated to an increase in productivity. The higher the efficiency, the higher the productivity. In this paper, efficiency is measured by the income from the land for the period used, labor cost per day, and return on capital.

For traditional practice, the labor required for one cycle is 81 man-days and would entail a capital of around PHP 133,422. The combination of these two serves as the input. To measure the output per year, net income is multiplied by the number of months allotted from planting to harvest. Since traditional practices induce plants to flower one month earlier than recommended, the production cycle period is only 13 months from a rental value of PHP 6,000. Land productivity was measured at around PHP 95,000. Labor is valued at PHP 1,893 per day, higher than the daily average wage from an off-farm job. The capital return is 1.14, which means that for every PHP 1 input, there is a return of PHP 1.14 output.

Table 12: Productivity of Traditional and Innovative Production Systems

Production Practice	Traditional	Innovative Production	Difference
Labor (days)	80.58	161.00	80.42
Capital (PHP)	133,422	248,532	115,110
Productivity			
Land (PHP)	95,004.99	213,784.09	118,779.10
Labor (PHP/day)	1,893	2,306	412.34
Capital (PHP)	1.14	1.49	0.35

Using new innovative production in pineapple farming improved productivity. However, the labor and capital input required per hectare of production systems that apply innovations is almost double that of traditional production. Although innovative production needs more labor and capital, it brings higher productivity than traditional production. The land productivity for innovative production for 14 months is more than double the traditional land productivity level at 13 months. Hence, the issue is not land availability but maximizing the productivity of land used for a specific period. However, improvement in labor

productivity may not be significant because innovative production needs more labor input per area. That is, innovative production is a labor-intensive practice. However, labor productivity is satisfactory where farmers' time is paid off more than the average wages they would have from an off-farm job, whether practicing traditional or innovative production. In terms of capital, an added value of PHP 0.35 is good enough for short-term investments or one cycle of pineapple production.

Estimated Income by Production System - Income analysis (Table 13) showed that in traditional pineapple farming, income increases by growing other crops and livestock. Meanwhile, income from planting pineapple under coconut is higher in farms that apply innovative production, even without other crops. This implies that land productivity can be maximized if the land is utilized for intercropping (coconut + pineapple) by applying innovative production for pineapple.

Farmers' decision on the production system to practice, whether single-crop, multi-crop, or integrated, depends on their land area and land tenure status. In the study area, most of the farmers previously planted coconuts before mixing pineapple and other crops like rice and lowland vegetables. Expanding one crop at the expense of another may depend on profitability. Hence, if the farmer observes that one crop generates more income, the rest of the land may be allotted to that crop.

Table 13: Productivity of Traditional and Innovative Production Systems for Pineapple by Cropping System

Production System	Single-crop: Pineapple under Coconut (PHP)	Multi-crop: Pineapple + Coconut + Rice (PHP)	Integrated: Pineapple + Coconut + Rice + Swine (PHP)
Traditional			
Cost	115,633	138,338	193,625
Pineapple	115,633	57,698	57,698
Coconut		13,888	13,888
Rice		66,752	66,752
Swine			55,287
Net Income	91,965	108,337	81,394
Pineapple	91,965	45,982	31,270
Coconut		45,632	11,408
Rice		16,723	16,723
Swine			21,993
Innovative Production			
Cost	202,173	181,727	203,720
Pineapple	202,173	101,087	101,087
Coconut		13,888	13,888
Rice		66,752	66,752
Swine			21,993
Income	206,943	165,826	132,217
Pineapple	206,943	103,472	82,093
Coconut		45,632	11,408
Rice		16,723	16,723
Swine			21,993

To increase income, pineapple farmers may adopt innovative production and allot more area for pineapple cultivation over other crops. The survey showed that from a total area of 3 ha, only 1.6 ha or less is allotted to pineapple cultivation. This is because traditional pineapple farming practices are profitable when combined with other crops. Meanwhile, applying innovative production showed that farmers are better off planting pineapple than other crops, provided the technology package is adopted. Farmers can apply for production loans to finance their financial requirements in pineapple production and rent land for one cycle. Hence, the question of adoption also relies on the availability of credit programs and technical know-how of the farmers, which depends on farmers' awareness level of technologies and/or their decision to adopt the package of technologies.

Estimated Required Production Area - The pineapple cultivation area required for farmers to earn an income above the poverty threshold if they cultivate only pineapple in both traditional production and innovative production is shown in Table 14. This table is calculated based on a standard family size of five members. If the farmer cultivates by traditional production, 1.16 ha is needed to earn an income that meets the basic food requirements and 1.67 ha to earn an income that meets the poverty threshold or above.

Table 14: Estimated Area Required for Pineapple Production

Parameter	Traditional Production	Innovative Production
Net annual income per hectare (PHP)	86,399	212,640
Required area for the basic food requirement (ha)	1.16	0.47
Required area for the Philippine poverty threshold (ha)	1.67	0.68

Note: Basic food requirement and poverty line are calculated for five family members

The average pineapple cultivation area of surveyed farmers was 1.2 ha. Thus, it is clearly difficult for a farmer who cultivates the size of an average pineapple area to earn an income above the basic food requirements using traditional production. Only 16 of the respondent farmers cultivated an area large enough to earn income more than the poverty threshold using traditional production. On the other hand, if a farmer adopts innovative production, he needs only 0.47 ha of pineapple cultivation to earn an income that meets the basic food requirements and 0.68 ha to earn an income that meets the poverty threshold. For most pineapple farmers to escape poverty, innovative production must be adopted.

5. CONCLUSION AND IMPLICATIONS

Socioeconomic characteristics influence how farmers live and make decisions on-farm and off-farm. These decisions translate to farming practices and the adoption of innovations. Higher education, smaller family size, and larger land area mean higher chances of generating income above the poverty threshold. However, around 73 percent of Queen pineapple farmers lived below the poverty threshold, and only 27 percent had better economic conditions. Most poor farmers had low educational attainment, large household size, and less than a hectare of pineapple production area.

Queen pineapple farmers have a moderately high education level and are primarily in middle age. Hence, capacity-building training on production innovations can help farmers understand the technology adoption process. Because most farmers are at an active age, it is also an excellent opportunity to implement production innovations since it involves additional labor, especially in broader cultivation areas.

Cooperative membership must be improved, indicating the need for a campaign on the benefits of cooperatives. Since most respondents are experienced farmers, the challenge is encouraging changes in their production practices by adopting innovations. While the average land area is adequate, it must be maximized to improve farmers' income.

Innovative production increased productivity in terms of land, labor, and capital. However, not all farmers have the capacity to adopt innovative production practices due to limiting factors, such as financial capital, tenurial status, and technical know-how. Innovative production is recommended for those who own the lands or tenants with the authority to decide on crop prioritization and with an average area of at least 0.5–1 hectare allotted to pineapple. To get out of poverty using their traditional practice, a farmer must plant 1.6 ha, which is more than the average farm size. If they adopted innovative production, they would only need to plant 0.68 ha, which is far below the average farm size.

The income level of the traditional pineapple production practice is higher in farms that apply multi-cropping. This indicates that income from pineapple using traditional practices is insufficient, and other crops are needed to increase farm income. However, it can be noted that using production innovations, single-cropping generated an income higher than multi- and integrated farming systems. This implies that production innovations can generate sufficient income without combining it with other crops or growing animals. This way, farmers can consolidate farming capital into pineapple production, generating higher net income than other crops.

Thus, expanding production areas through mixed or integrated cropping or adopting production innovations for single-cropping is recommended. In addition, farmers must regularly seek government assistance/support regarding new technologies and capacity training. The participation and support of private investors in the pineapple industry's value chain should also be encouraged. Finally, extension strategies should be adopted. These include (1) establishing demo/model farms to encourage farmers to adopt innovations, (2) conducting season-long training to improve the skills of farmers, (3) producing a techno guide for cultivating pineapple in the local language, and (4) providing credit programs with low-interest/staggered loan release based on farm activities.

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