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Towards a resilient mango (Mangifera indica) industry in Central Luzon, Philippines: A case study of Nueva Ecija's development needs

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ABSTRACT
The mango industry functions as a vital economic sector for Nueva Ecija but faces rising production instability, which requires urgent development of protective measures. The output trend shows a decline since the last few years, although it experienced growth before, indicating emerging weaknesses that require specific solutions. The study described the current farm practices in planting materials, cultural management, harvest, postharvest, marketing, and financing through a descriptive quantitative design involving 110 growers from 11 cities and municipalities in Nueva Ecija province. Researchers collected data through structured questionnaires and analyzed it using frequency and percentage distributions. The research showed strength in access and availability of production equipment, while weaknesses include inadequate working capital and limited training. Opportunities are in value-added production through the processing center of the Palayan City Mango and Grain Growers Association. However, the rising cost of farm inputs, pest infestation, and adverse weather conditions continue to affect profitability. The development plan entails capacity building, pest management, and infrastructure enhancement to make the mango industry more resilient in Nueva Ecija.

Contribution/Originality: The research study generates new knowledge by examining mango farm practices through primary data, which is collected from organized associations in 11 cities and municipalities. The goal is to develop a policy-ready development plan with clearly defined implementing agencies and timeframes.

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1. INTRODUCTION
Mango (Mangifera indica L.) is a high-value tropical fruit widely grown in Asia, Central and South America, and Africa. Asia alone is responsible for about 76% of the world's mangoes, with the country producing 15 million metric tons per year (Galán Saúco, 2015). In the Philippines, following banana and pineapple, mango is the third most important fruit crop (Reyes, Cayabyab, & Copuyoc, 2020). The Carabao mango, in particular, is famous for its exceptional sweetness and was named the world's sweetest mango variety in the 1995 Guinness Book of World Records (Inquirer.net, 2013).

The Philippine mango industry supports around 2.5 million Filipinos both directly and indirectly (Department of Agriculture, 2017). Mangoes are widely grown in the Philippines, according to the Philippine Mango Industry Roadmap 2017-2022. Mangoes are cultivated by large corporate farms, medium-sized farms, and, most importantly, small farmers who own at least 10 to 12 trees. The roadmap estimates that the area of the mango sector exceeds 146,841 hectares, with 70% of the production area managed by small-scale growers. However, smallholder farmers

face challenges such as limited access to financing, restricted availability of advanced farming technologies, and dependence on service contract sprayers and lessee agreements, which impact their efficiency and profitability.

The Philippine mango industry has been producing less than in previous years. The production of mangoes in the Philippines reached its peak of 902.7 thousand metric tons in 2015. Since then, it has declined. By 2019, production had fallen to 737 thousand metric tons. This indicates an average annual decline of 4.8% (Paguia, Paguia, Ventura, Javier, & Roldan, 2021). The carabao mango variety, which accounts for 82% of total mango production, also experienced a decline in production volume by 5.2% in 2021.

Central Luzon is a major mango-producing area in the Philippines. However, it has also experienced a decline in production. The production significantly decreased from 2015 to 2017, from 52.68 thousand metric tons to 34.86 thousand metric tons. Like other agricultural provinces in the region, Nueva Ecija is not exempt from this downturn. The province's mango yield fell from 9,402 metric tons in 2015 to 5,690 metric tons in 2017 (Philippine Statistics Authority, 2017). Mango is the top fruit in Nueva Ecija in 2024, which contributed the most to the total fruit production of the province despite a drop in volume. Mango production in Nueva Ecija fell to 9.8 thousand metric tons, making it the second-biggest mango-producing province in Central Luzon. Zambales was the largest, with 16.8 thousand metric tons of production. Next were Bulacan's 7.9 thousand metric tons and Aurora's zero production. The continuous decline in mango production not only concerns the provincial economy but also the national mango supply chain. One reason is that Nueva Ecija accounts for 23.33% of the mango production area in Central Luzon (Philippine Statistics Authority Region III, 2024).

There are several factors attributable to the declining productivity of the mango sector. Stakeholders and reports state that the main limitations are limited access to the market, lack of postharvest facilities, high input costs, pest infestations (Cecid fly, mango pulp weevil, etc.), and poor farm-to-market infrastructure (Department of Agriculture – High Value Crops Development Program, 2017). Farmers also lack adequate support for mango tree rehabilitation, nor do they have information on government assistance programs.

Carabao mangoes, known for their sweetness, are highly perishable and prone to postharvest damage, anthracnose, and stem-end rot (Montecalvo, Santos, & Reyes, 2019). In addition, the Philippine mango industry is at a competitive disadvantage compared to other countries such as Mexico, Thailand, and Vietnam due to the lack of significant investment in R&D to make mango cultivars more resilient and productive (Department of Agriculture – High Value Crops Development Program, 2017).

Labor issues further compound the industry's difficulties. During peak harvest, workers experience occupational hazards, irregular pay, and exploitative short-term contracts (Sacramento, 2020). These socio-economic challenges and logistical hindrances hamper the sustainable development of the mango value chain and deepen rural poverty.

Due to the above-mentioned problems, there is a need to conduct a comprehensive assessment of the mango industry in Nueva Ecija, which is a major production area in Central Luzon. The study will aim to assess the current condition of the mango industry in Nueva Ecija, focusing on key farm practices in terms of planting materials, cultural management, harvesting, postharvest handling, marketing, and financing. The SWOT analysis framework aims to identify the strengths, weaknesses, opportunities, and threats of the mango industry in Nueva Ecija, illustrating how internal and external factors affect its performance.

This study will be used to build a localized mango industry development plan. The results also contribute to wider policy discussions on improving mango farm practices. The ultimate objective is to assist stakeholders such as farmers, cooperatives, local governments, and policymakers in developing a more resilient, inclusive, and productive mango value chain in Nueva Ecija.

2. MATERIALS AND METHODS

The current farm practices of mango growers in Nueva Ecija regarding planting materials, cultural management, harvesting, postharvest, marketing, and financing were the focus of a descriptive quantitative research design. Using a quota sampling technique, 110 registered mango growers were sampled. Quota sampling requires the researcher to identify specific groups, from which participants are selected to ensure the inclusion of relevant sub-groups (Iliyasu & Etikan, 2021). In this research, 10 members per association were chosen to represent mango growers from the municipalities/cities of Zaragoza, Rizal, Caranglan, Laur, Palayan City, General Mamerto Natividad, Gapan City, Peñaranda, General Tinio, Cabiao, and San Antonio. The list of mango associations was provided by the Provincial Agriculturist Office of Nueva Ecija. The criterion of 20 or more trees was based on the classification by Dela Cruz (2007), where those with more than 20 are classified as commercial farm operators in the Philippines. A key principle of the study was to limit its analysis to the commercial-scale mango growers.

The researchers used quota sampling to achieve representation from different Nueva Ecija municipalities, but this sampling approach has inherent limitations. The results may face selection bias because participants were chosen through predefined quotas instead of random sampling. The results may be less generalizable to the broader population because participants from accessible or cooperative grower groups show different characteristics than those who were not included. The study findings need careful interpretation because they might not represent all the different types of mango growers that exist in the province. The method of quota sampling proved suitable for collecting essential data from organized growers' associations, which had members with production experience.

Despite the data covering growers from various associations and areas, the data were presented in a consolidated form to show the overall picture of farm practices in the mango industry in Nueva Ecija, not to compare municipalities or associations. The researchers collected data through a structured survey questionnaire via face-to-face interviews, ensuring clarity for the respondents. The researchers followed ethical guidelines such as informed consent and confidentiality. The frequency distributions and percentage analyses were conducted in MS Excel and served as the basis for the mango industry development plan and strategic recommendations in Nueva Ecija.

3. RESULTS AND DISCUSSION

3.1. Farm Practices of the Mango Industry in Nueva Ecija

3.1.1. Planting Materials

Table 1 presents the sources of planting materials of mango growers in Nueva Ecija.

Table 1. Sources of planting materials used by mango growers in Nueva Ecija.

Source of planting materials	Frequency (N=110)	Percentage
Grown by growers	4	3.64
Purchased	106	96.36
Partly grown, partly purchased	0	0
Total	110	100

Mango growers in Nueva Ecija largely make use of grafted seedlings bought elsewhere. This means that, as shown in the table, 96.36% of respondents said that they do not propagate their own seedlings. The extensive reliance on commercially obtained seedlings is an acknowledgment of the advantages of grafted types, such as early bearing, better uniformity, and disease resistance, as cited by Camungao, Velasco, Mesa, and San Jose (2013). Because of its market value, sweetness, and consumer demand, the Carabao mango is the most popular variety. Seedlings generally come from nearby nurseries and Department of Agriculture (DA) programs. For example, growers in Cabiao and San Antonio can access certified nurseries near their municipalities for more stable, higher-quality planting materials. In upland areas such as Laur and Caranglan, growers will have difficulty transporting their seedlings. Growers will start to send deliveries from the nearby provinces only when the seedlings are ready. Esguerra, Rolle, and Mercado (2012) found that the socio-economic and geographical differences in access to seedlings greatly affect the long-term productivity of orchards. Furthermore, most farmers prefer using medium-sized seedlings (3–4 ft) as they establish faster in the field with lower mortality rates. Different municipalities have different preferences for size due to differences in land area, topography, and choice of cropping systems, reflecting the growers' decisions in their choice of planting materials.

3.1.2. Cultural Management

Table 2 presents the cultural management practices employed by mango growers in Nueva Ecija,

Table 2. Cultural management practices employed by mango growers in Nueva Ecija.

Cultural management practices	Frequency (N=110)	Percentage
Fertilizer used		
Organic	17	15.45
Inorganic	80	72.73
Combination	13	11.82
Planting distance		
10m x 10m	54	49.09
10m x 5m	4	3.64
12m x 12m	9	8.18
15m x 10m	6	5.45
20m x 20m	37	33.64
Type of cropping system		
Inter-cropping	61	55.45
Mono-cropping	49	44.55
Flower induction		
Self-spraying	43	39.09
Contract spraying	67	60.91
Insect, pests and disease control		
Organic pesticide	0	-
Synthetic pesticide	110	100.00
Fruit bagging		
Practiced	52	47.27
Not practiced	58	52.73

Mango production in Nueva Ecija requires cultural management practices such as land preparation, fertilization, pest control, and fruit bagging. In most cases, land clearing and digging are done by hand. However, in accessible areas, some growers use rotavators and tractors. The distance between any two plants varies, typically ranging from 10m x 10m to 20m x 20m. The distance depends on the size of the land and the cropping systems. A common practice among mango growers is intercropping, where 55.45% of the respondents grow mangoes with rice, vegetables, bananas, and calamansi. Farmers in lowland areas like Zaragoza and General Tinio often use this technique to utilize their land and sources of income. Despite its benefits, intercropping can make pest management more challenging due to the diversity of crops, which may facilitate pest transmission. Therefore, pest monitoring and control become more demanding (Wanole, Tejashri, & Chakraborty, 2020). Mostly, fertilization practices are inorganic. All of the

respondents applied either Triple 14 or Urea. They applied these on a seasonal basis, taking into account the yield of crops. Some growers also include chicken manure as an organic input, despite the capacity of organic amendments to improve soil health and soil nutrient retention (Dikinya, Saka, & Mufwanzala, 2010; Roba, 2018). To induce flowering in trees, growers usually apply potassium nitrate and calcium nitrate from the 6th year of trees for flower induction. Around 60.91% of growers use contract sprayers for their input applications. This reduces labor demand but also limits the grower's knowledge of using the right chemical at the right time. Pest and disease management is a constant concern for growers, with cecid fly damage and anthracnose being the main threats. All respondents use chemical pesticides and fungicides, with some reporting a season of up to six sprays. According to Tumang (2019) overdependence on chemicals without proper identification of the pest may result in pesticide overuse. Consequently, residues will accumulate and cause harm to the environment. Even though fruit bagging, a Good Agricultural Practice (GAP), improves the quality of the fruit, only 52% of growers implement this practice because of the high cost of labor and materials. Bibi and Baloch (2014) stated that bagging reduces pesticide use and improves the appearance of fruit for export. However, nearby municipalities like Gapan have more farmers adopting bagging because they have easier and faster access to labor and materials..

3.1.3. Harvesting

Table 3 shows the harvesting schedule of mango growers in Nueva Ecija.

Table 3. Harvesting schedule of mango growers in Nueva Ecija.

Time of harvest	Frequency (N=110)	Percentage
Fruit maturity		
Lean months		
December	15	11.28
January	3	2.26
February	7	5.26
Peak months		
March	26	19.55
April	38	28.57
May	29	21.80
June	15	11.28

Note: Multiple responses.

The harvesting is usually conducted during March and April. 28.57% of growers harvest in April, and 19.55% in March. The timing of the picking season is determined by the maturity of the fruit, atmospheric conditions, and market prices. Some growers practice early harvesting, known locally as *pauna*, to sell at higher prices in off-season markets, while others practice late harvesting, called *pahuli*, which exposes the crop more to the rainy season. Most growers do not harvest their products themselves; instead, they enter into contracts where buyers or traders perform the harvesting. This approach reduces labor and logistics costs for farmers, estimated at ₱8000-10000 per hectare. However, it also diminishes the growers' control over quality and pricing. Manual harvesting tools such as poles and baskets are commonly used. Harvesting occurs from 9 am to 3 pm to prevent sap burns on the fruit. No respondents reported using mechanized tools for harvesting. Additionally, there is no fruit sampling or residue testing, as most growers do not export.

3.1.4. Postharvest Handling

Postharvest activities in Nueva Ecija are still not fully developed and are inconsistently practiced, resulting in high mango losses. Most growers still use old bamboo crates lined with old newspapers to package their fruits to prevent bruising, sap burns, and damage from bad packaging materials. These crates are relatively cheap but do not offer adequate physical protection during movement, and spoilage is likely. Briones (2013) stated that poor handling and absence of cold chain facilities cause postharvest losses, with mango production ranging from 20% to 30% during the harvest season. Similar findings were reported from Nueva Ecija, where none of the growers had access to cold storage facilities or climate-controlled transportation. This situation is believed to contribute to postharvest losses, especially in distant areas with poor roads. The municipalities of Cabiao and Gapan are closer and experience less spoilage because of shorter travel distances. Upland areas such as Laur and Caranglan take longer to transport their products, resulting in increased spoilage. Most growers also lack knowledge about postharvest treatments such as hot water dipping, waxing, and fungicidal coating, which are used in commercial operations to extend shelf life and maintain fruit quality. Ventura, Paguia, Paguia, Telmo, and Marabe (2021) said that the use of such technologies can reduce spoilage and maintain the quality of fruits during distribution, showing a potential opportunity for the mango industry of Nueva Ecija.

Postharvest fruit and vegetable losses resulting from mechanical damage, decay, pest infestation, and temperature control problems represent a worldwide issue (Patil, 2009; Sivakumar & Wall, 2013). The Mexican government has implemented successful technologies to minimize postharvest losses through improved handling, storage, and transportation systems (Naqvi, 2004). Thailand acknowledges the need for appropriate postharvest technology and quality control methods, which must be carried out to maintain mango quality during supply chain operations (Le et al., 2022). Multi-dimensional success in postharvest management depends on stakeholder cooperation between modern handling approaches, market solutions, and infrastructure development (Kader, 2004;

Palumbo et al., 2022). The implementation of these combined approaches illustrates the fundamental role of integrated postharvest strategies in minimizing losses and increasing product longevity.

3.1.5. Marketing

Table 4 presents the marketing practices of mango growers in Nueva Ecija.

Table 4. Marketing practices of mango growers in Nueva Ecija.

Marketing practices	Frequency (N=110)	Percentage
Mango buyers		
Retail market	18	10
Agent	17	17
Trader	75	73
Mode of payment		
Cash	108	98
Consignment	0	0
Both	2	2
Mode of distribution to buyers		
Delivered	10	10
Pick up	93	83
Both	7	7

Mango marketing in Nueva Ecija is primarily conducted through contracts with traders and wholesalers who set the price of the mangoes. Although this system reduces growers' marketing responsibilities, it also diminishes their bargaining power and income potential since the prices are controlled by intermediaries. According to Brown et al. (2006), reliance on middlemen prevents growers from capturing the full value of their crops and responding effectively to price fluctuations. This issue is prevalent in the Nueva Ecija mango industry. Price fluctuations remain a significant challenge, with farmgate prices rising from ₱80 to ₱100 per kilo during the off-season and dropping to ₱20 to ₱30 per kilo during peak harvest periods. Without systems to monitor market prices and access to timely market information, growers are at a disadvantage in making informed price-related decisions, leaving them vulnerable to market volatility. As pointed out by Brander (2018), branding and local marketing networks in the sector of mangoes are not well developed, which reduces opportunities for product differentiation and premium pricing. Several towns join together through a cooperative or growers' association for organized marketing, reaching institutional buyers like Department of Trade and Industry fairs or Department of Agriculture-supported outlets. Most growers are still outside this orbit due to a lack of incentives and no capacity-building initiatives that can supplement their market access and income generation potential.

3.1.6. Financing

Table 5 shows the sources of financing utilized by mango growers in Nueva Ecija.

Table 5. Sources of financing utilized by mango growers in Nueva Ecija.

Source of Financing	Frequency (N=110)	Percentage
Self-financed	38	34.55%
Borrowed capital from private lending institutions	3	2.73%
Special lending programs of the government	0	-
Cooperative loan	2	1.82%
Contractual arrangement	67	60.91%
Total	110	100.00%

The results indicate that 60.91% of mango growers in Nueva Ecija are highly dependent on contractual arrangement schemes. These growers engage the services of sprayers under a production-sharing agreement to cover the costs of inputs, labor, and equipment. This practice is commonly adopted in General Tinio, where growers find this solution appealing as they do not share production costs. Unlike the growers from Zaragoza, Laur, and San Antonio, who use income from other crops such as rice, those from Penaranda and Cabiao rely on savings or rice loans to fund mango production. Only three out of a hundred growers are able to obtain loans from private institutions. In Gapan and Caranglan, some farmers borrowed up to ₱150,000 at an interest rate of 2.5% to 3% per month, with a repayment period of 5–6 months. Although cooperative loans with no collateral at 2% monthly interest are available in General Tinio, only 1.82% of growers have availed themselves of this type of loan. According to respondents, no one accessed government loan programs such as the Agricultural Competitiveness Enhancement Fund (ACEF), which offers loans at 2% interest per year. The main reasons for not accessing these funds are a lack of knowledge and documentation. Overall, the absence of available credit, combined with rising input costs, may prevent many growers from opting for either contractual arrangements or self-financing, potentially restricting their ability to hold or expand mango production.

3.2. SWOT Analysis of the Mango Industry in Nueva Ecija

Table 6 presents the perceived strengths of the mango industry in Nueva Ecija.

Table 6. Perceived strengths of the mango Industry in Nueva Ecija.

Strengths	Percentage	Percentage	Rank
Planting materials			
Availability of quality planting materials	74	67.27	2
Cultural management			
Production equipment are available	76	69.09	1

Note: Multiple responses.

Quality planting materials and production equipment are among the identified strengths of the mango industry in Nueva Ecija. 67.27% of respondents reported having access to good-quality planting materials, specifically grafted Carabao mango seedlings, from credible nurseries both within and outside their municipalities, including Batangas and Guimaras. According to Esguerra et al. (2012) the Seed Center of the Department of Agriculture in CLSU, Muñoz, has a program dedicated to providing quality seedlings to growers. In terms of cultural management, 67.27% of respondents indicated possessing production equipment such as power sprayers, which are essential for spraying chemicals to control infestations. Farmers today utilize tools like Robin-brand power sprayers to maintain crop health as pests become more harmful. Some farmers also have water pumps and irrigation systems to ensure crop stability during dry seasons. However, growers who are under contract benefit from the use of these equipment, as contract sprayers are responsible for their operation.

3.2.1. Weaknesses

Table 7 presents the perceived weaknesses of the mango industry in Nueva Ecija.

Table 7. Perceived weaknesses of the mango Industry in Nueva Ecija.

Weaknesses	Frequency	Percentage	Rank
Planting materials			
Lack of knowledge on mango variety	10	9.09	10
Cultural management			
Poor soil condition	17	15.45	8
Limited seminars and training on mango production	68	61.82	2
Lack of water/Irrigation facilities	20	18.18	7
Harvesting			
High percentage of reject mangoes	65	59.09	3
PostHarvest			
Inadequate postharvest facilities	14	12.73	9
Marketing			
Low price due to low quality of produce	49	44.55	5
Low price due to oversupply	60	54.55	4
Poor farm-to-market roads	37	33.64	6
Financing			
Lack of working capital	88	80	1

Note: Multiple responses.

The mango industry in Nueva Ecija faces several weaknesses that impact both productivity and profitability. The most critical issue, reported by 80% of respondents, is the lack of working capital, which hampers farmers' ability to purchase inputs, hire labor, and maintain orchard health. Mango cultivation is costly, primarily due to expenses related to pest and disease control. Many producers have resorted to contractual arrangements with pest and disease control sprayers and have sought financial assistance, as noted by (Delos Santos, 2012). Limited access to training and seminars was identified as another significant weakness by 61.82% of respondents. Many mango growers rely on ancestral knowledge and have not benefited from formal training, resulting in the continued use of outdated practices and inadequate pest management strategies. According to Ledesma, Aquino, and Agbisit (2016) success in mango orchards heavily depends on proper training in pruning and disease control, yet access to such training remains limited. Some growers claim that seminars are only available to a select few. A key production challenge for 59.09% of respondents is the high rejection rate of mangoes due to pest attacks, particularly by cecid flies. Rejection rates are higher when bagging is not employed, which helps reduce insect damage. Consequently, growers face economic losses as affected mangoes are sold at very low prices or discarded entirely. Price instability is another major challenge, with 54.55% of respondents observing low prices during peak seasons due to oversupply. Additionally, 44.55% report low prices resulting from low-quality produce damaged by pests. According to Eain (2015), even high-quality produce cannot command premium prices due to oversupply, which reduces its profitability. About 33.64% of growers have reported poor farm-to-market roads, which have aggravated logistical concerns. In upland areas like Caranglan, growers have observed that transportation costs are a significant factor. As a result, traders do not reach remote farms due to high transport fees, causing buyers to lose interest (Selim & Skorseth, 2001). Also, 12.73% of the growers suffer the impact of inadequate postharvest facilities. They often use cigarette cartons as harvesting containers, which are not strong enough to protect the fruit during transportation. Bambalele, Mditshwa, Magwaza,

and Tesfay (2021) says that the quality of postharvest facilities is essential to maintain quality and reduce losses during the marketing of fruits. 18.18% of growers confessed that lack of water during the dry season caused them problems. This is especially true in upland municipalities such as General Mamerto Natividad, Rizal, and Caranglan. Due to the unavailability of irrigation facilities, growers have to bring water from distant locations, which increases production costs and labor requirements. Mango trees can be cultivated more effectively with significantly higher yields through consistent irrigation (Morais, Silva, Freitas, & Braga, 2021). Additionally, some growers faced difficulties with poor soil quality (15.45%) and a lack of knowledge about mango varieties (9.09%). Some farmers in Penaranda purchased the wrong variety by mistake due to insufficient knowledge, which negatively impacted their production (Quijano, Quijano, & Diaz, 2022). To address these weaknesses, it is essential to improve financial support systems, provide access to training, enhance pest management, develop infrastructure, and increase the availability of quality planting materials.

3.2.2. Opportunities

Table 8 shows the perceived opportunities in the mango industry in Nueva Ecija.

Table 8. Perceived Opportunities of the Mango Industry in Nueva Ecija.

Opportunities	Frequency	Percentage	Rank
Cultural Management			
Improving productivity by using innovative technologies	110	100	1
Collaboration with the government, NGOs, and community groups	110	100	1
Postharvest			
Substantial surplus can be developed into a marketable value-added product	110	100	1

Note: Multiple responses.

Mango growers from Nueva Ecija have identified three high-impact opportunities to enhance productivity and profitability. Innovative technologies such as the Integrated Crop Management (ICM) and Postharvest Quality Management (PQM) are encouraged to control yield decline caused by pests and diseases (Department of Agriculture, 2017). Implementing these advanced techniques could increase the production of export-quality mangoes and reverse the declining trend in productivity. Mango growers in Palayan City, the capital of Nueva Ecija, have a significant opportunity due to the Mango Processing Center operated by the Palayan City Mango Grain and Growers Association (PCMGA). This is the only such facility in the province. Established in December 2017 by the Department of Agriculture, the Philippine Rural Development Project, the center produces mango juice, mango puree, and mango wine. Although operational, the center faces challenges related to FDA registration and the implementation of a Quality Management System (QMS), which are essential for product standardization and expanding market access. Addressing these issues through technical assistance and regulatory support presents a substantial opportunity for the center to grow its market share and leverage its status as the only mango processing plant in the area. Additionally, partnerships with government agencies, NGOs, and community groups can provide valuable learning, funding, and technical support. The Department of Science and Technology's mango industry strategic science and technology program aims to control pests, diseases, poor nutrition, and postharvest losses. Meanwhile, the Department of Trade and Industry conducts value-adding activities to improve mango marketability (Sacramento, 2020). Local government units (LGUs) support mango farming as a viable business through community development programs. Lastly, surplus mangoes can be transformed into marketable value-added products such as dried mangoes, mango puree, and sinigang mix powder, which have significant market potential. These are good product options for diversifying one's income when they are in harvest season (Department of Agriculture – High Value Crops Development Program, 2017).

3.2.3. Threats

Table 9 shows the perceived threats in the mango industry in Nueva Ecija.

Table 9. Perceived threats of the mango Industry in Nueva Ecija.

Threats	Frequency	Percentage	Rank
Planting Materials			
High cost of seedlings	31	28.18	10
Cultural Management			
Increasing costs of production inputs and labor	110	100	1
High costs of farm tools, equipment, and machinery	89	80.91	4
High incidence of pests and diseases	105	95.45	2
Bad weather/Calamities	97	88.18	3
Lack of laborers during peak season	58	52.73	8
Lack of adequately skilled manpower	48	43.64	9
Limited government support	62	56.36	7
Marketing			
Delayed payment by buyers	11	10	11
Frequent price fluctuation/Unstable prices	68	61.82	6
Financing			
High Interest on a loan	78	70.91	5

Note: Multiple responses.

Mango growers in Nueva Ecija face many serious threats, as revealed in the SWOT analysis. All of the respondents said that the greatest threat is increased costs of inputs and labor, which put a strain on the farm budgets. Growers in Gapan observed that the price of a fruit bag increased from 30 centavos to 70 centavos per piece, and the rise in the price of pesticides and fungicides prompted them to avail of financing on a contractual basis (Delos Santos, 2012). In the same way, inflation is increasing the cost of labor. Consequently, farms need to import labor. All this increases losses on farms, particularly at the peak of the season. At this time, wages, food, and transport costs increase. Another threat mentioned by 95.45% of the respondents is pests and diseases, such as cecid fly, anthracnose, and mango pulp weevil, which are detrimental to the quality and yield of the crop. The presence of pests is aggravated by humidity and failure to manage them properly. Failure to bag fruits often results in rejection rates as high as 70–80%, leading to substantial economic losses (Rocha IV & Lagarteja, 2020). Typhoons and heavy rains pose risks to mango crops, with 97% of mango growers affected by bad weather and calamities. In 2020, mango farms in Laur were damaged after Typhoon Ulysses hit, causing loss of trees and fruit, according to growers. Additionally, fluctuating climatic conditions may lead to fungal diseases and a decline in the quality of the yield (Makhmale, Bhutada, Yadav, & Yadav, 2016). The cost of farm tools and implements is said to be high by 80.91% of respondents. Many farmers are faced with challenges of financing necessary farm tools like power sprayers, water pumps, utility vehicles, and many more for maintaining their farms. It is too costly for small-scale growers to establish a deep well to irrigate their crops. As a result, they will not be managed properly during the dry season. 78% of respondents say high-interest-rate loans make financing challenges more difficult. Some farmers borrow from rural banks at an interest rate of 2.5% to 3% monthly, while others borrow from informal sources at an interest rate of up to 10%, which increases the risk of being in debt (Ololade & Olagunju, 2013). 61.82% of growers are facing frequent price fluctuations and unstable prices, which are putting the profitability of mango farming under threat. During peak harvest, prices decline sharply owing to higher supply and market saturation. In order to profit most from the purchase and sale of these crops, buyers and traders manipulate the prices (Eain, 2015). Farmers in Penaranda and Zaragoza claimed that prices fell by ₱5.00 – ₱25.00 after they brought their crops to market, which could adversely affect their incomes. Furthermore, limited government support poses a significant threat, with 56.36% of respondents. Mango growers from other municipalities complained about not receiving adequate support from the government in terms of production inputs such as farm tools. Some farmers attained only two sacks of fertilizer per hectare, while others benefited from power sprayers. According to some growers, two sacks of fertilizer, for example, are not enough to meet the fertilizer needs of a hectare of mango trees. Another issue of concern is the shortage of labor during peak season, with 52.73% of respondents facing this problem. This may pose challenges to labor-intensive tasks, such as fruit bagging, which directly affect fruit quality and ultimately their market value (Bayogan, Esguerra, & Campeon, 2006). The younger generation is also not interested in working on farms, which worsens the shortage of farm labor (Senapati & Padhi, 2020). Finally, 10% of growers are facing cash flow problems due to delayed payments by buyers, especially in remote areas like Caranglan, where access to direct buyers is limited. Some growers have delayed payments of several months, resulting in financial uncertainty and reliance on informal lenders. To counter these threats, the government must implement strategies that provide accessible financing, improve pest management practices, develop postharvest infrastructure, and strengthen market linkages to stabilize prices and ensure regular income for mango growers in Nueva Ecija.

3.3. Proposed Development Plan

The survey and SWOT analysis results serve as the foundation for the development plan, which transforms priority issues into specific objectives and practical strategies for the main production areas, with defined implementing agencies and estimated time frames.

Table 10 presents the proposed development plan for the mango industry in Nueva Ecija, presenting the area, issues, objectives, strategic initiatives, brief descriptions, responsible agencies, and time frames.

Table 10. Proposed development plan for mango industry in Nueva Ecija.

Area	Issues/Problems/ Concerns	Objective/s	Solutions/Strategic Initiatives/Project	Brief Description of the Strategy/Project	Players/Agencies Involved	Time Frame
Planting materials	Lack of knowledge on the mango variety	To provide farmers with the information and skills they need regarding planting materials.	Include in the provision of training and seminars regarding mango production (Good Agricultural Practices)	This strategy will advance and broaden knowledge of agricultural best practices by developing human capability.	Department of Agriculture (DA), Provincial and Municipal Agriculturist	3 – 6 months
	High cost of seedlings	To achieve lower costs and high-quality seedlings for mango growers..	Development of a mango nursery farm in the city/municipality	This creates quality, disease-free planting materials at a lower cost	DA, Municipal/City Agriculturists	3 – 6 months
			Accreditation of Nurseries	This project would support and provide opportunities for potential mango growers		
Cultural management	Poor soil condition, Lack of water/Irrigation facilities	To improve soil health and utilize water resources for crop production.	Soil Analysis and Conditioning Program, Rainwater Harvesting System	Soil test, apply organic manure, and put in place rainwater harvesting structures in water-scarce areas to grow crops.	DA, Municipal/City Agriculturists, State University and Colleges (SUCs), Department of Science and Technology (DOST)	1 – 2 years
	Limited training on mango production, High incidence of pests and diseases	To improve farm management skills and reduce pest damage	GAP and IPM Training Workshops	Training on GAP and IPM, pest identification and pruning to reduce reject rates and improve farm productivity.	DA, SUCs, CDA, Mango Associations	3 – 6 months
	High cost of inputs, High cost of farm equipment	To improve farm management skills and reduce pest damage.	Cooperative Input Supply Program, Farm Machinery Assistance	Create cooperatives to buy inputs in bulk and give help with equipment for spraying, irrigation.	Cooperative Development Authority (CDA), Local Government Units (LGU), Mango Associations	6 months – 1 year
Cultural management	Bad weather/Calamities, Lack of skilled farm laborers	To lessen production losses caused by disasters and train a skilled workforce.	Mango Rehabilitation Program, Community-Based Training Program	Offer production inputs and community training on crop management, pruning and pest control targeting youth and unemployed sectors.	DA, LGUs, SUCs, CDA	1 – 6 months

Area	Issues/Problems/ Concerns	Objective/s	Solutions/Strategic Initiatives/Project	Brief Description of the Strategy/Project	Players/Agencies Involved	Time Frame
Harvesting	High percentage of rejected mangoes	To assist mango farmers in processing their perishable mangoes, which include rejects, so that they can be converted into products that can be eaten for a longer time.	Product Processing and Market Support	The project encompasses training programs and the provision of primary processing facilities to add value.	DA, DOST, Department of Trade and Industry (DTI), through SSF, SUC, Private Industry	6 months – 1 year
Postharvest	Inadequate postharvest facilities	To enhance operations and provide postharvest services.	Provision of post-harvest facilities and Training Workshop for Mango Growers regarding post-harvest activities	Through this project, mango growers will be able to improve the quality, safety and extended shelf life of fruit.	DA, Provincial/Municipal Agriculturists	3 – 6 months
Marketing	Low price due to low quality of produce/ Low price due to oversupply	Creating new ways to make money through mango will help mango growers to add an income source.	Product Processing and Market Support	This project will carry out training and provide primary processing facilities for value addition.	DA, DOST, DTI, SUC, Private Industry	6 months – 1 year
	Poor farm-to-market roads	To hasten the transport and delivery of farm produce.	Construction of farm-to-market roads	With this approach, farmers will have much faster and safer access to getting their goods and fresh produce.	DA, DPWH, Provincial, City/ Municipal Agriculturist, LGU, CDA	1 – 3 years
	Frequent price fluctuation/Unstable prices	To gain market power (Negotiating power)	Establish a marketing cooperative	Make a cooperative in order to buy the harvest of its farmer-member at a fair price. It would encourage partnerships with major businesses or processors.		6 months – 1 year
Financing	Lack of working capital/ High interest on loan	Offer formal credit to help mango growers fund their business.	Link mango growers, associations to the government's financing programs	This will raise awareness and assistance to the farmers in terms of low-interest loans, terms and conditions.	Land Bank of the Philippines, DA's Agricultural Credit Policy Council	1 – 3 months

4. CONCLUSIONS

The farm practices of mango growers in Nueva Ecija display a combination of traditional and modern methods aimed at sustaining their production despite various challenges. The use of grafted Carabao mango seedlings demonstrates how growers prefer high-quality planting materials for higher yields and disease resistance. Most growers lack the financial capacity to operate the farm without requiring contractual arrangements for major production inputs and service activities. Moreover, there continues to be widespread use of pesticides and fertilizers due to pest infestation problems, most notably from cecid fly and anthracnose. Furthermore, improper application and limited technical training have contributed to high rejection rates. The postharvest handling practices are not well-developed; many growers lack cold storage and processing facilities, leading to increased postharvest losses. Although some farmers are practicing fruit bagging, the practice is not widespread due to the costly materials and labor involved. As a result, interventions focusing on capacity building and training in pest management, as well as improved postharvest infrastructure, will enhance farm practices and reduce losses.

The SWOT analysis indicates that the mango industry in Nueva Ecija has access to quality grafted seedlings and availability of production equipment. Low working capital, insufficient training, and a high rejection rate of mangoes are some of the weaknesses that hamper productivity and profitability. Rising production input and labor costs are the biggest threats to mango profitability for farmers in Nueva Ecija. Other major threats include pests, diseases, and weather disturbances. However, opportunities exist through government support programs such as those from DA, DTI, and DOST, which provide financing, technical assistance, and training. The PCMGA Processing Center can develop into a value-added production facility that can expand its current product line while also creating new value-added products once there is support for FDA registration and quality system development. To survive and thrive, Nueva Ecija's mango industry must address its weaknesses by developing a comprehensive program that builds on its strengths and mitigates the threats.

The research delivered detailed descriptive information about mango farm operations in Nueva Ecija but it did not perform statistical tests like correlation or regression analysis. The exploratory design of the research required it to focus on establishing baseline data, which prevented the use of inferential statistical methods. The study did not perform productivity results analysis for particular farming practices, as no statistical tests were carried out. Future research should incorporate more sophisticated statistical approaches in order to identify some of the relevant relationships concerning farming practices and results, such as yield, income, and operational efficiency.

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Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
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