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Value chain-based development plan for the calamansi (*Citrus microcarpa*) industry

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ABSTRACT

Calamansi, a staple condiment in Filipino cuisine, plays a pivotal role in the culinary heritage of the Philippines. The province of Nueva Ecija, situated in Central Luzon, has emerged as the primary producer of calamansi in the region. This study investigates the calamansi industry's dynamics in Nueva Ecija over a six-year period, encompassing 18 municipalities. A comprehensive analysis reveals that 756,136 calamansi trees are cultivated across 1,200 hectares of land, involving 1,481 farmers. Regrettably, both production and cultivation area have witnessed a declining trend during this period, with annual negative growth rates of -3.83% and -0.68%, respectively. Motivated by this concerning scenario, the researcher, a native of Nueva Ecija and a farmer, embarked on an agribusiness research endeavor. Employing a descriptive research approach and value chain analysis, this study scrutinizes the current state of the calamansi industry. Primary data were collected from 50 calamansi growers, while secondary sources included provincial, city, and municipal agriculturists from relevant local government units. The findings unveil key challenges faced by calamansi growers, including high input costs, price manipulation by intermediaries and traders, price fluctuations, and losses due to pest infestations and adverse weather conditions. To enhance competitiveness and ensure the industry's stability, collaborative efforts along the value chain are imperative. This study underscores the need for collective action to promote the sustainability of the calamansi industry in Nueva Ecija, highlighting opportunities for growth and development.

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1. Introduction

Calamansi, widely recognized on an international scale as the "Philippine lime" in certain regions, predominantly bears the nomenclatures "calamansi" or "calamondin" among the majority of Filipino populace. In specific geographic areas of the Visayas and Mindanao, it is denoted as "lemonsito" (Xin et al., 2022). The Department of Agriculture (DA) of the Philippines has accorded official recognition to this indigenous Philippine fruit as "a cornerstone of the nation's fruit crops." Within the Philippines, a rich tapestry of fruit-bearing trees thrives, with calamansi ranking as the fourth most prominent in terms of both production volume and cultivated land area, trailing behind bananas, mangoes, and pineapples. Owing to its multifarious applications, the nation allocates a substantial swath of arable land for calamansi cultivation, resulting in a spectrum of commercial products, encompassing syrups, juices, teas, concentrates, and purees. Moreover, it is renowned for its natural anti-inflammatory properties and its utility as a remedy for coughs. As foreign consumers become increasingly acquainted with this fruit, the prospects for expanding both exports and production appear increasingly promising. The significant contribution of this fruit crop to the international export market is underscored by data from the Bureau of Agricultural Statistics (BAS). The Philippines, as the singular major global exporter of calamansi, primarily dispatches calamansi juices to pivotal markets such as the United States of America, Japan, South Korea, Canada, and Hong Kong. It is noteworthy that three Philippine regions, namely CALABARZON, MIMAROPA, and CENTRAL LUZON, emerge as the preeminent calamansi producers

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within the country, firmly establishing the pivotal role of calamansi in the nation's agricultural panorama.

Cheong et al. (2012) conducted an investigation aimed at characterizing calamansi (*Citrus microcarpa*), a diminutive citrus fruit extensively cultivated in Southeast Asia, with a focus on elucidating its volatile and non-volatile chemical constituents, as well as its physicochemical attributes. Employing the headspace solid-phase microextraction (HS-SPME) technique, the researchers successfully extracted volatile compounds from calamansi juice, subsequently subjecting these constituents to analysis via gas chromatography-mass spectrometry (GC-MS). Their analysis unveiled a total of 54 volatile chemicals, including familiar compounds such as limonene, terpinene, and linalool, commonly encountered in various citrus fruits.

Furthermore, the physicochemical properties of calamansi juice, encompassing parameters such as pH, total soluble solids (TSS), and titratable acidity (TA), were meticulously assessed. The researchers ascertained that the juice exhibited a pH of 2.56, a TSS measurement of 6.95 °Brix, and a TA level of 6.35 g/L, with all values reported in grams per liter.

Additionally, the non-volatile constituents within the juice underwent evaluation via high-performance liquid chromatography (HPLC), revealing the presence of a diverse array of organic acids, flavonoids, and phenolic compounds. In summary, this research delivers valuable insights into the chemical composition and potential applications of calamansi juice, holding substantial implications for its utilization across sectors such as food and beverage, pharmaceuticals, and related industries. These findings augment our understanding of the spectrum of bioactive compounds present in citrus fruits, thus contributing to the broader comprehension of citrus fruit diversity.

The production of calamansi, a citrus fruit that is frequently used in Filipino cooking, had a decline of -2.5 percent in the fourth quarter of 2022, with an estimated output of 24.90 thousand metric tons, as compared to the same time in 2021. This resulted in an overall output of 24.90 thousand tons. In spite of this decrease, the Zamboanga Peninsula remained the leading producer, providing 3.80 thousand metric tons, which is equivalent to a 15.2 percent share of the total production. Meanwhile, Caraga and Central Luzon trailed closely behind, accounting for 13.6% and 11.8% of the total production, respectively. These two regions were located in the Philippines.

On the other hand, during the period of July to December 2022, the area planted with calamansi was 19.31 thousand hectares. This is a modest decline of -0.9 percent in comparison to the same time in the previous year, which had an area planted of 19.48 thousand hectares. This suggests that the calamansi industry is still alive and that farmers are still planting and harvesting the fruit despite the modest decline in the area planted with calamansi trees.

According to the information that was presented, the cultivation of calamansi is still a significant agricultural activity in the Philippines, notably in the regions of the Zamboanga Peninsula, Caraga, and Central Luzon. The fall in production, on the other hand, maybe a matter of worry for stakeholders; therefore, it would be useful to research the factors contributing to the decline and seek viable solutions to address these issues (PSA, 2022).

According to ACIAR (2012), the value chain is a series of interconnected economic activities that add value to the final product and take into account the principles of sustainable development. The value chain analysis, also known as VCA, is a helpful tool for determining the top-level business process. It devises alternative methods to boost sustainability (Sultan and Saurabh, 2013), strategies that integrate multiple factors, not just the production process but also the environmental, social, and technological aspects, which will enhance production efficiency through the adoption of Green Productivity (GP).

In 2006, the Asian Productivity Organization (APO) introduced the concept of Green Productivity (GP), with the overarching objective of advancing both the economic and environmental facets of a given region, with the ultimate aim of attaining Sustainable Development (SD). The implementation of the GP paradigm is envisioned to empower the organization to enhance its productivity levels while concurrently elevating its environmental stewardship performance. This strategic approach entails the reduction of waste generation and the optimization of resource utilization, thereby fostering greater efficiency in resource management.

According to Zhang et al. (2008), GP is a technique that reduces a company's negative impact on the environment while simultaneously increasing production. The formula for calculating eco-efficiency, which is a measure used in sustainability analysis (SA), is the economic value contributed divided by the environmental effect. At the level of the corporation, the application of eco-efficiency seeks to achieve high market values by lowering costs, boosting profits (Caiado et al., 2017), and lowering waste and emissions (Henriques and Catarino, 2015). This makes it an ideal tool for the growth of eco-efficiency. Since sustainable development is achieved by taking into account economic, social, and environmental factors (Charmondusit et al., 2014), the GPI ought to be combined with other indicators or instruments (Hur et al., 2004) with the purpose of achieving a more all-encompassing scope (Sala et al., 2015). Therefore, the purpose of this research is to fill the void by combining VCA and SA in order to come up with the most effective method (Tell et al., 2016).

The studies of Ahmed (2012) and Darmawan et al. (2014, 2018), are only a few examples of studies that used the GP technique. In spite of this, there is not yet a GP study about fresh-cut vegetables in Indonesia. There have been various research works

that only used VCA (Sultan and Saurabh, 2013; Darmawan et al., 2014), and these investigations have been completed. During this time, the focus of a variety of research works that used SA (Sutjahyo et al., 2017) was on analyzing the growing of vegetables. Since SSS Co., an Indonesian fresh-cut vegetable agro-industry, has been leaking non-treatment wastewater containing chlorine dioxide disinfectant to the agricultural region, there is a potential risk that it may affect both consumers and the environment over the long run (Artés-Hernández et al., 2017). As a result, it is absolutely necessary to carry out a GP study in order to improve the longevity of vegetables that have been freshly cut.

In this study, the VCA tool that was used was called Green Value Stream Mapping (GVSM), and the strategy that was employed was the GP method (Darmawan et al., 2014). A GVSM was performed on three of the competing products offered by SSS Co. Following that, a descriptive VCA was carried out (Narakusuma et al., 2013) with the goal of formulating a plan to attain sustainable competitiveness and development (Sultan and Saurabh, 2013). The process known as sustainability analysis (SA) is a complex one since it takes into account a wide range of factors, including economics, technology, contract farming, and the environment. The studies of Adiga et al. (2016), Pitcher and Preikshot (2001), and Cissé et al. (2014) on Rapid Appraisal for Fisheries were used as the technique to conduct the assessment of the sustainability of fisheries. A case study that examines the value chain and sustainability of the production of fresh-cut vegetables was conducted by Wiryawan and Djatna (2020). The researchers investigated the entire value chain of the organization, from production to consumption, locating the most important participants and activities and determining whether or not each stage could be maintained in the future. Additionally, the economic, social, and environmental impacts of fresh-cut vegetable production at SSS Co. were investigated as part of this study. According to the findings of the researchers, the value chain of the organization was well-established; yet, there were areas that needed development in terms of sustainability, notably in terms of decreasing waste and encouraging social responsibility. In general, the study gives recommendations to businesses on how they can improve the level of sustainability present in their value chains as well as insights on the opportunities and difficulties that are present in the fresh-cut vegetable industry. This is a meaningful study that also motivated the researcher by applying some of the aspects of value chain analysis in the Calamansi Industry in the Philippines.

The value chain analysis conducted by the Department of Agriculture in Oriental Mindoro concluded that it could strengthen the reputation of the province as the Calamansi King of the Philippines by focusing on increasing the volume of calamansi production, developing inter-firm relations, improving access to support services, building more farm-to-market roads, and upgrading the processing capabilities in the province. After a thorough value chain analysis, key industry opportunities and constraints affecting the competitiveness of the whole value chain and the individual enterprises were identified. The study even conducted a stakeholder's workshop, considering market opportunities and the key constraints they faced, wherein the industry stakeholders set the directions they would collectively pursue in the next few years. Based on the aforementioned data, it is essential to discern the potential gaps and constraints within the realm of calamansi production in the province. These factors impede its capacity for growth and expansion, rendering it comparatively underdeveloped in comparison to more competitive regions. This prevailing situation has served as a catalyst for the researcher, who, being both a farmer and a native of Nueva Ecija, has embarked on an agribusiness research endeavor of this nature.

Furthermore, the preceding literature reviews have underscored the latent prospects within the calamansi industry in certain regions of the country. Simultaneously, they have illuminated the associated challenges that may obstruct the progression of cultivators within this industry. Additionally, they have shed light on the agricultural potential of calamansi in other parts of Southeast Asia. However, it is noteworthy that no prior research has established the existence of a comprehensive value chain study in Nueva Ecija, and it is in this context that this study assumes significance.

The generic term value chain analysis (VCA) was popularized by Porter (1985). It was defined as a set of activities that an organization carries out to create value for its customers. The idea is based on the process view of organizations, seeing a manufacturing (or service) organization as a system, made up of subsystems each with inputs, transformation processes, and outputs. Inputs, transformation processes, and outputs involve the acquisition and consumption of resources–money, labor, materials, equipment, buildings, land, administration, and management. The way in which value chain activities are performed in each subsystem determines costs and affects profits. With this, one can identify the sources of value of his organization. Today, value chain analysis has become an instrument for evaluating the production activities of a firm/industry. Even agriculture sectors nowadays adopt the concept of VCA to make a clearer understanding of different agri-based undertakings. In agriculture, a value chain analyzes the full range of activities that are required to bring a product or service from conception through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final customers, and final disposal after use.

The researcher used the value chain approach as popularized by Porter (1985) which is now being used by many companies in order to achieve what they called "competitive advantage" by adding value

within their organizations. Such an approach has also been adopted in the field of agriculture and is considered a powerful tool for sustainable economies by many countries. Through this approach, the researcher assessed every aspect of the calamansi industry from the inputs provision, production, and post-production to marketing in order to have a clear and in-depth understanding of the industry's strengths, limitations, and opportunities. This is with the goal of developing a strategic plan that would enable the province to achieve a competitive advantage in calamansi production, not only in the local market but also abroad in the coming years.

This research endeavor was undertaken to conduct a comprehensive analysis of the calamansi industry in the province of Nueva Ecija, employing the value chain analysis framework. The primary objectives encompassed a detailed examination of various facets within the calamansi industry, including the provisioning of inputs, production processes, post-production activities, marketing strategies, and a comprehensive assessment of cost and return dynamics. Furthermore, this study delved into the identification and analysis of the prevailing issues and constraints that permeate the calamansi industry, specifically addressing challenges within the realms of input provisioning, production procedures, post-production operations, and marketing strategies. In response to these identified challenges, this research aspires to formulate a strategic action plan meticulously tailored to enhance and fortify the calamansi industry's prospects and sustainability in the context of Nueva Ecija.

2. Methods

The investigation employed a descriptive research approach, a methodological framework employed to procure information regarding the contemporary state or circumstances within a particular context. The research endeavor entailed an exhaustive examination of the calamansi industry through the lens of value chain analysis, with specific emphasis placed on input provisioning, production processes, post-production activities, marketing strategies, and a comprehensive cost and return analysis (Fig. 1). The study also encompassed an examination of the industry's predicaments and constraints. The analytical outcomes subsequently served as the foundational framework for the development of a strategic action plan aimed at fostering the growth and sustainability of the calamansi industry in Nueva Ecija.

To obtain primary data, survey questionnaires were diligently administered to the research participants, alongside in-depth interviews. A judiciously defined sampling quota of ten (10) respondent-growers was established for each municipality, with a deliberate effort to mitigate potential bias and subjectivity. The researcher thoughtfully distributed the survey questionnaires across various barangays within the top five calamansi-producing cities and municipalities. Furthermore, the instrument's reliability was meticulously ascertained using the test-retest methodology, which involves administering the instrument with a minimum two-week interval before the final distribution and completion. This was executed among non-respondent growers within the research context. The results of the two tests were subsequently correlated using the Pearson Product Moment of Correlation formula. The obtained reliability coefficient, registering at 0.81, attests to the instrument's consistent and dependable performance. Face validation was also implemented as a crucial validation measure throughout the course of this study. The primary respondents encompassed the community of calamansi growers, while secondary data sources comprised provincial, city, and municipal agriculturists affiliated with the Local Government Units (LGUs) operating in Nueva Ecija. In total, fifty (50) respondent-growers actively participated in the research initiative. The criteria for identifying the research participants were meticulously aligned with the demographic attributes furnished by the Provincial Agriculturist Office. In addition to the statistical analyses employed, such as frequency and percentage calculations for numerical data, non-numerical data collected through interviews played a complementary role in corroborating and reinforcing the findings derived from the quantitative data, thereby enhancing the overall robustness of the study's outcomes.

3. Results and discussions

The calamansi value chain largely consists of people who serve as the key players and farm activities associated with its cycle of operation. Key players are actors of the market involved in the chain. They are the people who have some involvement in calamansi cultivation whether related to the provision of inputs, production, post-production, and marketing activities (e.g., growers, laborers, nursery operators). Each player must participate effectively in the chain in order to capture added value at each stage and ultimately improve the productivity and quality of the product for consumers.

3.1. Overview of calamansi industry in Nueva Ecija

The majority of respondents in calamansi-producing municipalities in Nueva Ecija exhibited distinct patterns in landownership, with 64% owning the land they cultivated, 22% possessing a combination of ownership and tenancy, and 14% leasing the land. Furthermore, the age distribution of calamansi trees was observed, with 58% falling within the 4-7 years bracket, 26% within the 8-12 years range, and 16% aged 1-3 years. Concerning land size, most respondents cultivated 1-2 hectares

of land (32%), followed by 3-4 hectares (30%), less than 1 hectare (22%), and more than 5 hectares (16%). In terms of seedling acquisition, a significant majority (82%) purchased the seedlings they planted, while a smaller proportion engaged in a mix of growing and purchasing (18%). Notably, the majority of purchased seedlings were grafted (98%), with a minority originating from seeds (2%). Calamansi growers adopted varying seedling sizes, with 64% selecting medium-sized seedlings, while 30% opted for small seedlings, and 6% favored large seedlings.

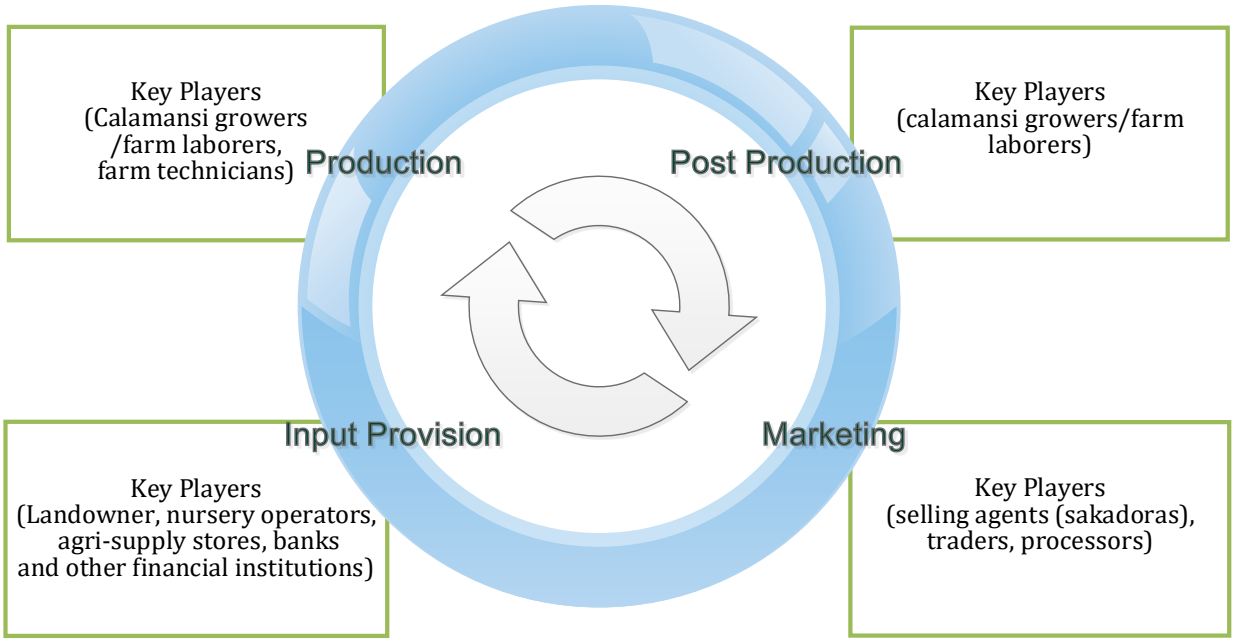

Fig. 1: Calamansi value chain analysis in Nueva Ecija

Fertilizer and foliar application practices were found to be contingent on tree age. Specifically, growers utilized 15 bags of fertilizer and two liters of foliar on a hectare of land when the trees were aged 1-3 years, 36 bags of fertilizer and three liters of foliar when aged 4-7 years, and 15 bags of fertilizer and five liters of foliar for trees aged 8-12 years. To combat pest infestation, growers resorted to the use of imported chemical insecticides and fungicides.

Regarding financial aspects, a substantial majority (78%) fully financed the cultivation of their trees, while the remainder borrowed capital (22%). Those who sought external funding mainly relied on informal lenders (46%), followed by trader-capitalists (27%), and banks and other financial institutions (27%).

Cost disparities were evident in agricultural activities across different localities. For ploughing and harrowing, Cabanatuan City and Palayan City incurred the highest expenses at P3,500.00, whereas the three municipalities had lower costs, less than P500.00. Hired labor for hole preparation also exhibited regional variation, with Cabanatuan City and Palayan City paying P1,800.00, in contrast to the three municipalities at P1,500.00.

Labor sources diverged among growers, with 44% relying on family members, 40% hiring labor within the municipality or cultivation area, and 16% recruiting labor from outside the region. Transplanting labor costs were highest in Cabanatuan and Palayan City at P3,000.00, while the three municipalities paid less than P500.00.

In the context of pruning and weeding, Cabanatuan and Palayan City growers incurred labor costs of P900.00, whereas those in the three municipalities paid P750.00. For irrigation, the majority of calamansi growers utilized deep wells with water pumps (66%), while the rest relied on various sources, including rivers, streams, and canals (34%). Notably, Palayan City recorded the highest fuel cost per hectare at P4,000.00, while San Leonardo and Cabiao reported the lowest at P3,000.00.

Calamansi tree yields displayed a progressive pattern, with approximately 200-250 red bags per hectare at two years, 300-350 bags at 3-5 years, 420-450 bags at 6-8 years, and 700-750 bags at 9-11 years. Remuneration for pickers varied with seasonality, offering P5.00/kilo during the lean season when prices were higher and P2.00/kilo during peak seasons when prices dipped.

Post-harvest activities typically involved hiring laborers known as "obras." In peak season, Cabanatuan and Palayan City growers disbursed P4,000.00 for "obras," while the three municipalities paid P3,500.00. During lean periods, compensation amounted to P2,500.00 in Cabanatuan and Peñaranda, and P2,000.00 in San Leonardo, Palayan City, and Cabiao.

Notably, the farm-gate prices for calamansi exhibited seasonal fluctuations, with the highest

prices typically observed in April and the lowest in September. A predominant practice involved selling calamansi produce to traders on a cash basis, either through market delivery or direct pickup at the farms.

Analysis of cost distribution indicated that during the initial two years of farming activity, labor costs, encompassing land preparation, transplanting, and cultural management activities, constituted the highest expenses, followed by input provisioning costs. As the trees matured, both input and labor costs increased, paralleled by higher anticipated income in subsequent years. During lean months, expenses accounted for 60% of the total annual capital, with only 40% spent during the peak season. Importantly, income during lean periods was estimated to be 100% higher than during peak seasons.

3.2. Challenges in calamansi industry operations

Regarding the provision of farm inputs, a persistent issue throughout the entire cropping year was the elevated cost associated with fertilizers, fungicides, and herbicides. The inadequacy of financial resources posed an occasional challenge, albeit not consistently, and there were intermittent instances of escalated seedling costs during farming operations.

In terms of production, an enduring predicament involved the lack of government support for seminars and training programs aimed at enhancing the technological proficiency of calamansi growers. Pests and diseases were recurring concerns but did not manifest continuously. Infrequent challenges encompassed water scarcity and deficient irrigation facilities, a shortage of farm laborers, unfavorable soil conditions, and adverse weather events or calamities.

Concerning post-production activities, growers frequently grappled with calamansi spoilage and wastage during peak seasons, along with a dearth of available employment opportunities for agricultural laborers.

Within the realm of marketing, ongoing challenges included price manipulation by intermediaries, characterized as "kasadoras," as well as the regular oscillation and instability of prices. Manipulation of prices by prominent traders was a persistent issue. Other problems, such as intense competition, depressed prices stemming from subpar produce quality and overabundance, and the absence of permanent market stalls or reliable buyers, manifested periodically but not consistently across the cropping year. Additional sporadic issues comprised deficient farm-to-market road infrastructure and delays in payment for goods.

3.3. Proposed strategic action plan for the calamansi industry

The investigator has advanced intervention strategies aimed at the enhancement of the calamansi industry in the province of Nueva Ecija, which may be effectively conveyed to pertinent governmental entities for appropriate execution. Tables 1 through 4 encapsulate the comprehensive strategic blueprint delineating provisions for inputs, production processes, and marketing endeavors.

4. Conclusion

In conclusion, the calamansi growers in Nueva Ecija, particularly in the top five producing cities and municipalities, have showcased resilience and determination in their pursuit of economic prosperity within the agricultural sector. Their ownership of the farms they cultivate has provided them with a substantial opportunity to shape their own destinies in agriculture. However, this journey is not without its challenges and nuances.

One striking aspect of their agricultural practices is the reliance on locally sourced seedlings, often from Batangas. This regional collaboration demonstrates the interconnectivity of the Filipino agricultural landscape. Additionally, the use of inorganic fertilizers, insecticides, and fungicides, while necessary for productivity, places a financial burden on these growers, with some resorting to informal lenders for financial support. It highlights the need for affordable and sustainable agricultural inputs.

Interestingly, a subset of experienced growers has adopted innovative farming techniques that deviate from conventional methods, proving their efficacy. These pioneers exemplify the potential for continuous improvement and adaptation within the industry.

Pest infestation and adverse weather conditions emerged as formidable adversaries, significantly influencing the frequency of calamansi harvests. These growers face the daunting task of mitigating these factors to maintain a stable income throughout the year.

Despite challenges, diligent cultural management and timing have proven to be potent tools for increasing agricultural income. However, the industry faces persistent obstacles such as high input costs, price manipulation by intermediaries, recurrent price fluctuations, and the problem of spoilage and wastage during peak harvest seasons.

In light of these challenges, the call for collaboration and collective action is essential. Achieving competitiveness and stability in the calamansi industry in Nueva Ecija requires the active participation of all stakeholders in the value chain. This includes government agencies, farmers' associations, researchers, and industry leaders. By working together, they can address the issues at hand, implement sustainable agricultural practices, and create an environment where calamansi growers can thrive and contribute to the economic development of the region. Ultimately, the success of the calamansi industry hinges on the shared commitment to its growth and sustainability.

Table 1: Strategic action plan for calamansi industry in terms of input provision

Constraints/problems	Intervening strategy	Responsible group/unit
High cost of fertilizers, pesticides and insecticides	Establishment of supply cooperatives that offer a cheaper cost of fertilizers, pesticides, and insecticides for grower-members	Cooperative Development Authority (CDA)
High cost of seedlings	Establishment of calamansi nurseries or calamansi nursery farms through City/Municipal Agriculture Office, State Universities and Colleges and Private Entities Provide training on calamansi propagation e.g., grafting, marcotting, and growing of seedlings so that the growers no longer have to buy seedlings from nurseries	Department of Agriculture (DA), Local Government Unit (LGU), State Universities and Colleges (SUCs)
Insufficient financial resources	Establish cooperatives and let this organization offer loans to calamansi growers at reasonable rates. Tap the Department of Agriculture to offer financial assistance or loans for calamansi growers at reasonable rates and terms	Cooperative Development Authority (CDA), Department of Trade and Industry (DTI), Local Government Unit (LGU)

Table 2: Strategic action plan for calamansi industry in terms of production

Constraints/problems	Intervening strategy	Responsible group/unit
Lack of seminars and training on calamansi production to improve the farmers' technological know-how	Link growers to state universities in the province such as the Central Luzon State University and Nueva Ecija University of Science and Technology (Gabaldon Campus) that specialize in agricultural production and development.	State Universities and Colleges (SUCs)
Pests and diseases	Link growers to state universities in the region or in other state universities in other provinces such as CLSU, NEUST, and UP Los Bañ̃os in order to provide faculty-trainers specialized in the field of pests/insect control management. Link growers to the City/Municipal Agriculture Office in order to provide technicians who can assist the growers in pest management of their farms.	Department of Agriculture (DA), Chemical Companies, State Universities and Colleges (SUCs), Local Government Unit (LGU)
Bad weather/calamities	Tap the government agency concerned to provide available agricultural technology that could detect natural disasters, such as drought and typhoons, early on, in order to mitigate, if not eliminate, the potential risks to farmers of such calamities Training may also be provided to growers on how to engage in other livelihood activities alongside their calamansi production, such as small-scale livestock, in order to recover their post-disaster losses from farming.	Department of Agriculture (DA), Department of Science and Technology (DOST), National Disaster Risk Reduction and Management Council (NDRRMC), Department of Trade and Industry (DTI)
Lack of water/irrigation facilities	Tap the concerned government agency to consider water harvesting techniques such as rain catchment systems/tanks for areas that depend on rainwater sources.	Department of Agriculture (DA), Department of Science and Technology (DOST)
Lack of farm laborers during peak season	Link to "kabesilyas" from other barangays or neighboring municipalities Link to Barangay Chairman of the community if he can suggest people living in the locality who are in need of part-time work	Barangay Local Government Unit Growers informal organizations
Poor soil condition	Outsource a chemist or technician who will educate the calamansi growers on good soil management by adding beneficial amendments, which will help improve plant growth and health	Department of Agriculture (DA), Chemical Companies, Department of Trade and Industry (DTI), State Universities and Colleges (SUCs), Private Agencies, Bureau of Soils and Water Management (BSWM)

Table 3: Strategic action plan for calamansi industry in terms of post-production

Constraints/problems	Intervening strategy	Responsible group/unit
Spoilage and wastage of calamansi during peak season	Retail the products at lower prices to businesses that are in need of calamansi as a condiment and households that use calamansi as a good accompaniment for dishes like pancit or rice noodles, rice porridge, or arroz caldo and also can be juiced for a refreshing drink	Calamansi growers, business establishments processors
Lack of farm workers to do the post-harvest activities	Link to "kabesilyas" from other barangays or neighboring municipalities Link to Barangay Chairman of the community if he can suggest people living in the locality who are in need of gainful work	Barangay local government unit Growers informal organizations

Table 4: Strategic action plan for calamansi industry in terms of marketing

Constraints/problems	Intervening strategy	Responsible group/unit
Price manipulation of selling agents (sakadora) Price manipulation of big-time traders	Establish marketing cooperatives to purchase harvests from farmer members at a fair price. These cooperatives would promote collaborations with large enterprises or processors in cities and other municipalities Establishment of marketing cooperatives	Department of Agriculture (DA), Local Government Unit (LGU), Department of Trade and Industry (DTI)
Frequent price fluctuation/unstable prices	The concerned government agencies should monitor the prices of inputs in order to detect if there will be price manipulations of traders and other establishments	Cooperative development authority
Too many competitors Low price due to low quality of produce and oversupply Absence of permanent market stalls/No buyer or market outlets	Encourage investors to establish and finance business that is engaged in processing calamansi and its by-products to add value to the fruits that would create a positive impact on the Value Chain	Department of Agriculture (DA), Department of Trade and Industry (DTI), Local Government Unit (LGU), Department of Science and Technology (DOST)

Compliance with ethical standards

Ethical consideration

All procedures employed for the analysis of data originating from a particular source strictly adhered to ethical protocols. Proper attribution and acknowledgment of the data sources have been meticulously observed, with comprehensive documentation provided in the reference section.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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