Activity 1.3

This summary forms part of the ACIAR Project AGB/2012/061 *Improving smallholder farmer incomes through strategic market development in mango supply chains in southern Vietnam*

Study: Year 1 summary – Current flowering and on-farm practices

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Summary

The purpose of this study was to provide an understanding of the on-farm practices of smallholder mango producers in southern Vietnam based on a series of semi-structured interviews. It included a review of the supporting research and recommendations that underlie these farming activities, performed by the regional institutes. The output from these investigations was to develop recommendations for activities to be undertaken in the subsequent season in activity 2. The farmers involved in this survey and interventions are those who supply the pack houses and whose fruit will be traced through the supply chain to the consumer. The activity design sought to directly benefit farmers' net income through improved farm management options, while also providing connections with consumers. This process is proposed to increase the profitability of all actors in the value chain to assist the ongoing sustainability of the southern Vietnam mango industry.

This study was undertaken by:

1. Reviewing published studies relating to production and flowering practices
2. Conducting 20 semi-structured interviews with farmers in Dong Thap and Tien Giang provinces
3. Identifying opportunities for future activities in years 2 and 3 of the project

Published studies revealed that advances in crop manipulation have been developed and adopted by southern Vietnamese mango growers. There has been a focus on increasing production out of season and reducing farm losses. However, this management system requires extensive use of chemical inputs, fertiliser, and sprays. The government recognises the need for food hygiene and safety and is actively promoting alternative safe production methods and greater net returns for farmers, through supplying off-season markets. A range of recommendations across the production system of farms, including consideration of the potential impacts of climate change, have been developed. These recommendations include:

1. Evaluate the effects of temperature on floral induction, with aims to understand the vulnerability of mango production in southern Vietnam to the temperature increase associated with climate change projections
2. Assess alternatives to paclobutrazol—such as prohexadione calcium and foliar-applied uniconazole—to reduce chemical inputs and chemical residues in the soil and to ensure the viability of the industry if the use of paclobutrazol is restricted
3. Consider the use of forchlorfenuron to improve fruit size, taking care not to induce internal fruit disorders, and increase farm gate fruit price by increasing the proportion of first-grade fruit (due to increased fruit size)
4. Review alternative methods of assessing harvest maturity (such as near infrared spectroscopy), considering consumer perceptions of ripe fruit quality, to determine whether there are higher value markets for more mature large fruit
5. Review fertiliser recommendations to determine if there are opportunities to improve nutrient use efficiency and reduce on-farm input costs.

Contents

1. Introduction

1.1 Aim and purpose

This activity was undertaken to provide a clear understanding of current flowering and on-farm production practices in southern Vietnam to inform the design and development of interventions to improve smallholder farmer livelihoods. The outputs from this study inform the overarching project outcomes for Objective 2.

1.2 Activities and outputs

The activities and outputs, as prescribed in the project outline, included in this study are:

1. Desktop review of research studies and current practices, covering:
    - 1.1. Vietnam regulatory requirements
    - 1.2. Regional general farming practices
    - 1.3. Cambodia flowering practice research and seasonal product flows
2. Identifying Field Extension Officers in targeted provinces to assist in facilitating access to the farm leaders, so that they can participate in the research study.
3. Workshop training for local researchers to design and undertake structured farm interviews and focus groups to capture current flowering and on-farm production practices. This includes pruning and canopy management, fertiliser and nutrient management, pest and disease management, skill levels of farmers, assessment of the impact of practices on cost, yield, quality and losses, and acknowledging potential environmental issues.
4. Semi-structured interviews with farmers to gain an understanding of current on-farm production practices, targeted production times, impact on cost, yield, and acknowledging potential environmental issues.
5. Summarising and highlighting the opportunities where seasonal flowering manipulation would add value back to the farm gate.

2. Desktop study

2.1 Background

Since 2010 there has been an increase in mango production in Southern Vietnam with the export value of Vietnamese mangoes increasing from USD 0.46 million in 2010 to USD 35.43 million in 2016. The south of Vietnam is a key mango growing area representing 92% of the national output. The Provinces with the largest plantings of mango in the Mekong Delta are Dong Nai (12,385 ha), An Giang (10,247 ha), and Dong Thap (10,169 ha). In Tien Giang province, the increase in area planted to mango 2013-2018 was 2.49% per annum, while production has increased 5.36% per annum. In the area devoted to mango growing of 4800 ha, production was estimated to be 110,000 tons. This was mainly grown in Cai Be district and included Cat Hoa Loc, Cat Chu, and green-mango varieties (Tien Giang DARD, 2019).

The aim of this desktop review was to examine the published research and extension material relevant to the current regional mango farming practices. This was to inform the project about the research and recommendations supporting farm practices revealed in the farmer surveys and to further understand drivers of seasonal product flows and flowering manipulation. This review summarises opportunities that will add value back to the farm gate and sustainability.

2.1.1 Climate

Rainfall in the Tien Giang and Dong Thap is around 1800mm and is predicted to increase slightly in the future (Tuan and Chinvanno, 2011). Based on the weather data from Ho Chi Minh City (see Figure 1), the wet season starts around May and continues until October. The monthly rainfall is consistent across this period, meaning that fruit development during the wet season needs protection to prevent the development of rot and latent infections. The efficacy of chemical sprays to control pathogens and to induce flowering during the wet season will potentially be impacted by precipitation and relative humidity during this time. During the dry season from December to April, there is little or no rain.

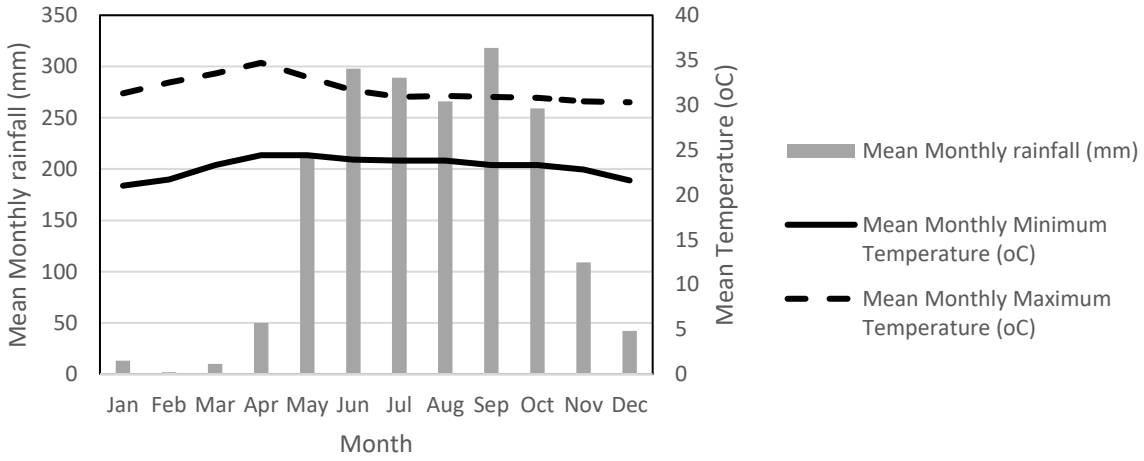

Figure 1. Mean monthly maximum and minimum temperatures (oC), and mean monthly rainfall (mm) for Ho Chi Minh City

Source: Climate-data.org (2020)

Without chemical intervention in the Mekong Delta, mango trees usually flower naturally in December and are harvested from April to May (Tran Van Hau, 1997). Due to the effects of climate change, the number of days with maximums greater than 35°C in the Mekong Delta are expected to increase to exceed 200 days per year, along with the occurrence of temperatures >41°C, by 2030 (Tuan & Chinvanno, 2011).

2.2 Flower manipulation

Managing mango flowering and cropping is carried out over 12 months. It commences with pruning and fertilising the tree after harvest, which stimulates "vegetative growth". Subsequent growth is carefully monitored to target a specific growth stage and cropping date to treat with a "gibberellin synthesis inhibitor" (paclobutrazol). This growth inhibitor reduces the tree vigour and builds reserves to support fruit growth. The responsiveness to chemical induction treatments can be increased by foliar nutrient treatments, "conditioning" the leaves to respond to inductive treatments. Chemicals that can simulate the effects of cold temperatures and bud growth to cause "flower induction" are applied. A signal generated by the leaves, which is transported to the growing terminal, results in flower initiation. During flower development through to early fruit development, a range of nutrients and growth regulators are strategically applied to increase "fruit set and fruit retention". A schematic diagram of this process showing the stage in flush development are shown in Appendix 6.1.

2.2.1 Vegetative growth

To renew the canopy and physically manage tree structure, trees are pruned after harvest. To accelerate this process, trees are treated with thiourea to promote bud break and gibberellin to negate the floral inductive effects of thiourea (Tran Van Hau, 2009).

2.2.2 Gibberellin synthesis inhibitors

Paclobutrazol is an anti-gibberellin synthesis compound that is applied to the soil to reduce tree vigour and to assist in the accumulation resources that support fruit production. It is sold as a powder or suspension at concentrations of active ingredient of 10–25%. Therefore, the level of active ingredient must be specified when making comparisons. Irrigation is restricted leading up to this stage to assist in preventing unwanted vegetative growth.

Timing of treatment

The ability of paclobutrazol to assist flowering in the on-season (December – January), late-crop (March – April), early-crop (June – July), and off-season (September – October) was demonstrated by Tran Van Hau *et al.*, (2012). The largest fruit were harvested in the on-season and early season, while the highest yields were recorded in the early-, late-, and off-season periods. There were no significant differences in any fruit quality parameters from the different seasons. The effects on yield were attributed to pests and diseases. The flowers were most severely affected by thrips during the on-season, as thrips are prevalent during hot, dry conditions. Flowers were less affected by thrips during off-season. Flowers are affected by anthracnose predominantly in the early season and to a lesser extent in the late-season when raining reduces and higher temperatures are expected.

Dose

The optimum PBZ application level for Cat Chu and Cat Hoa Loc was found to be 1.5g ai/m canopy diameter (Tran Van Hau *et al*., 2015a). At higher and lower doses, the number of fruit and yield per tree was reduced. While there was no significant difference in the brix of harvested fruit from these different PBZ treatments, there appeared to be a reduction in brix with increasing PBZ use. This dose is considerably higher than used in other parts of the world that use 1 g ai/m canopy diameter, with a maximum dose /tree in Australia a.i of 5g.

Alternative Gibberellin synthesis inhibitors

The use of paclobutrazol is used almost universally by the world's leading mango-producing countries, including those supplying to the USA. The use of paclobutrazol on mangoes is prohibited

in the USA but they are the world's leading importer of mangoes. Uniconazole is a triazole-like paclobutrazol and affects the same stage gibberellin synthesis as PBZ and has been shown to have similar beneficial effects on yield as paclobutrazol in mangoes in Vietnam (Tran Van Hau *et al.,* 2018). In this work, uniconazole was applied to the soil and not the foliage as it had previously been shown to be effective in Palmer mangoes and is used in Australia as a foliar spray to increase yields in avocado. Using uniconazole as a foliar spray greatly reduces the amount of chemical needed to have been previously shown to be effective in Palmer mango (Lima *et al.,* 2016).

Another anti-gibberellin synthesis compound, prohexadione calcium (calcium-oxide-3-propionyl-4-oxo-5 cyclohexene 3-carboxylate (ProCa), has been successfully trialled in mango in Mexico. ProCa operates at the end stages of gibberellin synthesis by inhibiting the formation of highly active gibberellins from inactive precursors (Verma *et al*., 2010). Prohexadione calcium (ProCa) has been favoured in other mango production regions because it disintegrates relatively rapidly (half-life approximately 7 to 10 days) and is effective only in young shoots. Furthermore, the compound is translocated almost exclusively in the xylem and is, therefore, unlikely to be accumulated in fruits (Rademacher, 2000). ProCa in the soil is thought to break down within 24 hours. It is suggested that the capacity of ProCa to replace paclobutrazol in mango production systems be evaluated in southern Vietnam.

2.2.3 Leaf conditioning

A range of chemicals have been suggested to be used to accelerate maturation of mango leaves to make them responsive to inductive chemicals. These include potassium sulphate monoammonium phosphate, ethephon, and monopotassium sulphate. There appears to be no quantitative data to support the use of these chemical treatments. An alternative explanation by Tran Van Hau (2009) suggested that using a foliar fertiliser that is low in nitrogen but has elevated levels of potassium and phosphate improved leaf function but inhibited vegetative flush in the weeks prior to application of treatments to stimulate flowering. These treatments are applied 4 – 6 weeks prior to use of chemical for floral induction.

2.2.4 Chemical floral induction

The application of two successive sprays, one week apart, of either 0.5% thiourea or 3% KNO_3 are used to induce mango flowering in Vietnam. The second spray is applied at a lower concentration. Inflorescence emergence is observed within two weeks. A study by Tran Van Hau (1997) further detailed mango responses, and subsequent research was conducted to more precisely define the application rates and timing for mango cultivars grown in southern Vietnam (Tran Van Hau *et al*., 2015a). While both thiourea and KNO_3 are effective in inducing flowering in southern Vietnamese mango varieties, thiourea is far more potent (Tran Van Hau & Nguyen Bao Ve, 2003).

More recently there has been a realisation that the use on thiourea may not comply with farm certification in the future (Tran Van Hau *et al*., 2018). Thiourea is not authorised to use in the USA and Australia due to its classification as a carcinogen (IPCS, 2020 access). In Australia, it is considered an industrial chemical and cannot be used in agriculture. Thiourea is considered a carcinogen so all care should be taken to avoid direct human exposure (Sandhyamayee *et al.,* 2011). Therefore, there is a concern that both paclobutrazol and thiourea may be banned in Vietnam owing to its effects on the environment and human health. Consequently, it is urgent to study the alternatives for flowering induction procedure, such as uniconazole and potassium nitrate, to replace the current method of employing paclobutrazol and thiourea.

Others treatment that have been shown to be effective at inducing flowering include KNO_3 3% + Urea 3%, Trehalose -6- phosphate at 4000 ppm (Doan Thi Cam Hong & Nguyen Trinh Nhat Hang, 2013), cincturing and root pruning (Vo The Truyen & Nguyen Thanh Hieu, 2003), and 10% KNO_3 applied 40-60 days after PBZ treatment (Nguyen Trinh Nhat Hang & Nguyen Thanh Tai, 2017).

2.2.5 Fruit set and fruit retention

Growth regulators

Immature fruit loss is concentrated in the first 20-30 days after fruit set in both Cat Hoa Loc and Cat Chu mango (Tran Van Hau, 2009). By combining the use of naphthaleneacetic acid (NAA) with gibberellin (GA_3), further benefits of these growth regulators on fruit product in mango have been shown. This is in combination with foliar fertiliser sprays of GA_3 (5-10 pmm) and NAA (20ppm) at 1-2 weeks after flowering and again with GA_3 (5-10ppm) at four-five weeks after fruit set (Tran Van Hau, 2009). Sprays of the auxin, (NAA), and borax have been shown to increase the productivity of CHL mangoes (Nguyen Van Tho *et al*., 2009a).

Forchlorfenuron (CPPU) is a cytokinin that has been reported to increase fruit size in other mango cultivars when applied at concentration of 10-15 mg/L. A single spray of CPPU at 32g/L at seven days and 21 days post-flowering has been reported to increase fruit size but had no significant effects on fruit shape or quality in Tainong 1 (Guo *et al*., 2017), and could be considered for use in Vietnam.

Foliar nutrients

Foliar sprays of $CaCl_2$ (2g/L) in combination with an appropriate adjuvant from one week after fruit set until two weeks before harvest increased the yield by 180-200% (Tran Thi Kim Ba, 2007). It should be noted that, in Thailand, the use of calcium sprays during fruit development are thought to increase losses due to bacterial black spot.

Similarly, spraying potassium in the form of KCO_3, KCl, KNO3, or K_2SO_4at 2g/L also increased yield by 7-9 kg per tree as well as fruit total sugar content and skin hardness (Tran Thi Kim Ba, 2007).

2.3 Other production issues

2.3.1 Fruit bagging

The widespread use of paper bags to provide physical barriers to prevent infestation from a range of pests including fruit fly and Red banded mango caterpillar (*Deanolis albizonalis*). While it is necessary to treat the developing fruit with pesticides prior to bagging, it greatly reduces the need for subsequent pesticide use. There have been a series of studies using bags made of different materials in Cat Chu (Doan Thi Cam Hong & Nguyen Trinh Nhat Hang, 2013; Doan Thi Cam Hong & Trinh Nhat Hang, 2016) and Cat Hoa Loc (Vo The Truyen & Nguyen Thanh Hieu, 2003). Almost invariably, there is a reduction in fruit drop, increase in yield, and brighter fruit colour as well as a reduction of insect damage to almost zero. Most of the bags had no detrimental effect on fruit quality.

2.3.2 Harvest maturity

The stage of development at which mango are harvested determines their post-harvest storage, transport requirements and ripe eating characteristics. The harvest maturity of Cat Hoa Loc is described as being 85 days after fruit set (DAFS), which is reduced to 80 days in off-season fruit (Tran Van Hau *et al*., 2015a). This is the stage when calcium carbide-assisted ripened fruit had a brix^o value of greater than 20^o and fruit had a characteristic Cat Hoa Loc flavour. This corresponded to a density of 1.02 g/cm^2. This study monitored changes in fruit compassion and growth at 70-95 days after fruit set (DAFS). Harvesting fruit at 85 DAFS reduced potential fruit size 8.6-11.8%, depending on the season the study was performed. Harvesting at 80 DAFS reduced fruit size by 13.2%. Internationally, mangoes are harvested after they have achieved their mature size. There are other anomalies in this critical study including the low starch contents in developing fruit and fruit high dry matter >17% from 70 DAFS.

2.3.3 Internalisation of bacteria in mangoes

It has recently been shown that mangoes can internalise *Salmonella* bacteria if in contact with contaminated water for periods as short as 30 seconds. Once infected, there is currently no known method to decontaminate the fruit (Mathews *et al*, 2017; Mathews *et al.*, 2018). It is therefore essential that mango fruit only come in contact with potable water after harvest. This includes during the use of mango washes to prevent sap burn and the use of post-harvest fungicide treatments.

2.3.4 Mango ripening

To assess quality, fruit have been ripened using calcium carbide (Tran Van Hau *et al*., 2015a). Commercial grade calcium carbide has a common impurity that risks contaminating fruit and operators with arsenic and phosphorous acid as well as exposure to acetylene. The process is described as producing carcinogens and is associated with birth defects and is banned in most countries. It also changes the mature fruit composition, reducing nutritional value, sugar content, and shelf life (Preethi *et al*., 2019).

2.3.5 Fertiliser

Timing of fertiliser application

There is some agreement in the Mekong Delta to apply the macronutrients on four occasions. These are:

1. After harvest and pruning
2. At floral induction and flowering
3. Three weeks after fruit set
4. Eight weeks after fruit set

About half of the fertiliser is applied after harvest and pruning with no nitrogen applied at floral induction and flowering, and only nitrogen and potassium applied at the third and fourth stages during fruit development.

Amount of fertiliser

There have been extensive investigations to examine the amount of fertiliser to apply to get maximum yield and farm gate quality using varying degrees of sophistication and analytical methods. Those focussing on the macronutrient nitrogen, phosphorus, and potassium are shown in Appendix 6.2. A recent extension article describes the fertiliser schedule for Cat Hoa Loc for non-bearing trees 1-4 years old and bearing trees (see Appendix 6.3 and Appendix 6.4). Research in Australian mangoes indicates that a ton of mangoes requires the equivalent of 845 grams of nitrogen. Assuming comparable nitrogen contents in Vietnamese mangoes, these recommendations indicate inefficient nitrogen use.

Source of potassium

In southern Vietnam, potassium chloride is extensively promoted as a fertiliser. Internationally, it is not recommended when on saline/sodic soil or where there is a risk of salt in irrigation water. Potassium sulphate is preferred for use on mangoes as it has a minimal effect on soil pH, provides a good source of sulphur, and mangoes are thought to be sensitive to chloride ions. Carneiro *et al* (2017) compared the use of KCl and K_2SO_4 fertiliser, concluding that K_2SO_4 had a higher efficacy in producing mango fruit than KCl, and recommended application rates and timing of application for a crop of 23.1 t/ha, with a total annual application of less than 200 g per tree. This is less than the amount of recommended for a one-year-old tree in Vietnam (see Appendix 6.3).

Pest and disease management

Extensive investigations have been performed in southern Vietnam targeting the major insect pests (fruit fly, thrips, fruit borers, mango hopper, leaf hopper; see Appendix 6.5) and pathogens (anthracnose and black spot canker; see Appendix 6.6). These investigations have developed

recommended control measures and innovative new non-chemical-based means to manage these issues. These are ongoing threats to production and are major management costs for framers.

2.4 Policy

In recent years, Vietnam has increased mango exports to China (a primary trading partner) but also to markets that were previously challenging to trade with, such as Russia, Australia, Japan, South Korea, USA, and New Zealand.

Using scientific and technological advances focused on cultivation and manipulation of mango flowering, mango production now occurs throughout the year in Vietnam. According to the latest plan approved by the Ministry of Agriculture and Rural Development (MARD), mango is to be most concentrated among 12 major fruit crops by 2020, with a plantation area of 45,900 ha. Moreover, of the 12 major crops, mango is one of the five selected to expand production. Mango production is now spread over the year according to MARD. In order to avoid “a fall in price during the on-season”, agricultural experts suggest out-of-season should be promoted as it will assist to increase farmers’ income.

The DARD report on the implementation of the mango industry 2016–2020 sets out the importance of the development of the mango industry as a departmental role and aspirations (Nguyen Thanh Tai, 2018). It emphasises the production of hygienic and safe fruit and production processes that can be certified under GlobalGAP or VietGAP. It acknowledges that there is a need for improvement in harvest, post-harvest processing, storage, and transport. It supports the development of necessary infrastructure and transition to regional branding. It wants to enhance the co-operation between co-operative organisations to organise production and create quantity and quality products to meet the requirements of each type of market.

More specifically, it notes the need to find replacements for thiourea and paclobutrazol. It emphasised the use of organic processes and the need to manage soil health and nutrition and supports seeking solutions to limit the impact of climate change as part of sustainable development. It mentions the development of mango wrapping paper to improve post-harvest performance and supports policies for land accumulation. Overall, there is acknowledgment of the importance of developing the mango industry in southern Vietnam and the role of strong value chains supported by advanced technologies developed through cooperative processes.

Good agricultural production practices for safe vegetables and fruits in Vietnam are administered by an accreditation program called VietGAP. VietGAP is the Vietnamese regulator that provides principles, order, and procedures to guide organisations and individuals to produce, harvest, and conduct preliminary processing to ensure safety, improve product quality, and ensure social welfare and health for producers and consumers, environmental protection, and the traceability of products (Issued together with Decision No. 84/2008 / QD-BNN of July 28, 2008 of the Minister of Agriculture and Rural Development) village). Appendix 3 of VietGAP certification regulation issued under Decision No. 84/2008 / QD-BNN dated July 28, 2008 details the inspection criteria and guidelines for VietGAP assessment. For fruits and vegetables specifically, there are 37 indicators of category A (mandatory application), 24 criteria of category B (to be applied), and four criteria of category C (encouraged to apply). The latest version of the VietGAP National standard TCVN 11892: 1: 2017 with Decision No. 2802/ QĐ-BKHCN was released on October 17, 2017.

Official Letter No. 352 / HD-TT-CLT implementing Decree No. 99/2008 / QD-BNN dated October 15, 2008 of MARD on safe vegetable, fruit and tea production and trading (Subjects and roadmap Applicable under Clause 2, Article 1, Clause 1, Article 13). The roadmap for implementing this regulation is to implement the Prime Minister's Decision 107 / QD-TTG on July 30, 2008 on a number of policies to support the development of production, processing, and consumption of safe fruit and vegetables. The goal by the end of 2015 was to have concentrated production areas that meet the conditions for safe production and preliminary processing compliant with VietGAP (or equivalent GAP) for all fruit, domestic consumption, and raw material for processing and export.

Vietnam joined the Association of Southeast Asian Free Trade (AFTA) and the World Trade Organization (WTO) resulting in food quality and safety becoming an important competitive

advantage that could be used to protect domestic manufacturers. In order to increase the competitiveness of Vietnamese fruit progress, the creation of food quality and safety compliant with GAP standards is vital.

Between 2006 and 2018, the Southern Horticultural Research Institute (SOFRI) conducted research on breeding and creating advanced production processes (GAP) for several key fruit trees. The results have resulted in GAP certification models such as the model of Cat Hoa Loc mango production to achieve GlobalGAP certification in Can Tho province.

Farmers have gradually adopted “Good Agricultural Practices” (VietGAP). Due to the increasing export demand since July 2012, the cooperative members were granted the certificate of “Global Good Agricultural Practices by Cooperative Inspection Joint Stock Company” (Global GAP). Since then, all members of My Xuong Mango Cooperative have followed and are delivering efficiency. Cooperative members have also gradually shifted to production increasing towards the use of safe, organic methods. My Xuong Mango Cooperative has more than 100 members, with an area of 500 ha being used to produce according to VietGAP standards. The average output of mangoes is 5,000 tons per year, of which Cat Chu account for 70% of production and Cat Hoa Loc mangoes account for 30% of production. There is high output in the main season from December to June with the reverse case from June to September.

The Tan Thuan Tay Mango Cooperative has 120 members and is located in the Tan Thuan Tay Commune, Cao Lanh City. It is the second specialised mango cooperative in the Dong Thap Province and one of 16 cooperatives with the mission to develop into an advanced cooperative associated with specialised farming areas and branding of agricultural products in 2015. The goal of the cooperative in the coming seasons is to improve productivity, quality, and reputation of Cao Lanh mango products. This goal is in accordance with the orientation of agricultural restructuring of the city and the province’s economic development, with the construction of new rural areas.

2.5 Cooperatives

There are many documents, conferences, and seminars that address the linkage issues in fruit production. Most recently, at a conference on solutions for developing production and consumption of fruit trees in the southern provinces, the Department of Crop Production proposed the following:

1. Developing an economic model of cooperation in production and consumption for regions
2. Growing traditional specialty fruit trees and having great potential for producing goods
3. Replicating farmer clubs and agricultural extension clubs to produce fruit trees
4. Supporting and encouraging farmers to establish cooperatives or production cooperation groups
5. Creating the conditions for cooperative economic models to promote efficiency (Department of Crop Production, MARD, 2008).

Cooperation in production and consumption of products is concerned and directed by the state (On June 24, 2002, the Prime Minister issued Decision No. 80 encouraging enterprises to sign agricultural product contracts with producers). From 2002-2003, the Southern Fruit Research Institute, in collaboration with Curtin University (Australia), established four mango-planting cooperatives in the Mekong Delta (two cooperatives in Tien Giang and two cooperatives in Tra Vinh), Hoa Loc Cooperative (Tien Giang), Chau Nghe Mango Cooperative (Tra Vinh). Two of the above four cooperatives are currently operating quite well. In recent years, there have been more models, clubs, and cooperatives in the Mekong Delta. However, there are very few successful models. Many established cases are formal, operating efficiency is low, and the number of farmers participating is low.

The organisation of fruit cooperatives in the Mekong Delta is quite diverse, but cooperatives are established on the voluntary basis of farmers, which is entirely consistent with the revised cooperative law. The share contribution also has differences depending on the cooperatives. Marlo Kaye Rankin (2007), when researching on the issue of fruit-growing cooperatives in the Mekong

Delta, found that in 2005, in the case of Hoa Loc cooperative (Tien Giang), the cooperative expanded its scale quite quickly and had 69 members. When joining the cooperative, new members had to contribute 500,000 shares. Mango farmers in 13 communes of Cai Be district can become cooperative members if they want to and are eligible. The contribution of the cooperative members is not much, while the production and fruit trading activities of cooperatives are currently facing problems as they have capital difficulties. Although there are many customers that are approaching cooperatives to buy fruits (especially cooperatives with specialty fruits), the cooperatives cannot sign contracts, mainly because there are no qualified and stable sources of goods. It is clear that there are no uniform production processes in cooperatives.

In the past, there have been some models of cooperation in production that initially had positive signs (such as Hoa Loc cooperative model, Cai Be district in Tien Giang province) thanks to the connection between mango growers and implementation. In 2007, the cooperative signed a contract to supply 50 tons of mango Cat Hoa Loc mango for export processing companies to the Japanese market.

2.6 Discussion

Southern Vietnam has developed some of the most sophisticated means of flower manipulation for mango production in the world. Most of this work is described in Vietnamese in national science journals and are difficult to access as they are not included in international citation indexes. The Vietnamese work is largely focused on local mango cultivars such as Cat Hoa Loc and Cat Chu and has been performed largely at Cat Tho University and SOFRI. The methods used are generally similar to the chemical treatments used in other leading mango producers but recommendations on timing and chemical concentrations have been optimised for local conditions. With climate changes, it is not clear that these methods will remain effective. Alternative chemicals with reduced residual effects could also be evaluated for long term incorporation into this system. Vietnam has focussed on maximising production with the major quality parameters being fruit size and external appearance. Eating quality consumer perceptions and post-harvest shelf-life have received minimal attention. The rapid fruit development to achieve harvest maturity in 80-85 days after fruit set in Vietnam would appear to be amongst the shortest of any mango and are harvested prior to achieving full size. While this may represent the characteristic Cat Hoa Loc flavour whether this represents the optimal marketable product needs to be considered.

3. Research study – Provincial farmers

3.1 Overview

This study was conducted to provide local researchers training to design and undertake structured farm interviews to capture current flowering and on-farm production practices. Based on this training, tools for this activity were developed and surveys were conducted in Dong Thap and Tien Giang provinces. These surveys focussed on pruning and canopy management, fertiliser management, and pest and disease control, the skill levels of farmers, and assessment of the impact of practices on production costs, yield, fruit quality and losses. Observations on the potential environmental issues relating to sustainable production were also noted.

This study was conducted to understand the outputs from research and extension, along with government policies that influence farm management. It also enabled the drivers for seasonal mango production and fruit quality that the farmers respond to and the effects this has on their management decisions. These results will help inform activities further along the supply chain and identify other opportunities to increase farmers' net income.

3.2 Research approach

3.2.1 Research locations

The mango industry in southern Vietnam was segmented into the major production regions, and districts within these provinces were then identified. These districts represent typical mango farms in the Mekong Delta region of southern Vietnam.

3.2.2 Study methodology

The study methodology adopted an interview checklist form. The interview forms contained questions seeking to understand mango production in Tien Giang and Dong Thap provinces, Vietnam (see Appendix). Individual farmers in these two districts were then interviewed by team members using the semi-structured checklists as a guide. The individual semi-structured interviews were recorded by hand in the field. The project team entered and analysed the data using Excel software. Formal permissions were gained prior to conducting this work. The interviews were conducted between April and July 2019.

3.3 Key farmers in the study

3.3.1 Informants

The details of the informants interviewed in the survey are presented in Table 1.

Table 1. Research design

Farm Location	Method	Respondents	Numbers
Dong Thap province	Semi-structured Interviews	Farmers My Xuong commune, Cao Lanh district	5 interviewed
Dong Thap province	Semi-structured Interviews	Farmers Binh Hang Tay commune, Cao Lanh district	5 interviewed
Dong Thap province	Semi-structured Interviews	Farmers Tan Thuan Tay commune, Cao Lanh City	10 interviewed
Tien Giang province	Semi-structured Interviews	Farmers Hoa Hung commune, Cai Be district	10 interviewed
Tien Giang province	Semi-structured Interviews	Farmers Hoa Hung commune, Cai Be district	10 interviewed

Source: Author's analysis

3.4 Research results

3.4.1 Understanding of on-farm production and flower manipulation practices

In the interviews across the two regions, there was only one female farmer interviewed of the 40 farmers engaged in the process.

There were 20 Cat Hoa Loc orchards surveyed in Tien Giang and 10 in Dong Thap. The other orchards in Dong Thap grew Cat Chu and Dai Loan. These orchards were a similar size, but trees were planted at much higher densities (>500 tree ha). While many of the Cat Chu orchards were 20 years old, there were also orchards as young as five and six years old of Cat Chu and Dai Loan in the survey. The basic mean Cat Hoa Loc orchard statistics reported on in the surveyed provinces

are shown in Table 2. The farms in both regions were generally less than 1 ha but in Dong Thap, there were four farms of 1.1 ha farms of the 10 surveyed. On these farms, trees were planted at higher densities and had higher yields. The orchards in Tien Giang were generally older with no orchards less than 10 years old, with the oldest being 40 years old. Most of the trees in the Tien Giang province were propagated from seed with only one orchard recorded as having some grafted trees. In Dong Thap, four of the 10 orchards were propagated by grafting. Previous research in Vietnam has suggested that there are no elite rootstocks for use in propagation (Tran Van Hau *et al.,* 2001). The mean yields on a farm and area basis were recorded as being higher in Dong Thap than Tien Giang. This could in part be explained by the orchards being larger and being planted at higher densities.

Table 2. Survey results Cat Hoa Loc orchards

Province	Mean Farm size (ha)	Mean number of trees ha^{-1}	Mean number of trees $farm^{-1}$	Mean tree age (yrs)	Mean yield t $farm^{-1}$	Mean yield t ha-1
Tien Giang N=20	0.72	150.35	111.84	20.2	6.34	9.30
Dong Thap N=10	0.91	270.50	232.80	15	15.10	17.40

Source: Author's analysis

3.4.2 Tree nutrition

In the survey responses, the nutrients that growers applied to the tree were recorded by the amount, composition, and timing of application. It has been assumed that the total amounts (kg/ha^{-1}) are a summation of the total year's input. It should be noted that, as described in the review, Vietnamese mango growers have been recommended to fertilise trees on four occasions at different stages during canopy development (pre- and post-flowering and during fruit development). Growers usually fertilised their trees three to four times a year but some applied fertiliser on up to seven occasions. The main variation was due to the number of times growers fertilised during crop development.

In many countries, including Australia, the applied fertiliser is based on the amount of nutrient removed by the crop (or, in this case, mango fruit). Table 3 sets out the estimated nutrient (kg) removed per ton for Kensington Pride mangoes (including skin, flesh, and seed). Similar data could not be found for Cat Hoa Loc mangoes. This has been restricted to the macronutrients supplied in the survey responses. Based on the farmer responses, the amount of nitrogen fertiliser applied per farm, per tree, and per hectare has been calculated. Assuming that Cat Hoa Loc mangoes have similar nutrient composition as Kensington pride mangoes, the amount of nitrogen per hectare removed by the crop was calculated.

Table 3. Macronutrients harvested from Kensington Pride mango

Mango macronutrients	Nutrient (kg) per ton	Nutrient (kg) per ton of fruit required to compensate for crop removal and losses including leaching, fixation, and volatilisation
Nitrogen (N)	0.845	1.77
Phosphorus (P)	0.180	0.45
Potassium (K)	1.285	2.83
Calcium	1.15	1.61

Source: Winston, 2016

Based on the amount of nitrogen applied and the amount removed by the crop, the number of times in excess of the crop requirements was calculated (see Table 4). This process was repeated for phosphorus (P) (see Table 5), and for potassium (K) (see Table 6). The conversion factor for expressing P in terms of P_2O_2 and K as K_2O has been used. This was included as it is often used as a convention but these forms of fertiliser do not exist.

Table 4. Mean value of nitrogen (N) applied to orchards

Province	Mean total applied N (kg) farm^{-1}	Mean total applied N (kg) tree^{-1}	Mean total applied N kg ha^{-1}	Mean N removed by harvest kg ha^{-1}	Mean excess N application to harvested crop (times)
Tien Giang	130.45	1.24	186.04	7.86	26.32
Dong Thap	144.75	0.87	196.61	14.703	16.65

Source: Author's analysis

Table 5. Mean amount of phosphorus (P) applied to orchards

Province	Mean total applied P (kg) farm^{-1}	Mean total applied P (kg) tree^{-1}	Mean total applied P kg ha^{-1}	Mean P removed by harvest kg ha^{-1}	Mean excess P application to harvested crop (times)
Tien Giang	82.51	0.79	186.04	7.86	81.48
Dong Thap	120.26	0.69	196.61	14.703	67.95

Source: Author's analysis

Table 6. Mean amount of potassium (K) applied to orchards

Province	Mean total applied K (kg) farm^{-1}	Mean total applied K (kg) tree^{-1}	Mean total applied K kg ha^{-1}	Mean K removed by harvest kg ha^{-1}	Mean excess K application to harvested crop (times)
Tien Giang	103.63	0.94	142.19	11.95	13.90
Dong Thap	107.71	0.62	139.17	22.359	8.01

Source: Author's analysis

In all cases, the amount of macronutrient N, P, and K applied in Dong Thap and Tien Giang exceeded the crop by 8 to 80 times more than required, even considering the amount potentially lost to leaching, fixation, or volatilisation. It should also be noted that these calculations do not consider the recycling of nutrient through the breakdown of leaves and pruning, which are recorded in Australia as representing 40 - 50% of nutrient demands. This further accentuates apparent excessive amounts fertiliser being applied but it is unclear if this is required for the flower manipulation process to function.

3.4.3 Paclobutrazol

The amount of paclobutrazol applied per tree was calculated based on the orchard size and the number of trees planted per hectare (see Table 7). The amount of active ingredient applied was then calculated based on 15% and 10% w/w of the product being active ingredient. The actual level of active ingredient in commercial packs of paclobutrazol in Vietnam can be higher than this, as 20% w/w paclobutrazol was on packaging recovered from one of the study farms. The active ingredient content of the product used was not recorded as part of the survey.

Table 7. The mean amount of paclobutrazol (PBZ) product applied within an orchard

Province	PBZ Product kg ha-1	PBZ product g tree^{-1}	PBZ active ingredient @15% g tree^{-1}	PBZ active ingredient @10% g tree^{-1}
Tien Giang	24	177.5	26.6	17.8
Dong Thap	26	117.5	17.6	11.8

Source: Author's analysis

The registered amount paclobutrazol allowed to be used on mangoes in Australia, along with most other countries, is 1 g/m canopy diameter up to a maximum of 5 g/tree^{-1}. In Australia, this must be applied prior to mid-February with flowering occurring as early as May and fruit harvest at 120 days later in September. This equates to about 220 days from application to harvest. In Vietnam, the shortest time is about 150 days (application is 2.5 months prior to flower induction plus 80 days fruit set). This is 70 days less than in Australia. The optimal amount of paclobutrazol to be applied based on Vietnamese research (Tran Van Hau *et al.,* 2009) is 1.5 g ai /m^{-1} canopy diameter, which is 50% more than in Australia and no upper limit has been nominated. The mean amount of paclobutrazol applied as product per tree for the two provinces is shown in Table 7. The amount of active product based on 10% and 15% content in the commercial product is then calculated. The mean level of paclobutrazol applied in Tien Giang and Dong Thap ranged from two to five times the maximum level permissible in Australia. The upper-most levels of application were 10 to 15 times the Australian maximum in Tien Giang and six to eight times in Dong Thap. It should be noted that paclobutrazol is also available as a 25% active ingredient product in Vietnam so the level of excessive application could be considerably higher.

Paclobutrazol is believed not to be phloem mobile, meaning that it is not translocated to developing mango fruit. The observation that brix levels reduced in Cat Hoa Loc with increasing levels of paclobutrazol are consistent with the significant negative relationship reported in Palmer mangoes in Brazil where a reduction of total sugars, reducing sugar, and non-reducing sugars was observed in mango trees irrigated with paclobutrazol at 0.7–1.9 g ai per linear metre of canopy prior to flowering (De Souza *et al*., 2016). This suggests that either paclobutrazol directly or indirectly affects the accumulation of starch or the conversion of fruit reserves to sugars.

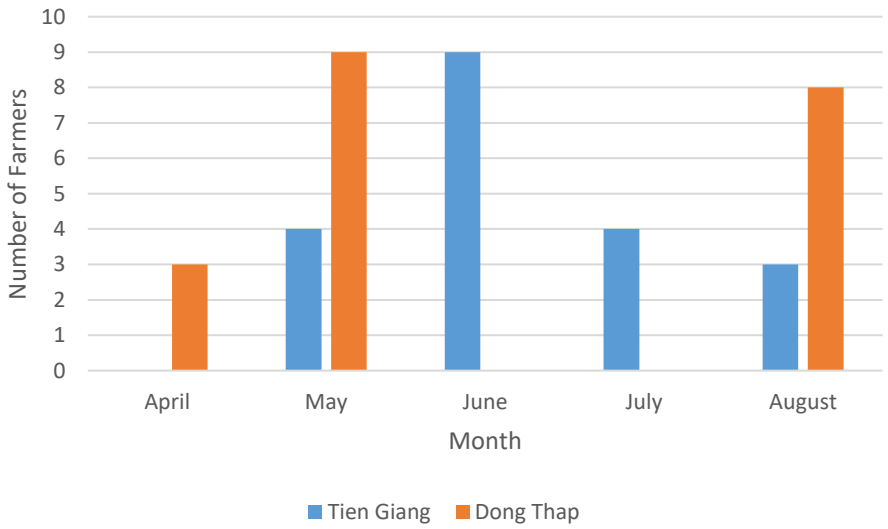

Figure 2. Paclobutrazol orchard application, April to August, Tien Giang and Dong Thap provinces

Source: Author's analysis

Based on the timing of paclobutrazol application, it is evident most growers were aiming to have mangoes produced in the late-, early-, and off-season (see Figure 2).

No information was provided from either province on the timing or methods used to chemically induce flowering.

3.4.4 Number of pesticide and fungicide sprays applied annually

The number of fungicide and pesticide sprays applied annually in Tieng Giang is shown in Table 8. There was usually one to protect the foliage after pruning and also another just prior to bagging. The rest of the sprays were to protect the forming and developing of flowers and fruitlets. Once the fruit were bagged, protective sprays ceased. These sprays primarily protected against anthracnose and fruit borers during the early-season, and thrips and leaf hoppers in the on-season.

Table 8. Annual pesticide or fungicide sprays applied, Tien Giang and Dong Thap provinces

Province	Mean number of pesticide or fungicide sprays	Minimum number of pesticide or fungicide sprays	Maximum number of pesticide or fungicide sprays
Tien Giang N=20	8.3	5	12
Dong Thap N=26	7.8	5	13

Source: Author's analysis

3.4.5 Bagging

All respondents bagged their fruit and the mean day after fruit set was near the 40 days recommended in the reviewed research papers (see Table 9). There were some growers that bagged earlier (after 20 days) and others much later (60-70 days), though only a few. There was a mixture of bag types used, listed as either yellow or white in Dong Thap while only White Taiwanese bags were used in Tien Giang.

Table 9. Bagging after fruit set, Tien Giang and Dong Thap provinces

Province	Mean number of days after fruit set that fruit are bagged	Range in the number of days of days after fruit set that fruit are bagged
Tien Giang N=(20)	44.25	30-60
Dong Thap N=(19)	40.26	20-70

Source: Author's analysis

3.4.6 Other information

The major concerns of farmers were:

- Thrips and anthracnose control
- Bad weather
- Fake chemicals and fertiliser
- Accessing additional labour
- Maintaining market prices
- Flower induction process
- Damage to fruit during transportation

All growers harvested fruit with a stem attached and de-bagged the fruit at a central location. Two of the growers reported harvesting after 120 days but it is not clear if this was the number of days after fruit set or the number of days after fruit induction.

3.4.7 Production costs and profitability

Detailed analysis of farm cost and profits was only possible for the survey conducted in Tien Giang. The input cost per farm ranged from 50 x10^6 VND ha^{-1} to 200x10^6 VND ha^{-1}. The size of the farms ranged from 0.3-1.3 ha. The yield ranged from 5-15 t ha^{-1} so individual farm production ranged from 3.0-15.6 tons. Based on these responses, it is possible to calculate the profitability of individual farm enterprises. The growers suggested that their farm gate sales price ranged from 20-80,000 VND kg^{-1} for grade 1 fruit, depending on the season of production. The profitability of individual enterprises for a farm gate sales price of 15,000 VND kg^{-1} (see Figure 3). In this scenario, three of the 20 enterprises were not profitable. All enterprises became profitable where they reached a farm gate sales price between 20-30,000 VND kg^{-1}.

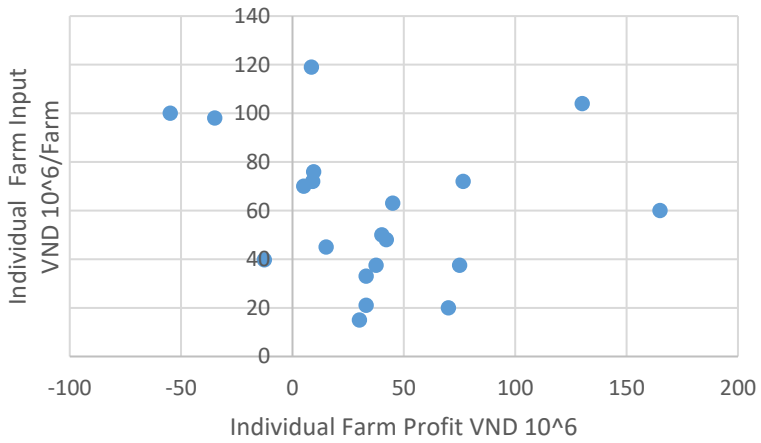

Figure 3. Farm profitability, Tien Giang Province

Source: Author's analysis

The mean profitability at farmgate sales price from 10-80,000 VND kg^{-1} across all 20 farm enterprises in the Tien Giang province is shown in Figure 4. These results appear to indicate that the mean cost of production is around 9-10,000 VND kg^{-1}. It is also evident that aiming for out-of-season product greatly increases profitability even if there is a yield penalty. The literature review of research in the Tien Giang and Dong Thap suggested that there was little if any yield reduction in the out-of-season production, and the major difference was in the lower price received for Cat Chu fruit compared to Cat Hoa Loc.

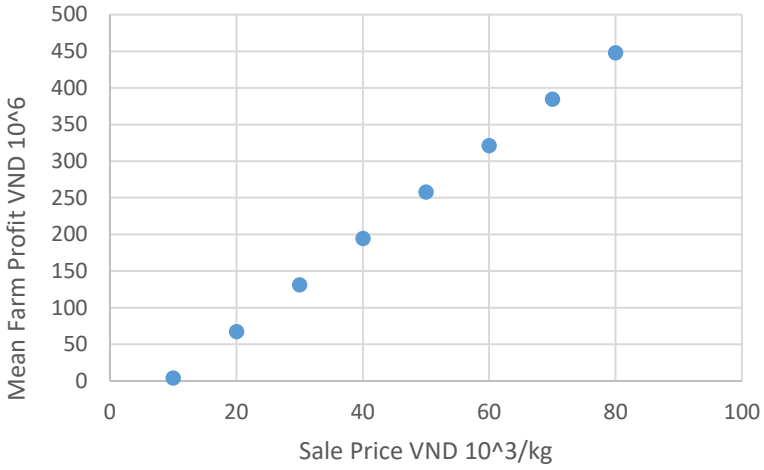

Figure 4. Farm profitability, Tien Giang Province

Source: Author's analysis

Previous value chain studies conducted in Dong Thap province found that the cost of production for Cat Chu was around 7,764.29 VND/kg. (Romo, 2016). The mean yield reported in this study for Cat Chu was 14,000 kg/ha. The sales price to the collector was 17,425 VND/kg, making the mean gross margin 9,460.71 VND/kg. At mean production of 14 t/ha, the gross margin per ha was 132.440 Million VND). The collectors were thought to add 1,000 VND/kg to the purchase price when selling to the wholesaler, with 500 VND/kg being the transport cost and 500 VND/kg as their gross margin. The challenge for the collectors was that they had to pay the farmers cash, while they were paid in installments by the wholesalers.

3.4.8 Farm operations and marketing

When asked, none of the farmers had information about mango processing. None of the farmers had plans to expand their farms, citing reasons including lack of land, insufficient labour, lack of time to manage the orchard, changing weather patterns, and being old.

All farmers from both provinces self-funded all on-farm activities to produce and harvest the crop. The farmers managed their own finances, though six of the 20 farmers in Dong Thap indicated that they either did not know about their finances or that their partner (wife) handled this aspect of the enterprise.

The traders to whom the farmer sold their crop predominantly had a long-term relationship and were trusted. Price was also critical in the decision to sell. The trader or cooperatives decided the grade of the fruit, though there was some negotiation. About half of the farmers reported getting feedback on the quality of their fruit. All fruit could be sold, and fruit were not sold only when the price was too low.

3.5 Discussion

The surveyed farms in Tien Giang and Dong Thap were small (less than 1.2 ha) but annual yields were high. Yields appeared higher in Dong Thap, which may reflect the younger orchards. Even then, trees were generally old (>10 years) and the use of grafting scions was mainly restricted to Dong Thap.

The fertiliser inputs appeared to far exceed the crop requirements and indicated inefficient utilisation. The importance that these high inputs play in the process of off-season cropping is unclear but they represent opportunities for reducing input costs.

The mean number of sprays used to control pests and disease in both provinces were comparable, with about eight per crop. However, there was large variation with some growers reporting up to 12–13 sprays. The need for sprays is expected, since off-season production occurs during the wet season when increase in disease pressure is expected. However, these sprays are applied in a comparatively short period, from floral induction until bagging, which could be as short as 60-80 days. This suggests that a review could rationalise these decisions and perhaps that improved spray application methods could be considered.

Farm management was directed at maximising production, with limited means for providing feedback on the performance of the fruit in the supply chain or marketplace. Payment was based on fruit size, with large fruit receiving the greatest returns. Growers had little knowledge of mango processing (freezing/drying).

High levels of soil-applied plant growth regulator were used to prepare the trees for flower induction, and the timing of application indicated that most growers were targeting off-season production. However, no information was provided on the chemicals used to induce flowering.

Bagging that prevents insect and disease losses was used by all farmers, but the type of bag used was region-specific.

Most farmers were able to fund their production practices without seeking finance. While most decisions on farming operations were made by the male partner, some farmers indicated that the finances were managed by their wives. Long-term trusted relationships were important in making sale decisions.

The major farmer concerns were associated with accessing labour, having sufficient time to manage the orchard, and becoming too old to manage the farm. Expansion of production was restricted by access to land. The major agronomy problems were associated with poor weather conditions, pest and diseases, fake chemicals, and the reliability of the flower manipulation process. Maintenance of fruit prices was critical.

The cost of production appeared to be around 10,000 VND/kg based on the relationship between price and profitability. This supports the preference for off-season production, when yields were comparable but prices were higher.

4. Conclusion and recommendations

4.1 Conclusion

Results from the farmer survey showed that orchards in Dong Thap and Tien Giang are small (>1.2 ha) but very productive. Farmers are currently able to target off-season production but there are concerns about the reliability and chemicals used. Their production systems require high levels of inputs, including labour for bagging, harvesting, and numerous sprays. The flower manipulation process requires high levels of plant growth regulators to control growth and make the tree responsive to chemical induction treatments. The research has adopted these technologies and refined them further to suit local conditions and be among the most sophisticated in the world. The research and farming practices are targeted at maximising production but there seems to be less consideration for the potential effects of the maximising of yield on the consumer perception of the product.

The recommended harvest maturity of 80–85 days after full bloom is based on fruit developmental studies. This stage of development precedes the fruit attaining full size so has yield implications. These studies have not involved consumer assessment of the ripe fruit, but the ripened fruit have high sugar content. Fruit assessed in these studies were ripened using calcium carbide that potentially changes the composition of fruit compared to other ripening practices. It is unclear how widespread the use of calcium carbide in Vietnam is for ripening fruit, but this process is banned in many countries due to risk of arsenic and phosphorus acid contamination and injuries caused to users. This ripening treatment can quickly bring fruit to eating ripeness, but treated fruit can have greatly reduced storage characteristics. It has the potential to mask fruit deterioration due to rots and internal defects that may develop in more controlled ripening processes. Consideration for reassessing harvest maturity using non-destructive near infrared technology and ethylene-assisted ripening should be considered.

Paclobutrazol was universally used by all farmers to assist in flowering and increase yields. The Vietnamese research has optimised the timing of application and dose of this chemical. The level used is higher and the time between treatment and harvest is shorter than in most countries. In some growers, these levels of application could be expected to affect ripe fruit's sugar content. There are alternative chemicals that could replace paclobutrazol that break down quickly. Being foliar applied, they could require changes to orchard design and spray application technology that would need to be developed.

The amount of fertiliser applied and recommended exceeds the crop requirement. It represents a major cost input, and ways to increase nutrient use efficiency would have benefits for profitability. These high levels of nutrition would be expected to cause increased pest and disease losses requiring increased control measures. They would be expected to increase levels of internal fruit breakdown. Development of cost-effective means to manage nutrient inputs and impacts of market fruit quality are needed.

Off-season mango production is the most profitable but requires fruit development during the wet season. This necessitates intensive chemical spraying to control pests and disease, though bagging is in part effective. There will be an ongoing need to review these activities to prevent the development of resistance and to manage residues. This may also require physical changes to orchard design to improve spray application methods.

The chemical treatments to manipulate flowering substitute cool conditions that normally trigger flower induction. Under excessively high temperatures, flower induction in mangoes is inhibited. The capacity of the current chemicals to overcome the increasing frequency of high temperature events and to promote flowering is unknown. This information is needed to develop strategies and the assess suitably adapted mango cultivars and production systems into the future.

Throughout these studies, the lack of focus on the preferences of the end consumer have had minimal consideration. To access high-value markets and increase net returns to farmers, this may have to change.

4.2 Recommendations

Recommendations based on this study include:

1. Evaluate the effects of temperature on floral induction, with aims to understand the vulnerability of mango production in southern Vietnam to the temperature increase associated with climate change projections.
2. Assess alternatives to paclobutrazol—such as prohexadione calcium and foliar-applied uniconazole—to reduce chemical inputs and chemical residues in the soil and to ensure the viability of the industry if the use of paclobutrazol is restricted.
3. Consider the use of forchlorfenuron to improve fruit size, taking care not to induce internal fruit disorders, and increase farm gate fruit price by increasing the proportion of first-grade fruit (due to increased fruit size).
4. Review alternative methods of assessing harvest maturity (such as near infrared spectroscopy), considering consumer perceptions of ripe fruit quality, to determine whether there are higher value markets for more mature large fruit.
5. Review fertiliser recommendations to determine if there are opportunities to improve nutrient use efficiency and reduce on-farm input costs.

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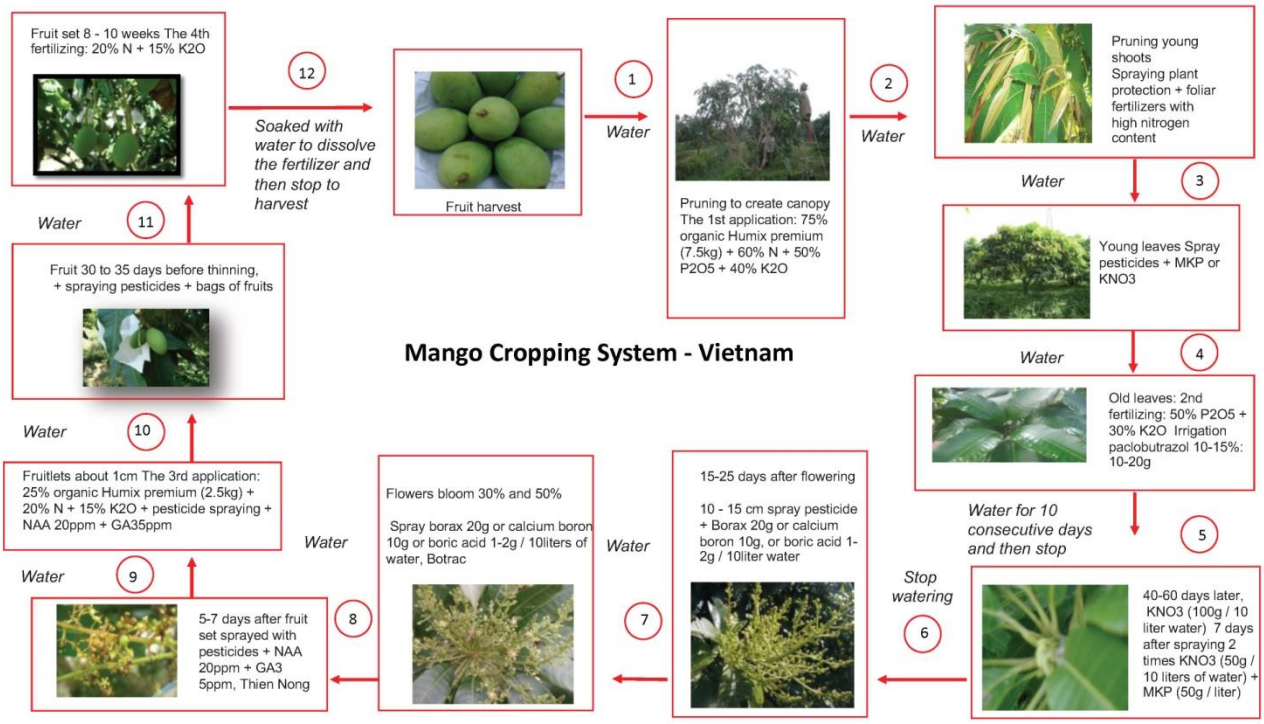
6. Appendices

6.1 Crop management cycle recommended for southern Vietnam

Summary of stages of development indicate by numbers 1-12. Pruning = stage 1, Vegetative flush = stage 2, Gibberellin synthesis inhibitor = stage 3, Leaf conditioning = stages 3-4, Floral induction = stages 5, Fruit set and retention = stages 6-9 Bagging = stage 10, Final Fertiliser = stage 11, Harvest = stage 12



Source: Doan Thi Cam Hong and Nguyen Van Son, 2019

6.2 Research based fertilisers

The recommended amount of nitrogen (N) Phosphorous (P_2O_5) and Potassium (K_2O) to be supplied to Cat Hoa Loc (grams/tree/year) in southern Vietnam based on research findings as indicated.

Authors	N	P_2O_5	K_2O	Other
Nguyen Thanh Hieu & Vo The Truyen, 2004	440	520	327.5	
Tran Nguyen Lien Minh & Nguyen Minh Chau, 2005	460	300	450	10 kg dynamic lifter
Tran Nguyen Lien Minh & Nguyen Minh Chau, 2005	920	600	900	
Nguyen Van Ke 2014	870	940	900	2kg Lime 10-30kg composted manure
	1035	675	900	2kg Lime 10 kg Humix
Tran Van Hau & Phan Huynh Anh, 2014	1300	1100	1400	

6.3 Fertiliser applications for non-bearing trees

The recommended amounts of nitrogen (N), Phosphorous (P_2O_5), and Potassium (K_2O) and respective urea, superphosphate, and potassium chloride equivalents a) for non-bearing trees 1-3 years.

Tree age (year)	Number of applications (years)	Dose (tree / year)		
		N (g) (Urea equivalent g)	P_2O_5 (g) (Super phosphate equivalent g)	K_2O (g) (Potassium chloride equivalent g)
1	4-5	150 g (326 g)	100 g (625 g)	150 g (250g)
2	4	300 g (652 g)	200 g (1.250 kg)	250 g (416g)
3	4	450 g (978 g)	300g (1.875 kg)	350 g (583g)
Every year, fertilising: - Decomposed organic fertiliser from 10-20kg Lime at the beginning of the rainy season: 200-300g / tree.				

Source: (Doan Thi Cam Hong & Nguyen Van Son, 2019)

6.4 Fertiliser applications for bearing trees

The recommended amounts of nitrogen (N), Phosphorous (P_2O_5), and Potassium (K_2O) and respective urea, superphosphate, and potassium chloride equivalents for bearing trees 4->10years old on the Mekong delta.

Tree age (year)	Dose (tree / year)		
	N (g) (Urea equivalent kg)	P_2O_5 (g) (Super phosphate equivalent kg)	K_2O (g) (Potassium chloride equivalent kg)
4	600 g (1.304kg)	400 g (2.500 kg)	450 g (750 g)
5	750 g (1.630kg)	500 g (3.125 kg)	550 g (916 g)
6	900 g (1.956kg)	600 g (3.750 kg)	650 g (1.083 kg)
7	1.950 kg (2.282kg)	700 g (4.375 kg)	750 g (1.250 kg)
8	1.200 kg (2.608g)	800g (5.000kg)	850 g (1.416 kg)
9	1.350 kg (2.934kg)	900g (5.625 kg)	950 g (1.583 kg)
10	1.500 kg (3.260kg)	1.000g (6.250 kg)	1.050 g (1.750 kg)
Over 10 years old	Increase fertiliser dosage to 10 – 15% per year and do not increase further depending on the dispersion and growth of the plant.		
Every year, fertilising: - Decomposed organic fertiliser from 20-30kg Lime at the beginning of the rainy season: 200-300g / tree.			

Source: Doan Thi Cam Hong & Nguyen Van Son, 2019

6.5 Studies related to major mango pest control in southern Vietnam

Studies of the major pests of mango in southern Vietnam showing the pests studied, recommended treatment, and authors or institute that conducted the research.

Pest	Treatment	Authors or Institute
Mango fruit borer, Branch borers, Yellow flies on mangoes, and important diseases including anthracnose and black spot canker,	Integrated pest management	Nguyen Ngoc Anh Thu & Nguyen Van Hoa, (2004)
Fruit Flies *(Bactocera dorsalis* and *B. correcta)*	Integrated pest management	SOFRI
Fruit flies	Actara 25 WG and Karate 2.5 EC	Tran Van Hau et al., (2015b)
Fruit borer (*Deanolis albizonalis* Hampson	15%; Napthalene 98% (6 traps per tree), Karate 2.5 EC (0,02 g.a.i/ litre) and Success 25 EC (0,9 g.a.i/litre	Huynh Thanh Loc et al., (2004b)
Sybulus sp. *Alicidodes frenatus* Faust, *Chlumetia transversa* Walker and *Placader ruficornis* Newman	Regent 5SC (irrigation), Karate 2.5	Huynh Thanh Loc et al. (2004a)
Thrips *(Scriptothrips dorsalis* Hood, *Megalurothrips sjostedti* Trybom*, Thrips hawaiiensis* Morgan. *M. sjostedti* and *T. hawaiiensis)*	Plant extracts	Nguyen Thi Kim Thoa et al., (2008)
Thrips	Spinetoram	Tran Thi My Hanh et al., (2018)
Mango hoppers *(Idioscopus nitidulus* Walker and *Idioscopus clypealis* Lethierry)	Thiamethoxam + Buprofezin, Pymetrozine + Buprofezin, Clothianidin + Buprofezin, Indoxacarb + Buprofezin, Thiamethoxam + Etofenprox, Pymetrozine + Etofenprox, Clothianidin + Etofenprox, Indoxacarb Etofenprox, Acephate + Etofenprox and Acephate + Buprofezi	Huynh Thanh Loc et al. (2017)
Leaf hoppers	Nitenpyram, Imidacloprid, Pymetrozine and Azadirachtin Biocides, Emamectin benzoate and *Verticillium lecanii* were also effective	Tran Thi My Hanh et al., (2019)
Leaf Hoppers	yellow and orange sticky traps with cyliders being the most effective	SOFRI

Source: Author's analysis

6.6 Studies related to major mango diseases in the southern Vietnam

Disease or Pathogen	Treatment	Authors or Institute
Anthracnose (*Colletrotrichum gloeosporiodes)*	Score sprayed 4 times at 7-day intervals and Kasumin	Nguyen Ngoc Anh Thu & Nguyen Van Hoa (2005)
Anthracnose (*Colletrotrichum gloeosporiodes)*	Antracol and Coc 85, and Song Lam 333 50ND (Salicylic acid containing product) and Stop 15WP Stop 15WP (ChitosaOligasacarit	Nguyen Ngoc Anh Thu & Nguyen Van Hoa, (2004)
Anthracnose (*Colletrotrichum gloeosporiodes)*	Bacterial antagonists pre- and post-harvest	Nguyen Van Hoa & Nguyen Ngoc Anh Thu, (2008)
Black spot canker (*Xanthomonas* sp.)	Bagging	Nguyen Ngoc Anh Thu & Nguyen Van Hoa, (2006)
Black spot canker (*Xanthomonas* sp.)	Bagging and Starner	SOFRI

Source: Author's analysis

6.7 Interview checklist – Provincial farmers – Vietnamese

Mango Production Interview Checklist

ACIAR Project

Improving smallholder farmer incomes through strategic market development in mango supply chains in southern Vietnam

Dự án ACIAR

Cải thiện thu nhập của nông dân sản xuất nhỏ thông qua phát triển thị trường chiến lược trong chuỗi cung ứng xoài ở miền Nam Việt Nam

Date (Ngày): …./……./……..

Interviewer: (Người phỏng vấn):……..……

Section I: GENERAL INFORMATION

Phần I: THÔNG TIN CHUNG

1.Farmer (Nông dân) ……..……

Male/Female (Nam/Nữ): ……..……

2.Province/District/Commune

Xã……Huyện…….……Tỉnh……...…

3.Group/Organization (Cooperative / farmer groups / production union)

Nhóm/Tổ chức (Hợp tác xã/Nhóm nông dân/ Hiệp hội sản xuất)

…….……...

4. Are you a part of a mango cooperative or other style of farming group?

Bạn có phải là thành viên của HTX hoặc một nhóm sản xuất xoài nào không?

.....

.....

5. In your words, please share the history of your mango farm? *(The (Interviewer: you are looking for - How long, how many trees)*

(Also, the interviewer – should be looking to complete the table on the next pages and prompting the farmer to share this type of information)

Theo lời của bạn, hãy chia sẻ lịch sử nông trại xoài của bạn?

(Người phỏng vấn: bạn cần biết–Xoài được trồng bao lâu, bao nhiêu cây)

(Ngoài ra, người phỏng vấn - nên tìm cách để hoàn thành các bảng trên các trang tiếp theo và nhắc nhở người nông dân chia sẻ những thông tin này)

.....

.....

.....

Section II: PRODUCTION SITUATION

PHẦN II: TÌNH HÌNH SẢN XUẤT

(Interviewer: Purpose of this section, we are seeking to understand the basic farm composition including setup/layout)

(Người phỏng vấn: Mục đích của phần này, chúng tôi đang tìm hiểu thành phần cơ bản của nông trại bao gồm thiết lập/bố trí)

Crop/Variety **Cây trồng/giống** **Characteristics** **Đặc điểm**	……	……	……
I.Farm characteristics **(Đặc điểm của nông trại)**			
Farm 1 (nông trại 1)			
1. Area (ha) Diện tích (ha)			
2. Type of land Loại đất trồng			

3. Number of trees/ha Số cây/ha			
3. Origin of tree Nguồn gốc cây trồng			
4. Age (year) Tuổi cây (số năm)			
5. Density (a x b) Mật độ trồng (a x b)			
6. Production Kg Sản lượng (kg)			
Other notes Khác			

Question: If you are producing – off season / flowering – can you describe how this is undertaken

(we need to capture method, timing, effectiveness and how decisions are made – who advises on this)

Câu hỏi: Nếu bạn đang sản xuất – trái vụ/ xử lý ra hoa – Bạn có thể mô tả lại cách thức thực hiện này.

(Chúng ta cần nắm được phương pháp, thời gian, hiệu quả và cách đưa ra quyết định như thế nào? – Ai ra lời khuyên/tư vấn cho việc này?)

.....

.....

.....

Section III: CULTIVATION TECHNIQUES

PHẦN III: KỸ THUẬT CANH TÁC

(Interviewer - We need an in depth understanding of their production systems, what they are doing, why they are doing it, how did they make the decision to do this, and issues with what they are doing…Let the farmer tell their story, please)

(Người phỏng vấn - Chúng ta cần hiểu rõ về hệ thống sản xuất của họ, những gì họ đang làm, tại sao họ làm việc đó, họ đã đưa ra quyết định như thế nào và những vấn đề họ đang làm là gì…Hãy để người nông dân kể câu chuyện của họ)

(Interviewer - ask follow-up questions as they talk about their farm practice, this will clarify some of the information)

(Người phỏng vấn - đặt câu hỏi tiếp theo khi họ nói về những các bước thực hiện trên nông trại của họ, điều này sẽ làm rõ một số thông tin)

(This next section will take a bit a time & gives us the monthly production practices information needed to understand on-farm production.)

(Phần tiếp theo này sẽ mất một chút thời gian & cung cấp cho chúng tôi thông tin thực hành sản xuất hàng tháng cần thiết để hiểu về tình hình sản xuất của nông trại)

Main Question: Can you talk us through your mango production practices for the season from January to December?

Câu hỏi chính: Bạn có thể cho chúng tôi biết các hoạt động sản xuất xoài của bạn trong mùa vụ từ tháng 1 đến tháng 12 không?

(Start with January and work through each month – one by one for 12 months)

(Bắt đầu với tháng một và công việc thực hiện qua từng tháng - từng bước một trong 12 tháng)

Follow up questioning to clarify within each month are:

Theo sau các câu hỏi để làm rõ trong mỗi tháng:

What's happening within the tree during this month?*Physiology*
Chuyện gì xảy ra với cây trồng trong tháng này (Sinh lý)

- **What are the inputs Fertilizer, chemical, water, labour**

(What Reason, Type, how, techniques)

Vật liệu đầu vào: Phân bón, hoá chất, nguồn nước, lao động đầu vào là gì?

(Lý do gì? Loại, như thế nào, kỹ thuật)

Who is making these decisions?

(Interviewer – you should investigate around these themes if the information is it immediately forthcoming

This will take longer at the start but will be much quicker as you work through the months.

Ai là người đưa ra những quyết định này?

Người phỏng vấn - bạn nên điều tra xung quanh các chủ đề này nếu thông tin được đưa ra ngay lập tức

Điều này sẽ mất nhiều thời gian hơn khi bắt đầu nhưng sẽ nhanh hơn nhiều khi bạn làm việc qua nhiều tháng

Month – January / February

Physiology*(flowering, flushing, dormant, stage off-cycle)*

(Sinh lý: ra hoa, xả nước, ngủ đông, giai đoạn kết thúc của chu kỳ)

.....

.....

.....

Inputs *(including types and how and techniques)*

Đầu vào (Bao gồm loại, như thế nào (cách thức) và kỹ thuật)

Fertilizer (Phân bón)

.....

.....

Chemicals *(include what chemicals, who makes the decision and who provides the advice regarding which chemicals and how)*

Hoá chất (bao gồm loại hoá chất gì? Ai đưa ra quyết định và cho lời khuyên liên quan đến loại hoá chất và làm như thế nào?)

.....

.....

Water *(where from and how the water is supplied)*

Nước (Nguồn nước được sử dụng từ đâu và được cung cấp như thế nào?

.....

.....

Labour*(e.g. pruning, bagging other and comment about who makes the decisions)*

Lao động (ví dụ: Cắt tỉa cành, bao trái và nhận xét về người đưa ra quyết định)

……

……

Input / **Product** (đầu vào) / **(Sản phẩm)**	Fertilizer Phân bón	Chemical…… Hoá chất….	Other Khác

Month – March / April

Tháng 3/Tháng 4

Physiology*(flowering, flushing, dormant, stage off-cycle)*

(Sinh lý: ra hoa, xả nước, ngủ đông, giai đoạn kết thúc của chu kỳ)

.....

.....

.....

Inputs *(including types and how and techniques)*

Đầu vào (Bao gồm loại, cách thức và kỹ thuật)

Fertilizer (Phân bón)

.....

.....

Chemicals *(include what chemicals, who makes the decision and who provides the advice regarding which chemicals and how)*

Hoá chất (bao gồm loại hoá chất gì? Ai đưa ra quyết định và cho lời khuyên liên quan đến loại hoá chất và làm như thế nào?)

.....

.....

Water *(where from and how the water is supplied)*

Nước (Nguồn nước được sử dụng từ đâu và được cung cấp như thế nào?

.....

.....

Labour*(e.g. pruning, bagging other and comment about who makes the decisions)*

Công lao động (ví dụ: cắt tỉa cành, bao trái và nhận xét về người đưa ra quyết định)

……

……

Input (đầu vào) / **Product** (Sản phẩm)	Fertilizer Phân bón	Chemical…… Hoá chất….	Other Khác

Month – May / June

Tháng 5/Tháng 6

Physiology*(flowering, flushing, dormant, stage off-cycle)*

(Sinh lý: ra hoa, xả nước, ngủ đông, giai đoạn kết thúc của chu kỳ)

.....

.....

.....

Inputs *(including types and how and techniques)*

Đầu vào (Bao gồm loại, cách thức và kỹ thuật)

Fertilizer (Phân bón)

.....

.....

Chemicals *(include what chemicals, who makes the decision and who provides the advice regarding which chemicals and how)*

Hoá chất (bao gồm loại hoá chất gì? Ai đưa ra quyết định và cho lời khuyên liên quan đến loại hoá chất và làm như thế nào?)

.....

.....

Water *(where from and how the water is supplied)*

Nước (Nguồn nước được sử dụng từ đâu và được cung cấp như thế nào?

.....

.....

Labour*(e.g. pruning, bagging other and comment about who makes the decisions)*

Công lao động (ví dụ: cắt tỉa cành, bao trái và nhận xét về người đưa ra quyết định)

……

……

Input (đầu vào) **Product** (Sản phẩm)	Fertilizer Phân bón	Chemical…… Hoá chất….	Other Khác

Month – July / August

Tháng 7/Tháng 8

Physiology*(flowering, flushing, dormant, stage off-cycle)*

(Sinh lý: ra hoa, xả nước, ngủ đông, giai đoạn kết thúc của chu kỳ)

.....

.....

.....

Inputs *(including types and how and techniques)*

Đầu vào (Bao gồm loại, cách thức và kỹ thuật)

Fertilizer (Phân bón)

.....

.....

Chemicals *(include what chemicals, who makes the decision and who provides the advice regarding which chemicals and how)*

Hoá chất (bao gồm loại hoá chất gì? Ai đưa ra quyết định và cho lời khuyên liên quan đến loại hoá chất và làm như thế nào?)

.....

.....

Water *(where from and how the water is supplied)*

Nước (Nguồn nước được sử dụng từ đâu và được cung cấp như thế nào?

.....

.....

Labour*(e.g. pruning, bagging other and comment about who makes the decisions)*

Công lao động (ví dụ: cắt tỉa cành, bao trái và nhận xét về người đưa ra quyết định)

……

……

Input (đầu vào) **Product** (Sản phẩm)	Fertilizer Phân bón	Chemical…… Hoá chất….	Other Khác

Month – August / September

Tháng 8/Tháng 9

Physiology*(flowering, flushing, dormant, stage off-cycle)*

(Sinh lý: ra hoa, xả nước, ngủ đông, giai đoạn kết thúc của chu kỳ)

.....

.....

.....

Inputs *(including types and how and techniques)*

Đầu vào (Bao gồm loại, cách thức và kỹ thuật)

Fertilizer (Phân bón)

.....

.....

Chemicals *(include what chemicals, who makes the decision and who provides the advice regarding which chemicals and how)*

Hoá chất (bao gồm loại hoá chất gì? Ai đưa ra quyết định và cho lời khuyên liên quan đến loại hoá chất và làm như thế nào?)

.....

.....

Water *(where from and how the water is supplied)*

Nước (Nguồn nước được sử dụng từ đâu và được cung cấp như thế nào?

.....

.....

Labour*(e.g. pruning, bagging other and comment about who makes the decisions)*

Công lao động (ví dụ: cắt tỉa cành, bao trái và nhận xét về người đưa ra quyết định)

……

……

Input (đầu vào) **Product** (Sản phẩm)	Fertilizer Phân bón	Chemical…… Hoá chất….	Other Khác

Month – September / October

Tháng 9/Tháng 10

Physiology*(flowering, flushing, dormant, stage off-cycle)*

(Sinh lý: ra hoa, xả nước, ngủ đông, giai đoạn kết thúc của chu kỳ)

.....

.....

.....

Inputs *(including types and how and techniques)*

Đầu vào (Bao gồm loại, cách thức và kỹ thuật)

Fertilizer (Phân bón)

.....

.....

Chemicals *(include what chemicals, who makes the decision and who provides the advice regarding which chemicals and how)*

Hoá chất (bao gồm loại hoá chất gì? Ai đưa ra quyết định và cho lời khuyên liên quan đến loại hoá chất và làm như thế nào?)

.....

.....

Water *(where from and how the water is supplied)*

Nước (Nguồn nước được sử dụng từ đâu và được cung cấp như thế nào?

.....

Labour*(e.g. pruning, bagging other and comment about who makes the decisions)*

Công lao động (ví dụ: cắt tỉa cành, bao trái và nhận xét về người đưa ra quyết định)

……

……

Input (đầu vào) **Product** **(Sản phẩm)**	Fertilizer Phân bón	Chemical…… Hoá chất….	Other Khác

Month – November / December

Tháng 11/Tháng 12

Physiology*(flowering, flushing, dormant, stage off-cycle)*

(Sinh lý: ra hoa, xả nước, ngủ đông, giai đoạn kết thúc của chu kỳ)

.....

.....

.....

Inputs *(including types and how and techniques)*

Đầu vào (Bao gồm loại, cách thức và kỹ thuật)

Fertilizer (Phân bón)

.....

.....

Chemicals *(include what chemicals, who makes the decision and who provides the advice regarding which chemicals and how)*

Hoá chất (bao gồm loại hoá chất gì? Ai đưa ra quyết định và cho lời khuyên liên quan đến loại hoá chất và làm như thế nào?)

.....

Water *(where from and how the water is supplied)*

Nước (Nguồn nước được sử dụng từ đâu và được cung cấp như thế nào?

.....

.....

Labour*(e.g. pruning, bagging other and comment about who makes the decisions)*

Công lao động (ví dụ: cắt tỉa cành, bao trái và nhận xét về người đưa ra quyết định)

……

……

Input (đầu vào) / **Product** (Sản phẩm)	Fertilizer Phân bón	Chemical…… Hoá chất….	Other Khác

Question: What are the practices that you have the most problems with.?

Câu hỏi: Những công việc trong quá trình thực hành của bạn có nhiều vấn đề nhất?

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……

Question: If you could change one thing to improve your farm what would that be?

Câu hỏi: Nếu bạn có thể thay đổi một số vấn đề để cải thiện trang tại của mình thì đó sẽ là gì?

……

Section IV: HOW THE VALUE CHAIN WORKS
PHẦN IV: CHUỖI GIÁ TRỊ HOẠT ĐỘNG NHƯ THẾ NÀO

(Interviewer - we need to understand how the chain works from harvest to farmgate or pack-house (as applies).

(Người phỏng vấn - chúng ta cần hiểu cách thức hoạt động của chuỗi từ khâu thu hoạch đến nông trại hoặc nhà đóng gói (khi áp dụng).

Including - inputs, methods, financial flow, information flow and decision makers/controllers with in the chain.

(Bao gồm: đầu vào, phương pháp, nguồn tài chính, nguồn thông tin và người ra quyết định/ người kiểm soát chuỗi)

Also, we need to identify any issues that they are having problems with and what they see that needs improving.)

(Ngoài ra chúng ta cần xác định những vấn đề nào mà họ đang gặp phải và những gì họ thấy cần phải cải thiện)

Question Can you describe your harvest process from just before picking to fruit being delivered to the pack-house/sorting.

(Who does this *where does their responsibility start/ finish*)

Câu hỏi : Bạn có thể mô tả quá trình thu hoạch của bạn từ trước khi hái đến khi trái được bắt đầu chuyển đến nhà đóng gói / phân loại

(Trách nhiệm của ai làm việc này khi bắt đầu / kết thúc)

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……

Question: Can you describe the packing/grading procedures (if any) that happen on your farm? If you are not involved who is responsible for this.

Câu hỏi: Bạn có thể mô tả các quy trình đóng gói / phân loại (nếu có) trong trang trại của bạn không? Nếu bạn không liên quan thì ai chịu trách nhiệm cho việc này?

……

……

……

……

(Interviewer – enquire regarding…. (Người phỏng vấn)

- *who decides the grading standards*? (Ai quyết định các tiêu chuẩn phân loại?)

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……

- *Reject rates for what reason, is there fruit that cannot be sold (Tù chối giá bán vì lý do gì? Có trái cây không thể bán được không?)*

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……

- *Who makes the decision for processing grade fruit*? (Ai đưa ra quyết định cho quy trình phân loại trái cây?)

……

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……

Question: From your experience where does the most damage of your fruit happen on your farm? and/or happen to fruit still in your control?

Câu hỏi: Từ kinh nghiệm của bạn, nơi nào trong nông trại làm thiệt hại nhiều nhất trái cây của bạn nhất? và / hoặc xảy ra với trái cây vẫn trong tầm kiểm soát của bạn?

……

……

Question: How do you decide where to send your fruit?

Ask the farmer how often they change and why

Bạn quyết định như thế nào về nơi mình sẽ bán sản phẩm?

Hỏi nông dân về mức độ thay đổi nơi bán và tại sao?

……

……

Do you get feedback from the buyer eg quality, customer needs etc…)

Bạn có nhận được những phản hồi từ người mua hay không? Ví dụ như: chất lượng, nhu cầu của khách hàng,….

……

……

Question: Can you explain how your farming finances work for the payments for your fruit.

Câu hỏi: Bạn có thể giải thích cách quản lý tài chính để nông trại của bạn hoạt động, các khoản thanh toán cho sản phẩm của bạn.

We need to know if money has been advanced for their crop and how and when payment decisions are made.)

Chúng ta cần biết nếu tiền đã được ứng trước cho sản xuất của họ và làm thế nào và khi nào đưa ra quyết định thanh toán)

……

……

……

Question: What is your greatest issue with the current way you harvest and market your fruit?

Câu hỏi: Vấn đề lớn nhất của bạn trong quá trình thu hoạch và việc tiêu thụ sản phẩm hiện tại của bạn là gì?

(finish your section with this question – 'what is keeping them up at night – what are their worries – one question please)

(kết thúc phần của bạn với câu hỏi này "điều gì khiến cho họ mất ngủ- điều gì làm họ lo lắng- hãy hỏi một câu hỏi)

……

Section V: PROCESSING
PHẦN V: SƠ CHẾ/ CHẾ BIẾN

Screening Question (câu hỏi sàng lọc)

PR1: Consider for a moment… the fruit that you can't sell as fresh whole fruit, do you supply these mangoes to a processor? (tick yes or no) **YES**… OR **NO**…. (Stop if NO, proceed to next question if YES)

PR1: Hãy xem xét một chút về sản phẩm mà bạn không thể bán trái tươi, bạn có cung cấp những quả xoài này cho nhà chế biến nào không? (đánh dấu CÓ hoặc KHÔNG) (dừng lại nếu đánh KHÔNG, tiếp tục câu hỏi tiếp theo nếu đánh là CÓ)

(If they supply processing… ask them to describe how this function operates and if they are continuing or not to supply for processing)

(Nếu họ cung cấp cho chế biến, hãy yêu cầu họ mô tả cách thức hoạt động như thế nào và khi họ đang tiếp tục hoặc không tiếp tục cung cấp cho chế biến)

……

……

……

PR2: Can you describe to us the way you engage with a processor who wants to buy your fruit.

PR2: Bạn có thể mô tả cho chúng tôi cách bạn liên lạc với nhà chế biến ai muốn mua sản phẩm của bạn.

(We need to understand how their business model works from theperspective of who is driving supply – ask how the payment system works)

(Chúng ta cần hiểu mô hình kinh doanh của họ hoạt động như thế nào từ góc độ ai đang thúc đẩy nguồn cung - hỏi hệ thống thanh toán hoạt động như thế nào)

……

……

……

PR3 Do you see processing as a viable option for some of your fruit

Level of enthusiasm for processing?

Barriers for sending to processors?

Are they willing to participate in processing activities?

PR3 Bạn có thấy chế biến là một lựa chọn khả thi cho một phầnsản phẩm của bạn

Mức độ thuận lợichochế biến?

Rào cản cho việc bán cho chế biến?

Họ có sẵn sàng tham gia vào các hoạt động chế biến không?

.....

Other Processing comments:

Ý kiến khác về chế biến

……

Section VI: PRICING

PHẦN VI: GIÁ CẢ

Sale prices of mango fruit (giá bán xoài)

Early season (Đầu mùa vụ): ……

Mid-season (Giữa mùa vụ):……

End of season (Cuối mùa vụ):……

Off season (Hết mùa vụ):……

What is your total cost per hectare of mango cultivation?

Tổng chi phí cho một hecta xoài của bạn là bao nhiêu?

……

Do you plan to expand your mango area next year? Bạn có kế hoạch mở rộng diện tích trồng xoài trong năm tới?

☐ No (không)

☐ Yes. If yes. How many more ha Có. Nếu có. Diện tích là bao nhiêu hecta:.....(ha)

Which mango variety? (Giống xoài):.....

Reason (lý do) :…..

Do you have any final comments about mango production to share with us?

Bạn có ý kiến cuối cùng nào về vấn đề sản xuất xoài muốn chia sẻ với chúng tôi?

Sincerely, thank the farmer for their cooperation and time.
Trân trọng cảm ơn quý ông/bà đã bỏ thời gian hợp tác!