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List of Abbreviations

ACIAR	Australian Centre for International Agricultural Research
AIPD-Rural	Australia-Indonesia Partnership for Decentralization – Rural Economic Program
AusAID	Australian Agency for International Development
CAPAS	Centre for Agricultural Policy and Agribusiness Studies, Padjajaran University
CIF	Cost, Insurance, Freight
EU	European Union
FOB	Free on board
HWT	Hot water treatment
MRL	Maximum Residue Limits
NTB	West Nusa Tenggara Province
NTT	East Nusa Tenggara Province
UAE	United Arab Emirates
US	United States of America
VHT	Vapour heat treatment

Preface

This report titled *Eastern Indonesia Agribusiness Development Opportunities (EI-ADO)- Analysis of Mango Value Chains* [1] was prepared by the Collins Higgins Consulting Group Pty Ltd as commissioned by the Australian Centre for International Agricultural Research (ACIAR). The information and recommendations from this study will inform AusAID in the design of the Australia Indonesia Partnership for Decentralisation – Rural Economic Development Program (AIPD-Rural).

The report involved the analysis of secondary data, field trips and key informant interviews with stakeholders in the mango value chain of Eastern Indonesia. The field work for the report was carried over the month of September 2012.

The author of the study is Tiago Wandschneider, with extensive support provided by and Ian Baker and technical input from Ronnie Natawidjaja and Teddy Kristedi. Environment and gender inputs were overseen by Emmanuel Santoyo Rio. Field support and data collection was provided by Gamal Pratama, Putu Cakra and Pak Harris.

Thanks must go to: the interviewees and industry stakeholders who generously gave their time to answer questions; and to ACIAR and AusAID for inputs and comments in framing the report.

The views expressed in this report are those of the authors and do not necessarily reflect the views of the Collins Higgins Consulting Group, ACIAR or the Governments of Australia or Indonesia.

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Executive Summary

Introduction

This study was conducted to inform the design and implementation of pro-poor interventions in the mango value chain under a new AusAID program: the Australia-Indonesia Partnership for Decentralisation - Rural Economic Program, or AIPD-Rural. A wide range of issues deemed important for an understanding of the structure, conduct and performance of mango value chains, and their potential as vehicles for poverty reduction, are covered. Value chain constraints and upgrading opportunities are analysed. Entry points for pro-poor chain innovation with strong private sector involvement, potential impacts from different interventions, and targeting strategies are discussed. Gender and environmental impacts from value chain upgrading processes are highlighted.

Indonesia's position in global production and trade

Representing approximately 40% of global production, India is the world's leading mango producer, followed by China, Thailand and Pakistan. Despite strong growth in the international mango trade, over 95% of mangos produced are consumed domestically. Mexico has been the leading mango exporter for decades, followed by India. Whilst the United States is the leading importer of mangoes, the EU now represents the primary export destination. The Gulf States constitute the third largest export market. In East and Southeast Asia, five countries account for the bulk of imports: Malaysia, Hong Kong, Singapore, Laos, and Japan.

Indonesia is the sixth largest mango producer in the world. The country has a very marginal presence in the international market, however, despite some favourable export development conditions which includes an abundant and very cheap supply of mangoes in October and November - a period when other Asian countries have little local production and limited access to alternative sources of supply. Exports account for only 0.1% of domestic production. Singapore remains the main destination market for Indonesian mangos, followed by the UAE. Occasionally, some mangoes are exported to Malaysia and Hong Kong.

A dependency on expensive air transportation constitutes a major barrier to the development of mango exports. Exporters have so far failed to capitalise on sea freight opportunities because they lack the required knowledge around post-harvest technologies which would preserve fruit quality.

The international mango trade is based on yellow- and red-skin varieties. The fact that Arumanis, the main commercial variety in Indonesia, has green skin when ripe is often perceived as a major reason why mango exports have not developed. The research team considers that this has been overstated.

Indonesian mango imports are also very small. Between 800 and 1,100 tonnes per annum are imported during the off-season months, mainly from Thailand and South Africa. Demand for imported mangoes is very small as a result of high prices and consumers' preference for local varieties.

Production

Most mangoes are harvested in October and November. NTB has a late harvest. In parts of Western and Central Java, many farmers have successfully adopted crop manipulation technologies which have delivered an early harvest between May and July. A main harvest follows in October and November.

Over the past decade, production increased at an annual average rate of nearly 5%, peaking in 2009 at 2.2 million tonnes. Between 2003 and 2007, growth was driven by an expansion of area, but more recently productivity gains have become a more important driver. Mango yields in Indonesia are high by international standards: the country has relatively favourable natural conditions for mango cultivation and several resilient and productive cultivars.

Mango cultivation is concentrated along the northern coastal areas of Java, which accounts for over two-thirds of national production. While East Java has traditionally been the centre of mango production, its dominance is being slowly eroded following an expansion of planted areas in other parts of Java and other islands.

Production systems

Mango is a smallholder crop. The vast majority of mango farm households own or manage less than 100 trees, i.e. less than 1 hectare. In Java, tree ownership provides an incomplete picture of the size of mango farms, as the renting of trees is widespread, especially in the western and central parts of the island. In a context where land is scarce and expensive, this has enabled many farmers (and traders) to develop and expand mango cultivation. In North Lombok, the renting of mango trees is rare.

Arumanis, a highly productive cultivar that enjoys strong market demand, is the dominant variety in Indonesia. Most Indonesian consumers appreciate its large size, nice aroma, firm flesh, low fibre content, and sweetness. This variety fetches the highest prices, after Gedong Ginku.

Mango cultivation is undergoing a process of commercialisation, characterised by increased use of external inputs. This process is most advanced in West and Central Java. NTB is at the opposite end of the commercialisation spectrum, with mango farmers making very limited use of external inputs in the production of their crops.

Fertilisers are being applied following local norms, without sufficient understanding of mango nutrition and soil composition. In East Java and NTB, the mango research team also saw many orchards where trees had not been pruned and were too large for effective spraying and harvest. Correct pruning positively influences fruit yield and size.

Farmers consistently named pests and diseases as the second most important issue of concern, after low prices. Spraying is the most common control strategy. In Cirebon and Pemalang, most spraying is undertaken to protect the early, high-value mango crop. In East Java, the use of fungicides and insecticides is becoming more common. By contrast, in NTB, very few farmers apply insecticides and fungicides, despite availability of a broad range of relevant chemicals in local stores.

Key knowledge gaps on agro-chemical use, and some alternatives to spraying, including fruit bagging and systemic insecticides, were identified. While serious concerns have been raised about the environmental impacts of systemic insecticides, it

is unclear whether these pose greater risks to the environment and human health than the intensive spraying programs currently carried out in Cirebon or Pemalang.

In these two districts, many farmers are successfully manipulating flowering for early-season production. This has had very significant impacts on farm profitability, on-farm wage employment, and tree rental values. In Situbondo and Probolinggo, some farmers have been using a growth regulator, but only to improve fruit yields during the main season and not as part of an off-season strategy, as they lack the necessary knowledge to control pests and disease during first flowering. The study team also came across many cases of misuse of Paclobutrazol in those two districts. These examples illustrate the challenges associated with adoption of new technologies in contexts where farmers have poor technical knowledge and very limited access to appropriate advisory services.

Processing

The Indonesian mango processing industry is still at a very embryonic stage. Cirebon in West Java and Kediri in East Java have the largest number of processors. These are small, home-based enterprises.

In Indonesia, mangoes are mainly consumed as fresh fruit or fresh juice. Some dried mango, mango candy, and other mango-based products can be found in urban shops and supermarkets, but in very small volumes. These are often imported. Several brands of locally produced mango juice can be found in shops and supermarkets, but the local product content is minimal.

Limited domestic demand is certainly an important, but not the only, factor hindering the development of a mango processing industry. Supply-related factors also play an important role. These include short harvesting seasons, poor product development and marketing expertise, financial constraints, difficulties by small enterprises to break into the modern retail segment, and strong competition from imports.

Consumer preferences

Indonesian consumers show a marked preference for large and sweet mangoes with nice aroma, firm flesh, and little fibre content. The Arumanis variety possesses all of these traits. Consumers appreciate mangoes that are harvested ripe, but these are very expensive due to high production and marketing risks. As a result, mangoes are normally harvested and retailed while still green. Contrary to other countries, Indonesians have no strong preference for yellow- or red-skin mango. Furthermore, most consumers are not particularly bothered about skin blemishes or marks. At present, the average Indonesian consumer is not particularly demanding as far as fruit quality is concerned: price is still the main determinant of mango purchasing choices.

Prices

Low prices during the peak harvesting season are the main issue of concern for farmers. In the context of an expanding volume of production, mango farm households are likely to continue experiencing very low prices during the peak harvesting months, unless significant changes in seasonal supply patterns and exports take place.

Mango prices follow a U-shaped curve, with a clear dip in October and November, when the market is literally flooded with mangoes. In mid- to late November, as the Java harvest is coming to an end, prices start rising. At this time, mangoes from Bali and NTB are exported to Java.

The fresh mango value chain in Situbondo

Mango value chains in Situbondo are structured and organized according to spatial product flows. Village collectors and district wholesalers are key actors in intra-district chains, but play a marginal role in longer, inter-provincial chains, where the product collection and assembly functions are mainly performed by larger village or sub-district traders. Improvements in local production and marketing systems will have to be driven by developments in chains linking farmers to markets. Intra-district chains absorb small volumes of lower-quality fruit, thereby offering limited upgrading opportunities.

Mango growers in Situbondo have good physical access to inputs. These are typically purchased by men. Prompt payment is the norm. Chemical companies do not regard mango farmers as an important potential market and have therefore focused their extension efforts on other crops. As a result, their staff lack the necessary technical expertise to promote specific product solutions for mangoes. Knowledge flows along the mango input distribution chain are very limited.

Mango farm households either sell the fruit on their trees or rent the trees out to others. Many farmers selling their own fruit belong to groups, which have been formed around the delivery of extension services and financial assistance from the government. These groups have little chances of evolving into successful collective enterprises, but provide a good entry point for an upgrading of production and marketing systems.

The research team found no evidence of significant credit flowing from local traders to farmers. This finding is consistent with those of other similar studies. Mango growers also have limited (if any) access to technical information from traders. Farmers reportedly learn from each other, but the knowledge base sustaining such interactions is generally poor.

Village traders in Situbondo typically have close links to wholesalers in urban markets across Java, from whom they receive seasonal advances. Village traders are responsible for sorting, grading, and delivering the fruit. Transactions are coordinated by phone. For reasons discussed in the report, the distribution of power between village traders and wholesalers is rather balanced.

Trading enterprises with their own premises outside markets also perform wholesaling functions. These enterprises do not differ much from more traditional wholesalers in their procurement systems and the financial services provided to suppliers, but tend to have stricter quality requirements.

Most mangoes from Situbondo are sold through traditional retail outlets. Despite its strong growth, the modern retail sector still accounts for a fairly small share of the mango market (an estimated 5% for Java). Prices and cultural factors help explain the dominance of traditional markets.

Modern retailers are less engaged with upstream chain actors than traditional wholesalers, providing no supplier credit. They have stricter quality standards than

traditional channels, but do not engage with suppliers to help them meet those standards. The relationship with suppliers is governed by written contracts with clear rules and sanctions for non-compliance.

The fresh mango value chain in North Lombok

Farmers in North Lombok sell their mango fruit on the tree to local collectors. Provision of input credit, cash loans, or technical information by collectors is limited.

The passivity of mango chain actors in North Lombok cannot be overemphasised. Mangoes are not managed as a commercial crop. Neither farmers nor collectors are pursuing intensification strategies or renting trees to expand farm size. Very low prices at harvest time are a major contributing factor. In addition, both farmers and collectors lack an understanding of technical upgrading options and the potential impacts of different innovations on the profitability of mango farming.

Most of the mango harvest from North Lombok is channelled to Java and Bali. The quantities retailed within the districts and provinces are small by comparison. Seasonality is the main factor driving inter-island trade. Visiting traders from Java and Bali account for most of this trade. They provide working capital funds to local collectors - their main strategy for securing product, and sort and grade the fruit themselves.

Quality management systems

Sorting and grading of mango fruit is normally done at the local assembly, wholesaling, and export stages, according to buyer specifications. The evidence gathered suggests that at least some farmers are aware of the proportion of different grades of mango in their supply and are likely to use this knowledge in negotiations with buyers.

Indonesian mango chains are characterised by fairly unsophisticated quality management systems. Adoption of post-harvest dip treatments could impact positively on export, modern retail, and inter-island chains, but traders are unfamiliar with these technologies. Post-harvest washing of fruit to prevent sap flow would also improve the quality of mangoes sold through higher-value channels, but both farmers and traders are unaware of this simple technology. Compression and rub marks could be significantly reduced through the use of single-layer cartons during transportation, but at present only higher-income consumers buying from modern retail outlets seem able or willing to pay for high packing costs.

Despite poor quality management systems and a high incidence of fruit flies and rotting diseases, physical losses within Java are relatively small. This is because value chains are organised to ensure that mangoes reach consumers soon after harvest, before these issues become a serious problem.

Chain constraints

Poor technical knowledge at each stage along the chain was identified as the most important barrier to pro-poor innovation in the Indonesian mango sub-sector. Poor knowledge of: crop manipulation for early-season production, mango cultivation more generally, and post-harvest dip treatments for addressing pest and disease problems were identified as particularly serious gaps.

While financial constraints and limited risk-taking capacity reduce the ability of many mango farm households to intensify production, low prices during the peak mango season and poor technical knowledge are considered more important factors.

Exporters also face a number of constraints in addition to poor technical knowledge in the post-harvest sphere, including poor quality management at farm level, lack of market access protocols with some Asian countries, and a lack of business linkages beyond current markets. Addressing these barriers without first developing the necessary expertise to manage fruit quality at the post-harvest level will have limited impact. Variety is another factor constraining export growth, with Arumanis not favoured by consumers in other countries due to its green skin. However, the study team sees considerable scope for growth in exports of Arumanis through improvements in quality management systems and a shift from air to sea freight.

A discussion on value chain constraints would be incomplete without mention of the numerous challenges and barriers that mango processing enterprises face. These include poor product development and marketing expertise, financial constraints, a short peak mango season, a relatively limited domestic demand for processed mango products, and strong competition in domestic and international markets.

Market-based Value Chain Development Opportunities

1. Early-season cultivation

Adoption of early-season production technologies provides the most obvious opportunity for increasing the incomes of mango growers in districts such as Situbondo and North Lombok. While presenting some challenges, these technologies are relatively affordable and within the reach of many mango farm households.

With appropriate support, 3,000 small growers in Situbondo and North Lombok, managing an area of 1,000 hectares, could realistically adopt off-season cultivation technologies successfully within five years. This would generate an estimated US$ 2 million in additional net farm income per annum (US$ 650 per household). These projections exclude wage employment impacts from more intensively-managed mango farms. Tree rental values would also increase if large numbers of farmers within an area develop more profitable early-season mango cultivation. An increase in market prices is, however, unlikely as this would require a systemic shift in seasonal supply curves, which cannot be achieved through intervention in just a few project districts.

AIPD-Rural should partner with local traders and selected agro-chemical companies for implementation of participatory and iterative farm demo-trials targeting small and medium mango growers. Complementary interventions include exchange visits to West and Central Java and the development of relevant information products. Proposed interventions are knowledge-intensive and have a strong learning component: strong input from outside experts is therefore required.

2. Export development

Export development can drive improvements in farm productivity and profitability and generate on- and off-farm employment. A series of interventions in export chains are proposed, including the transfer of post-harvest technologies, sea-freight trials, exporter visits to trial markets, product promotion in target markets, the testing of

consumer responses to Arumanis and Gedong Ginku, and the sharing of initial risks associated with a transition to sea freight. The emphasis on sea freight is justified by its potential impacts on export volumes and profits along the chain.

3. Upstream development of export and other quality chains

Upgrading the quality management systems at the farm level can deliver significant income benefits to mango growers through higher yields and prices, while also generating on-farm employment opportunities. AIPD-Rural is well positioned to address critical knowledge gaps in the cultivation sphere and link participating farmers to quality-conscious buyers, through village traders.

The proposed interventions ensure that upstream impacts from export development flow to target project beneficiaries. Impacts should not be confined to the export chain, as exporters also supply the modern retail segment and inter-island markets. Farmers could also be linked (through local traders) to “modern” wholesalers that do not export, but have an interest in accessing quality mangoes.

There is scope for the involvement, as partners, of village traders and modern wholesaling/exporting enterprises in project interventions. This includes participatory demo-trials and trainings for testing and promotion of on-farm technologies and practices, development of linkages with exporters and other premium buyers, and information products developed in collaboration with selected agro-chemical companies.

4. Processing

The development of a mango processing industry at scale would help address the main issue of concern to value chain actors, i.e. depressed prices during the main season, while also generating employment opportunities, especially for women. However, while small mango processing groups may generate interesting income opportunities for members, the mango study team does not see potential for leveraged impacts from interventions supporting the development of such enterprises. Likewise, the successful development of larger processing businesses may generate some jobs, but this sector is unlikely to reach a scale where systemic price effects can be envisaged, at least in the foreseeable future. Still, AIPD-Rural could consider supporting existing or new ventures with a view to encourage replication or crowding-in. Such interventions should focus on addressing key capacity gaps within target firms.

Poverty

Mango development processes in districts such as Cirebon and Pemalang show that mango can be a vehicle for poverty reduction and improved rural livelihoods. Situbondo and North Lombok, however, present a very different picture. Mango farm households in these two districts could earn significantly higher incomes from mango if they were able to replicate the experience of Cirebon and Pemalang growers.

Situbondo has a dualistic mango sector, with some medium-size and a few large producers and a vast majority managing a small number of trees. AIPD-Rural strategies will need to ensure that small mango growers with a commercial orientation, rather than medium or large renters, are the main beneficiaries of project interventions.

North Lombok has a fairly dry climate and limited irrigated land. Farmers in the district enjoy few livelihood diversification opportunities. In the main mango production areas, the crop accounts for a significant share of agricultural land. The local context in North Lombok is particularly challenging, especially in low-lying areas along the coast experiencing acute fruit set failure. AIPD-Rural could consider funding research aimed at identifying the source of the problem here, while at the same time supporting a shift to early-season cultivation in other parts of the district.

Gender

The mango farming landscape is dominated by men. Women's participation in the mango value chain is largely confined to the traditional retail trade. While the development of processing activities would create employment opportunities for women, the research team is somewhat sceptical about the medium-term prospects for the mango processing sector. An upgrading of quality management systems along export and domestic chains offers greater employment opportunities for women, as many of the enterprises supplying higher-quality markets employ female labour.

Environment

Given their deep roots and perennial nature, mango trees provide an effective barrier against soil erosion, especially on sloped land. The pruning of mango trees produces wood that is often used for fuel and other purposes. Conversely, the continued use of wooden crates for packaging mangoes, which are used only once and consume a lot of timber, presents an issue that is difficult to resolve.

Much lower levels of fungicides and insecticides are applied to mangoes than to crops such as vegetables. However, in areas characterised by more intensive cultivation systems, such as Cirebon and Pemalang, the use of chemicals is a problem for the environment and humans. By encouraging farm intensification, the proposed interventions could have some negative impacts on the environment and human health. Some of the technology options presented, however, particularly fruit bagging, would significantly reduce farmers' need to rely on chemicals to manage pests and diseases. Soil-applied insecticides are less benign, but their impact on the environment and human health needs to be better understood and compared with the impact of conventional fungicides and pesticides. Interestingly, research at University Mataram (UNRAM) is looking at Paclobutrozol as an adaptive strategy for climate change.

Research Gaps

Further research is needed on many areas covered in this study. For example, there is a need for a better understanding of varietal performance under sea-freight conditions, the response of consumers in different export markets to sea-freighted mangoes, the commercial shelf-life of the fruit, the economics of sea-freight shipments, and export opportunities and access barriers in different markets.

Much emphasis is given in this study to on-farm technical innovations for early-season production, improved productivity, and an upgrading of fruit quality. Research in different provinces is needed for fine-tuning technologies and management practices, identifying those that can deliver maximum benefits to farmers, and assessing their socio-economic feasibility.

Much can be learned about these issues during AIPD-Rural intervention processes, which should have a strong learning and adaptation element. ACIAR could also consider addressing some of these issues in future research-for-development projects.

Current knowledge about varieties is very poor. Not enough data is available to determine the opportunity to introduce Gedong Ginku in East Java. New yellow- and red-skin varieties are being promoted without sufficient understanding of their agronomic performance in different regions, response to Paclobutrozol and post-harvest treatments, shelf-life, and acceptability in domestic and export markets.

Little research has also been conducted on the processing sector. In-depth case studies and research on domestic markets would provide a better understanding of sector performance, as well as constraints and development opportunities.

Four other research gaps are discussed in the main report. First, more farm and chain margin data through structured surveys would complement and improve the findings from the current study. Second, a better understanding of incentives for quality upgrading at the farm level is required in light of the proposed interventions. Third, more information about modern wholesalers and exporters is necessary for identification of potential AIPD-Rural partners in the private sector. Finally, data on cultivated areas in project districts and the number of mango farm households across different size categories is needed for a more rigorous assessment of the impact potential of different interventions and the design of targeting strategies.

1 Introduction

This study was conducted in the context of EI-ADO Project – Analysing Agribusiness Development Opportunities in Eastern Indonesia. This is a project funded by the Australian Agency for International Development (AusAID), managed by the Australian Centre for International Agricultural Research (ACIAR), and implemented by Collins Higgins Consulting. Its aim is to identify agricultural commodity value chains and private sector agribusiness development opportunities with the most potential to increase incomes of poor men and women, not just farmers, in East Java, West Nusa Tenggara (NTB), and East Nusa Tenggara (NTT).

EI-ADO comprises a number of research activities. A prioritisation of commodity value chains based on a wide range of socio-economic criteria and the perceived opportunity for pro-poor chain upgrading and growth was carried out during the first six months of 2012. Five agricultural chains were selected for research. Mango was one of them. The five value chain studies will be completed by July 2013. Complementary research on poverty, gender, and environmental issues is also underway. A comparative analysis of key findings and recommendations from all chain studies will be finalised by November 2013.

EI-ADO research outputs will inform value chain interventions under a new AusAID program: the Australia-Indonesia Partnership for Decentralisation - Rural Economic Program, or AIPD-Rural. The goal of this program is to increase the incomes of more than one million poor male and female farmers in 20 districts of four provinces across Eastern Indonesia by 30%. This is to be achieved through better farm practices, better access to input and output markets, and a more enabling agribusiness environment, all of which are critical to improvements in farm profitability and value chain competitiveness. AIPD-Rural is particularly interested in partnering with the private sector for the design and implementation of value chain interventions.

The research is also of interest to ACIAR. There is growing recognition within the organisation of the importance of embedding agronomic research within market and value chain development frameworks and processes. These linkages are regarded more and more as critical for enhancing the relevance and impact of research-for-development efforts. EI-ADO value chain studies can make a contribution to this process. The studies will generate insights about knowledge gaps in the production and post-harvest spheres and provide an improved understanding of the incentives for pro-poor technology, product, and process upgrading in agricultural value chains. These insights can be used to inform the development of agricultural research priorities and activities in Indonesia that take into consideration market and value chain development processes and opportunities.

1.1 Study Team

The core study team was composed of two value chain specialists and one mango expert. Tiago Wandschneider, the International Value Chain Specialist, acted as Team Leader. Ian Baker, a professional with over 30 years of experience in the Australian mango sector as a researcher and farm manager, joined the team as International

Commodity Specialist. Ronnie Natawidjaja, a researcher from the Centre for Agricultural Policy and Agribusiness Studies (CAPAS) at Padjajaran University was the National Value Chain Specialist.

Three Field Coordinators provided invaluable assistance during the planning and preparation of the field work. Haris Fradilla assisted the team in Jakarta, West Java and Central Java, Gamal Pratama in East Java, and Putu Cakra in NTB. Teddy Kristedi participated in the key informant interviews in Java.

1.2 Study Objectives

The current study provides a description and analysis of mango value chains in two AIPD-Rural target districts: Situbondo, in East Java, and North Lombok, in NTB. The information and analysis presented are used as the basis for a discussion of possible entry points for pro-poor chain upgrading, the potential income impacts associated with different interventions, and targeting issues.

The analytical framework adopted, the research methods employed, the areas visited during the field work, and the structure and content of the report reflect the two study objectives. The first is to inform value chain upgrading interventions by AIPD-Rural with potential to improve the incomes of resource-poor households, ideally with strong private sector involvement. The second is to inform ACIAR's research-for-development priorities and activities in the Indonesian mango sub-sector.

1.3 Analytical Framework

The M4P tool book for practitioners of value chain analysis, "Making Value Chains Work Better for the Poor" (M4P, 2008), was used as the main reference for the development of the analytical framework that guided this and other EI-ADO value chain studies. A selective approach to data collection and the choice of tools and methods for data analysis was followed, taking into consideration the resources and time allocated to the studies.

The current study covers a wide range of issues deemed important for an understanding of the structure of mango chains, their conduct and performance, as well as their potential as a vehicle for poverty reduction. Emphasis is given to the constraints faced by farmers and other chain actors, and the opportunities available to them, in the wider context of the mango sub-sector and its position in the international trade.

The following are some of the key areas and issues covered:

- Indonesia's position in the global mango trade;
- Mango production systems;
- Domestic demand conditions;
- Exports and imports;
- Price trends and seasonality;
- Spatial product flows and market channels;

- Roles and functions performed by different chain actors;
- Vertical chain linkages, with an emphasis on information, knowledge and financial flows;
- Post-harvest quality management systems;
- Chain governance, i.e. the norms underlying market transactions and the sanctions and rewards (or incentives) for compliance with buyer standards;
- Key constraints faced by farmers, local traders, and other chain actors; and
- Opportunities and incentives for systemic, pro-poor chain upgrading.

In presenting the analytical framework that guided this study, it is important to highlight three cross cutting themes: poverty, gender, and the environment. AIPD-Rural has been developed to promote pro-poor outcomes and impacts that benefit both men and women, without compromising the natural resource endowments available to future generations. These three themes are also present in ACIAR's research-for-development work. AusAID and ACIAR therefore have a strong interest in understanding current and potential impacts of value chain development processes on resource-poor households, men and women, and the environment. There is a particular interest in the identification of strategies and interventions that have the potential to enhance the position of the poor and women within agricultural chains and mitigate or address any possible negative environmental impacts.

While short-duration value chain research exercises cannot provide an in-depth understanding of such broad and complex themes, the present study does shed light on some important issues and questions. For example, farm size, farm income, and farm employment data are presented. The lack of participation of women in production and the first stages in the chain is highlighted. Trade-offs between farm profitability and poverty reduction, on the one hand, and the environment and human health, on the other, are raised. Finally, the analysis on proposed interventions includes some assessment of the potential for involvement of resource-poor households, as well as a discussion of gender-related implications and some possible positive and negative environmental impacts. A parallel study on poverty, gender, and the environment will shed further light on gender and environmental issues.

Finally, a presentation of the analytical framework would be incomplete without some considerations about cost and margin analysis. This is a critical ingredient in value chain research, and one that was discussed at some length during the design and planning of the value chain studies. Analysis of costs and margins along whole product chains provides valuable quantitative evidence about key chain dimensions, which can then be used to guide public policy and other interventions. For example, much can be learned about the significance of different marketing cost components, the efficiency of the marketing system, the distribution of value or benefits along the chain, the profitability of different production strategies and market channels, and opportunities for efficiency gains and value creation.

These considerations notwithstanding, there was a consensus amongst all the parties involved in the design and planning of the value chain studies that not enough time and resources were available for collection of detailed price and cost data along whole

agricultural chains. Yet, this was not the only reason why the mango research team was unable to collect sufficient data to estimate marketing costs, and gross and net marketing margins, along the mango chain. The timing of the field work was a key constraint. Situbondo and North Lombok were visited in September, before the mango harvesting season. None of the farmers interviewed had started harvesting their crop at the time of the field visits.

It soon became evident, moreover, that collection of reliable price data was a rather complex exercise due to wide variations in fruit quality and prices at any given point in time, even within the same market channel, and the fact that mangoes from Situbondo and North Lombok are transported over long distances, within a short time, and to markets characterised by significant short-term price volatility. In order to produce a meaningful snapshot of margins practised along the chain, data collection teams would have to follow fruit consignments from farms in Situbondo and North Lombok to key destination markets, such as Jakarta. Clearly, this was not possible in the context of this study.

1.4 Study Methodology

A review of existing studies, reports, and government statistics was carried out early on during the research process to take stock of current knowledge and information, identify data gaps, and inform the choice of field work locations and sampling decisions. Secondary data and information were further reviewed during the report writing stages to support the analysis and findings.

Qualitative methods were employed for collection of primary data:

- *Focus group discussions* with farmers and traders and individual *semi-structured interviews* with chain actors and some knowledgeable observers were carried out. Checklists were used to guide the discussions with different categories of key informants (see Annex 2). The checklists were modified slightly during the initial field work stages, as some of the issues listed were not so relevant in the context of mango value chains. The research team also realised very early in the process that the checklists were too ambitious in terms of scope and depth of probing.

- *Direct observation* methods were employed during visits to villages, enterprise facilities, markets, and modern retail outlets. Much was also learned from simple observation: for example, about the scale of trading businesses, the functions performed by different chain actors, the participation of men and women at different stages in the chain, or the quality of mango fruit sold in traditional markets and modern retail outlets. In addition, spot price data in the modern retail segment was gathered from observation.

The mango research team also developed a short *structured questionnaire* for collection of farm price and cost data from some of the farmers participating in focus group discussions (see Annex 3). Market price data for several years was collected from the Management Board of Kramatjati Market, the main wholesale distribution centre for fruits and vegetables in Jakarta.

Triangulation and direct observation methods were employed to cross-check the quality of the data collected and evaluate the views expressed by key informants. Secondary sources were also used to assess the validity of primary data collected during the field work.

1.5 Choice of Study Districts

Given the limited time available for field work, it was decided that only one AIPD district in East Java and one AIPD-Rural district in NTB would be selected for assessment of local mango chains. The option of also covering one district in NTT was considered but soon discarded because mango cultivation is less important in this province than in East Java or NTB, and because the team faced acute time constraints.

In East Java, Situbondo was selected for research, as it is by far the largest mango producer amongst all four AIPD-Rural target districts in the province (see Table 1). Similar considerations led to the choice of North Lombok as the focus district in NTB (see Table 2). Situbondo ranks eleventh amongst 29 districts of East Java in terms of mango production. North Lombok is the third largest mango producing district in NTB, after Greater Sumbawa and East Lombok. The district also enjoys the most favourable agro-climatic conditions for mango cultivation across Lombok Island. It is known as the area that produces the best-quality mangoes and the main source of supplies for Bali and Java.

Table 1 Mango production (tons) in East Java by district, 2006-09

	2006	2007	2008	2009	Average 2006-09
Sumenep	86,401	58,000	65,174	92,229	75,451
Kediri	93,551	50,963	88,628	56,088	72,208
Probolinggo	36,322	62,715	38,945	80,943	54,731
Pasuruan	52,127	39,430	44,062	78,614	53,548
Bondowoso	41,476	49,000	39,266	59,773	47,379
Ponorogo	14,361	58,364	46,077	64,873	45,919
Madiun	35,543	25,123	40,046	77,031	44,436
Bojonegoro	32,568	36,610	22,533	24,032	28,936
Tuban	35,689	32,500	27,755	16,524	28,117
Mojokerto	31,865	35,948	16,414	23,648	26,969
Situbondo	16,550	20,956	43,629	14,683	23,955
Banyuwangi	23,280	19,132	25,028	25,321	23,190
Bangkalan	18,774	23,650	26,167	15,891	21,121
Gresik	19,560	18,298	25,592	13,536	19,247
Sampang	20,094	22,000	10,078	2,953	13,781
Trenggalek	9,366	15,500	5,717	3,924	8,627
Malang	6,132	8,125	4,192	7,899	6,587
Other districts	118,576	152,928	151,978	189,003	153,121
East Java	692,235	729,242	721,281	846,965	747,431

Source: Department of Agriculture of East Java Province

Table 2 Mango production (tons) in NTB by district, 2007 and 2009

	2006	2007	2008	2009	Average 2006-09
Great Sumbawa	15,053	19,229	14,478	27,954	17,656
West Lombok (including current North Lombok)	12,090	23,976	13,871	19,966	14,279
East Lombok	17,540	24,618	8,417	14,456	13,341
Bima	8,134	14,650	6,870	14,222	7,787
Bima Town	5,717	4,522	6,246	9,606	7,251
Central Lombok	3,307	7,960	7,146	7,978	5,089
Mataram City	2,608	3,481	1,935	817	3,107
West Sumbawa	1,942	2,754	1,160	2,807	1,848
Dompu	667	1,826	1,198	1,553	1,790
NTB province	31,865	35,948	16,414	23,648	26,969

Source: NTB Agricultural Office, in Suudi et al, 2010

The research team also visited three other production districts: Cirebon, in West Java, Pemalang, in Central Java, and Probolinggo, in East Java. In Cirebon and Pemalang

many mango growers are taking advantage of off-season opportunities. Located just next to Situbondo, on the way to Surabaya, Probolinggo is well known across Indonesia as a mango production and marketing centre. Contrary to initial expectations, however, Probolinggo and Situbondo do not differ much in terms of production and marketing systems. The research team also expected Probolinggo to play an important role as a distribution centre for Situbondo mangoes, but this assumption proved incorrect. Most of the harvest in Situbondo is channelled directly to urban centres within and outside the province by village traders.

Visits to these three districts provided a broader perspective on production and marketing systems in Java and critical insights regarding opportunities for developing early-season cultivation, processing, and exports. However, they reduced the time available for interviews in the two focus districts. The research team would have benefited from more time in Situbondo and North Lombok.

1.6 Field Work

The field work was carried out in September 2012 (see Annex 1). Twenty-six days were spent in Java and NTB, including four days travelling from one location to another.

The first four days were allocated to Jakarta, where the team interviewed a senior officer from the Directorate General of Horticulture (Ministry of Agriculture), a large fruit exporter, staff from two supermarket chains, one multinational agro-chemical company, and two large wholesalers in Kramatjati market. A senior researcher from Bogor University was interviewed on the way to Bandung. The purpose of these first discussions was to develop an initial perspective on government strategies and policies, constraints and opportunities along the mango chain, and the linkages between Situbondo and North Lombok and national markets.

The team then travelled to West and Central Java. Six days were spent in Bandung, Cirebon and Pemalang meeting farmers, traders, supermarket suppliers, exporters and processors, as well as one input distributor and one input retailer. During these interviews the study team confirmed that early-season mango cultivation is both technically feasible and very profitable. Interactions with exporters validated another key research hypothesis, i.e. that current weaknesses in post-harvest quality management systems constitute a major barrier to the development of mango exports from Indonesia. As a result, opportunities to scale-out successful, off-season mango cultivation systems and to develop a competitive mango export sector became two key focal points in subsequent interviews.

Situbondo and Probolinggo were the two next destinations. The research team spent six days in the two districts interviewing input dealers, farmers, plantation managers, traders, processing enterprises, and government officers. Some traders interviewed had some experience supplying modern retailers and export markets. With the benefit of hindsight, more time should have been allocated to interviews in Situbondo, at the expense of Probolinggo.

Two days were spent in Surabaya, Indonesia's second largest city. These interviews with market actors provided important insights about wholesale and retail trading systems.

The last week of fieldwork was spent in Mataram and North Lombok. In Mataram, the research team held a very informative working session with university and BTPT researchers who were involved in a recent ACIAR mango project. The Head of the provincial Dinas Pertanian, one input dealer, several wholesalers and inter-island traders, and two traditional retailers were also interviewed. The team visited the local Hero store, the only supermarket outlet in the entire province, and interviewed its main supplier of mango fruit.

In North Lombok, most of the time was spent interacting with input dealers, farmers and collectors. The team did hold several discussions with one potential exporter and a joint meeting with three of her staff and one BPTP researcher. The exporter in question participated in an ACIAR-funded export trial to Hong Kong, after which she initiated a collaborative venture with two mango collectors in North Lombok with the aim of developing the supply of quality fruit for that market. Unfortunately, the team could not meet inter-island traders from Bali and East Java who only visit North Lombok during the mango harvesting season. These traders are the main link between local farmers and outside markets.

The number and location of key informants interviewed is presented in Table 3. In total, the team conducted seven focus group discussions with farmers and traders, 20 structured interviews with individual producers, and 72 semi-structured interviews with chain actors and knowledgeable observers.

Report Structure

This report is structured in seven sections. Following this introduction, section 2 describes the overall sub-sector context and situation. This is the longest section in the report. It covers different sub-sector dimensions and includes data and analysis that is critical for a proper understanding of mango markets, value chain upgrading opportunities, and the constraints hindering pro-poor, systemic innovation. Much of the evidence supporting the research team's recommendations for intervention is presented in this section. It is shown, for example, that successful adoption of crop manipulation technologies in Central and West Java has had a huge impact on the profitability of local mango farms; that critical knowledge gaps in the post-harvest sphere pose a significant constraint to the development of exports; that the modern retailing segment is too small and disengaged from upstream chain actors to drive systemic change in the mango sub-sector, at least in the foreseeable future; and that the processing sector has not developed because some fundamental conditions for its competitiveness are missing.

Table 3 Summary of key informants

	Input suppliers	FGD	Producers	Traders	Retail	Processor	Research	Government	Total
Jakarta	1			4	2			1	8
Bogor							1		1
West Java									
Bandung				2		1			3
Cirebon	1		1	3		1			6
Central Java									
Pemalang	1	1	2	1					5
East Java									
Situbondo	2	3	5	3		1	1	1	16
Probolinggo	1	1	4	5		2		1	14
Surabaya				7	6				13
Malang				1					1
NTB									
Mataram	1			4	2		3	1	11
North Lombok	5	2	9	4			1		21
Total	**12**	**7**	**21**	**34**	**10**	**5**	**6**	**4**	**99**

Section 3 provides an analysis of the mango value chains in Situbondo and North Lombok. Special emphasis is given to spatial product flows; product, information, knowledge, and financial linkages along the chain; quality standards and management systems; and the key constraints faced by farmers and some other key chain actors. Secondary gross margin data for NTB is also presented and discussed. While section 3 does not shed much new light on possible areas for intervention, it does provide key elements for understanding the potential role of different actors in chain innovation processes. Such an understanding is critical for identifying the right entry points for intervention and the right targeting strategies. These are presented in section 4.

Much emphasis is given in section 4 to interventions with the potential to enable off-season cultivation, as these were identified as offering the greatest opportunities for impacts at scale. Interventions in the export and other quality chains, which also have significant impact potential over the medium to long term in particular, are also assessed at some length. Specific interventions linking farmers to the modern retail segment and supporting the development of processing enterprises are discussed more briefly, as the research team does not see much scope for a project such as AIPD-Rural to achieve significant impacts by intervening in these two chains. Some recommendations aimed at informing the research-for-development agenda of ACIAR and its activities in the mango sub-sector are also presented.

Section 5 brings together some key research findings under the three cross cutting themes (poverty, gender and the environment) informing the study. Special emphasis is given to the impacts of the proposed interventions on these areas. The study findings are qualified in Section 6, which highlights some important data and research gaps. Secondary sources of data and information are presented in this final section.

Three annexes are presented after the main report sections. The fieldwork schedule is shown in Annex 1, the checklists used during the key informant discussions in Annex 2, and the structured questionnaire used to collected farm gross margin data in Annex 3.

2 The Mango Sub-Sector in Indonesia

2.1 Indonesia's Position in Global Production and Trade

Mango is the third most widely grown fruit in the tropics and sub-tropics, after watermelon and banana. Global production has increased by some 50% during the last decade (see Table 4), i.e. by an average 4.5% per annum. This growth has been largely driven by favourable demand conditions in producing countries.

Three quarters of global production comes from Asia, with Latin America and Africa accounting for most of the remainder. With approximately 40% of world production, India stands clear as the leading mango producing country, followed by China, Thailand and Pakistan. Indonesia is the sixth largest producer, with a 3 to 5% share of global production, depending on the year.

Table 4 World production of mangoes, mangosteens and guavas ('000 tonnes)[2]

	2000	2005	2010	Share (%) 2010	% change 2000-10
World	*24,852*	*31,665*	*37,125*	*100*	*49*
Asia, including	*18,779*	*23,675*	*28,298*	*76.2*	*51*
India	10,504	11,830	15,027	40.5	43
China	3,211	4,250	4,351	11.7	36
Thailand	1,623	1,803	2,551	6.9	57
Pakistan	938	1,674	1,846	5	97
Indonesia	876	1,413	1,287	3.5	47
Bangladesh	187	622	1,048	2.8	46
Philippines	848	984	826	2.2	-3
Vietnam	574	367	574	1.6	0
South and C. America, including	*2,844*	*3,535*	*4,117*	*11.1*	*45*
Mexico	1,559	1,679	1,633	4.4	5
Brazil	538	1,002	1,189	3.2	121
Peru	125	235	458	1.2	266
Africa, including	*2,553*	*3,692*	*4,204*	*11.3*	*65*
Nigeria	730	731	790	2.1	8
Sudan	192	682	625	1.7	226
Kenya	113	254	554	1.5	390

Source: FAOSTAT, 09/10/12 and author's calculations

[2] *FAO data also includes mangosteens and guavas, but these two crops have a residual importance in terms of production and international trade.*

The world mango market is still a fairly residual market and one characterised by a high level of concentration on the supply side (see Table 5). Despite very strong growth in the international mango trade, over 95% of the world's harvest is still consumed within producing countries. Mexico has been the leading exporter for decades, benefiting from its proximity to the United States, followed by India. In 2010, these two countries exported more than 250,000 tonnes of fresh mangoes each, enjoying a combined 40% share of the world market.

Table 5 World exports of mangoes, mangosteens and guavas (tonnes)

	2000	2005	2010	Share		Change (%)	
				World Exports 2010	Domestic Prod. 2010	00-05	05-10
World	621,814	942,190	1,349,882	100	3.6	52	43
Mexico	206,782	195,210	275,366	20	16.9	-6	41
India	39,274	222,622	260,484	19.3	1.7	467	17
Thailand	8,755	1,519	144,566	10.7	5.7	83	9,417
Brazil	67,172	113,882	124,380	9.2	10.5	70	9
Netherlands	34,477	68,791	107,017	7.9	n.a.	100	56
Peru	21,070	57,618	96,942	7.2	21.2	173	68
Pakistan	48,453	48,855	85,923	6.4	4.7	1	76
Ecuador	25,502	39,965	39,978	3	21.3	57	0
Philippines	40,031	32,435	23,740	1.8	2.9	-19	-27
Indonesia	430	941	999	0.1	0.1	119	6

Source: FAOSTAT, 09/10/12 and author's calculations

Thailand, a major producer of tropical fruits, has enjoyed by far the highest export growth rates since 2005, recently overtaking Brazil as the world's third largest exporter of fresh mangoes. The two countries currently account for 20% of the global mango trade. Peru and Pakistan are also important exporters. Peru, in particular, has seen a significant increase in its share of the world market. In contrast, exports from the Philippines have been falling steadily due to strong competition from Thailand in key Asian markets and difficulties in complying with strict chemical residue regulations in Japan and quarantine regulations in China. Cases where mango consignments from the Philippines have been rejected upon arrival in Japan (because chemical residues in the fruit exceed the maximum legal limit) and China (because of fruit fly infestation problems) have been reported in the news.[3]

It is interesting to note that the mango industries in Asia and Latin America differ markedly in their export orientation (see Table 5). The major Latin American exporters ship 10 to 20% of their production overseas. In contrast, India exports less than 2% of

[3] *See, for example, Fresh Plaza, 25 May 2010; GMA News, 16 August 2011; and GMA News, 14 May 2012.*

its harvest. Thailand and Pakistan, the two Asian producers with a stronger export orientation, sell around 5% of their production abroad. Such contrasts reflect differences in domestic production, as well as geographical and seasonal factors. Peru and Ecuador, the two countries with the highest share of exports in relation to domestic production, have relatively small mango sub-sectors. Mexico shares its northern border with the world's largest mango importer. Finally, South American exporters, say Brazil or Peru, form part of a small group of countries (alongside Indonesia) that can supply the world market between September and March because they are located in the southern hemisphere and thus have counter-seasonality to northern hemisphere countries (see Table 6).

Table 6 Peak mango season in Indonesia and the main mango exporting countries

	Peak harvesting months											
	J	F	M	A	M	J	J	A	S	O	N	D
China												
India												
Thailand												
Pakistan												
Philippines												
Vietnam												
Mexico												
Indonesia												
Australia												
Brazil												
Peru												

Sources: Briones (2013); Fresh Plaza (2012); Gao et al (2011); Daily Times (2011); Mazhar (2007); DAFF (2004)

While the United States (US) remains the leading importer of mangoes, the European Union (EU) now represents the largest export destination (see Table 7). These two markets account for over two-thirds of world imports. During the past decade, imports into the US have increased by nearly a third, but have more than doubled into the EU. The Netherlands is the largest importer within the EU on account of its position as a point of entry into other European markets. However, Germany, the United Kingdom and France represent the main consumption markets due to their large populations and significant presence of first- and second-generation Asian and African communities.

The Gulf States represent the third largest export market - a position that reflects their large migrant population from the Indian sub-continent and Africa. Saudi Arabia and the United Arab Emirates (UAE) are particularly important markets, importing around 100,000 tonnes of fresh mangoes per annum.

In East and Southeast Asia, five countries account for the bulk of imports: Malaysia, Hong Kong, Singapore, Laos, and Japan. Malaysia imported some 40,000 tonnes in 2010, a significant increase over previous years. Hong Kong and Singapore import between 15,000 and 20,000 tonnes per annum each. Imports into Hong Kong have

been declining, a trend that partly reflects increased production in China. Despite having a population of just 6.5 million, Laos has recently overtaken Japan as a mango importer, benefiting from its proximity to production areas in Thailand.

Table 7 World imports of mangoes, mangosteens and guavas (tonnes)

	2000	2005	2010	Share (%) 2010	Change (%) 2000-10
World, including	*621,810*	*754,520*	*1,004,542*	*100*	*62*
European Union, incl.	*178,713*	*284,924*	*369,533*	*37*	*107*
Netherlands	61,856	98,043	142,546	14.2	131
Germany	23,321	37,142	48,451	4.8	108
United Kingdom	22,017	46,922	47,581	4.7	116
France	26,262	34,937	32,267	3.2	23
Belgium	16,118	12,199	16,417	1.6	19
Portugal	9,548	16,736	14,058	1.4	47
North America	*235,080*	*260,842*	*320,591*	*31.9*	*36*
United States	235,080	260,842	320,591	31.9	36
Gulf states, including	*86,721*	*109,050*	*125,983*	*12.5*	*45*
Saudi Arabia	28,325	50,632	58,250	5.8	106
United Arab Emirates	38,900	31,623	46,494	4.6	20
Kuwait	6,401	14,436	11,047	1.1	73
Southeast Asia, including	*36,451*	*36,913*	*81,015*	*8*	*122*
Malaysia	20,321	18,875	42,015	4.2	107
Singapore	15,113	16,210	18,232	1.8	21
Laos	212	29	15,956	1.6	743
Indonesia	64	869	1,129	0.1	166
East Asia, including	*42,971*	*32,915*	*35,893*	*3.6*	*-17*
Hong Kong	32,375	19,170	22,673	2.3	-30
Japan	9,627	12,377	10,504	1.1	9
China	0	1	562	0.1	n.a.

Source: FAOSTAT, 09/10/12 and author's calculations

Japan offers a premium but small and stagnant market, importing around 10,000 tonnes per annum. Strict chemical residue regulations coupled with expensive Phytosanitary requirements[4] limit the volumes entering the Japanese market and result in very high domestic prices (Briones, 2013; Monck and Pearce, 2007; Pasadilla and

[4] *Exporters are required to vapour heat treat (VHT) shipments to kill fruit fly larvae and pay for a Japanese inspector to be in their facilities for the duration on the mango export season*

Liao, 2006).[5] VHT facilities can cost up to US$ 1 million, a very significant investment in a context characterised by a short season, with the equipment having to lie idle for nine or 10 months during the year (Briones, 2013). In Pakistan, this has been identified as a major barrier to the development of mango exports to Japan (Express Tribune, 10 May 2012). In short, selling mangoes in the Japanese market can be a profitable business, but it is also a very expensive and risky venture. Even a developed country such as Australia, where exporters use VHT to eradicate fruit flies, has had to face temporary import bans due to strict quarantine regulations (ABC Rural, 15 January 2010).

It is somewhat surprising that mainland China barely features in international import statistics. One reason is that Hong Kong is providing a gateway to the Chinese market: it is much easier for exporters to access this market through Hong Kong, where no Phytosanitary restrictions are applied, instead of selling directly to China, which has quarantine restrictions and only accepts fruit from countries with which it has signed access protocols (Mazhar, 2007).[6]

More importantly, however, China has limited access to affordable supplies during its mango off-season, i.e. between September and March (see Table 6). Indonesia is the only major mango producing country in Asia with a late harvest, but having no bilateral quarantine protocol with China it cannot take advantage of this opportunity. That is not the case of Australia, which also harvests its mango crop late. However, in a normal year, Australia produces less than 50,000 tonnes of fresh mangoes, of which approximately 4,000 tonnes are exported (Australian Mangoes, undated). In addition to the low supply, Australian mangoes are expensive and can only be sold in the gift and other niche segments of the Chinese market (Gomez and Campbell, 2008). While the main harvest in Brazil and Peru coincides with the mango off-season period in China, long distances pre-empt the development of significant export flows.

Clearly, geography is a major determinant of international mango flows. Most of the international trade in mangoes is based on sea freight, a much cheaper option than air freight. The shorter the distance to destination markets, the lower the shipping costs. More importantly, however, is that short shipping times are crucial for maintaining fruit quality. Mangoes have to be consumed within 25 to 30 days after harvest and should have a shelf life of at least one week upon arrival at the destination market. Hence, exporting fruit that takes more than two weeks to reach its destination by sea becomes a highly risky venture: the probability that the fruit will be rejected or sold for a heavy discount is high. Produce can be sent by air, but volumes will be fairly small due to the high cost.

Proximity to major import markets is a critical determinant of export competitiveness. Sixty to 70% of mangoes imported into the US come from Mexico, with most of the remainder supplied by other Latin American producers, such as Brazil, Peru, Ecuador, Guatemala and Haiti (Evans, 2007; USAID, 2010). The Gulf States source most

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[5] In his review of a previous version of this report, Peter Johnson called our attention to the fact that, in bilateral negotiations of market access protocols with Japan, countries can reach an agreement to use Hot Water Treatment (HWT), provided it is proven this provides an effective solution to fruit flies.

[6] In the past, China has accepted extended HWT for fruit fly disinfestation, as in the case of the Philippines (AFTA Sources, 22 January 2010). This is much more affordable to exporters than VHT.

mangoes from nearby India and Pakistan (Fresh Plaza, 22 June 2012). Japan buys mainly from the Philippines, Thailand, and Mexico (Mango Trade Focus, 4 July 2009). The EU has a more diversified supply base because of its distance to major producing countries (UNCTAD, 2012; Gerbaud, 2007). Brazil, by far the largest supplier, with a share of the European market of about 40%, has a particularly dominant position during the last three months of the year. Peru, the second largest exporter to the EU, with about 25% of the market, is a major supplier between January and March. Mali and the Ivory Coast are important origins from late March to June. Consignments from Senegal reach the EU during the summer months, although this tends to be a quiet period in the market for mangoes due to the availability of many competing fruits. Deliveries from Israel and Spain are available from July to October and from September to mid-November, respectively.

Indonesia is uniquely positioned to supply Hong Kong, Southeast Asia, the Indian sub-continent, and the Gulf States between October and December, when access to alternative supplies is difficult and expensive. Geographical proximity to Asian markets and timing of production are two critical (and permanent) sources of competitive advantage that could underpin the development of a significant mango export industry in Indonesia.

Despite these strong fundamentals, and for reasons discussed in Section 2.5, Indonesia remains a marginal exporter. The country exports around 1,000 tonnes of fresh mangoes per annum, i.e. about 0.1% of its total production (see Table 5). Imports into Indonesia are equally small. Imports increased significantly during the last decade, but from an exceptionally low base (see Table 7). In 2010, Indonesia imported just over 1,100 tonnes of fresh mangoes. Exports and imports are further discussed in Section 2.5.

2.2 Production

2.2.1 National trends

In the last decade, Indonesia's mango sub-sector has undergone a significant expansion. Between 2003 and 2011, production increased by 40%, i.e. at an annual average rate of nearly 5% (see Table 8). After several years of continuous growth, production peaked in 2009 at 2.2 million tonnes. It dropped to 1.3 million tonnes in 2010, a year characterised by an unusually long and heavy rainy season, but recovered in 2011, when Indonesia had its second best harvest on record.

The contribution of area expansion and productivity growth has varied during the period under analysis (see Table 8). Between 2003 and 2007, growth in production was driven by an increase in the number of mango trees in productive age. However, productivity actually declined during that period. While weather conditions may have had some negative impacts on yields, this was a time when large numbers of recently-planted trees were just coming into production. More recently, productivity gains have become a more important driver of growth.

Table 8 Mango harvested area, production and yield in Indonesia, 2003-11

	2003	2005	2007	2009	2011	Average annual change (%)		Change (%)
						2003-07	2007-11	2003-11
Harvested area (ha)	158,894	176,000	203,997	215,387	208,280	7.1	0.5	31.1
Yield (tons/ha)	9.6	8.3	8.9	10.4	10.2	-1.5	2.9	6.3
Production (tons)	1,526,474	1,412,884	1,818,619	2,243,440	2,131,139	4.8	4.3	39.6

Source: Ministry of Agriculture and author's calculations

Table 9 Mango production in Indonesia by province, 2003-11

	2003	2005	2007	2009	2011	Share (%)		Average annual change (%)		Change (%)
						2003	2011	2003-07	2007-11	2003-11
East Java	688,272	604,952	593,824	694,314	754,930	45.1	35	-3.4	6.8	10
West Java	279,197	271,158	447,565	398,159	357,188	18.3	16.8	15.1	-5.1	28
Central Java	195,046	193,687	263,507	423,452	350,780	12.8	16.5	8.8	8.3	80
South Sulawesi	32,608	55,904	96,198	147,423	124,058	2.1	6.6	48.8	7.2	280
West Nusa Tenggara	39,010	66,012	103,015	99,360	113,830	2.6	5.6	41	2.6	191
East Nusa Tenggara	33,429	21,337	60,275	155,999	71,962	2.2	5.2	20.1	4.9	115
Bali	55,980	46,613	47,828	59,868	39,551	3.7	2.5	-3.6	-4.3	29
Other provinces	202,932	153,221	206,407	264,865	318,840	13.3	14.4	0.4	13.6	57
Indonesia	1,526,474	1,412,884	1,818,619	2,243,440	2,131,139	100	100	4.8	4.3	191

Source: BPS (2004, 2006, 2008, 2010, 2012) and author's calculations

The government has played some role in the expansion of mango areas through the distribution of free seedlings. In a recent ACIAR-funded mango farm survey in four districts of NTB, covering 400 households, nearly one-third of respondents had received free seedlings from government (Reardon et al, 2012). A similar survey in four districts of Java, covering 416 mango farm households across 24 villages, found that 20% of respondents in East Java had received free seedlings, whereas the proportion in West Java was only 3% (Qanti et al, 2012).

2.2.2 Geographical distribution and trends

Mango cultivation is concentrated along the northern coastal areas of Java, which accounts for over two-thirds of national production (see Table 9). The eastern part of the island, with its drier, more suitable climate for fruit production, has been the centre of mango production in Indonesia, but its traditional dominance is being slowly eroded following an expansion of planted areas in other parts of Java and other islands. East Java's share of national production fell from 45% in 2003 to 35% in 2011. Central Java saw its share increase from 13% to 17% during that same period. West Java has a similar share of national production.

Despite enjoying a more favourable climate for mango cultivation, East Java experienced much slower growth in production than Central or West Java (see Table 9). The 2011 harvest in these two provinces was 80% and 30% higher, respectively, than in 2003, whereas in East Java it expanded by a more modest 10%. In Central Java, production expanded throughout the whole period under analysis. West Java experienced very high growth rates between 2003 and 2007, but production has since contracted, whereas in East Java the mango sub-sector followed the opposite trajectory: production fell between 2003 and 2007, but since then the province has enjoyed several bumper harvests.

As discussed in the next section, many growers in Central Java have been able to take advantage of very profitable off-season marketing opportunities, thereby enjoying higher production incentives than mango farmers in East Java. While early-harvest technologies have also been successfully adopted by many farmers in West Java, the province has been unable to replicate the strong growth performance of Central Java. Of the three provinces, West Java experiences the highest rainfall levels, thereby having the least suitable climate for mango cultivation. West Java also has a more developed and urbanised economy, with farmers enjoying many other income opportunities, both in and outside agriculture.

The expansion of mango production was particularly impressive in relatively marginal provinces (see Table 9). Between 2003 and 2009, South Sulawesi, NTB and NTT saw their combined share of national production jump from 7 to 17%. South Sulawesi, the fourth largest mango producer, had its largest harvest on record in 2009. In NTB, production peaked in 2011, but most growth occurred during the 2003-07 period. NTT had an exceptional mango crop in 2009, but a very poor one in 2011. In that year it produced 77,000 tonnes, less than half of the 2009 harvest, a drastic drop that may be related to natural conditions.

2.2.3 Yields

In recent years, mango yields in Indonesia have fluctuated around 10 tonnes per hectare (see Table 10). This is high by international standards. In India, mango yields averaged 7.7 tonnes between 1991-2 and 2002-03 (Mango Resources Information System, undated). In the Philippines, the average annual yield for the 2004-08 period was 5.6 tonnes per hectare (AFMIS, 2009). For Thailand, Chomchalow and Songkhla (2008) report official yield data of 6.5 tonnes in 2004, 7.4 tonnes in 2005, and 7.7 tonnes in 2006. What this data reveals is that Indonesia has relatively favourable natural conditions for mango cultivation and cultivars that are well adapted to the local agro-climate and productive even under relatively low-input production systems.

Table 10 Mango productivity (tonnes/ha) in Indonesia and selected provinces

	2009	2010	2011	Average 2009-11
East Java	8.9	9	9.9	9.3
Central Java	9.4	8.8	9.2	9.1
West Java	16.7	10.7	12.7	13.4
NTB	10.6	11.4	10.6	10.9
NTT	15.2	9.9	9.7	11.6
Indonesia	*10.4*	*9.8*	*10.2*	*10.1*

Source: The Center of Data and agricultural information system (Pusdatin), Secretariat General, Ministry of Agriculture, Republic of Indonesia, 2012

Within Indonesia, yields are highest in West Java. This province does not have the best climate for mango cultivation, so higher productivity must reflect more intensive cultivation practices. East and Central Java have different weather patterns but fairly similar yields: the evidence gathered during the fieldwork indicates that mango growers in Central Java follow much more intensive farm management practices than their counterparts in East Java, thereby achieving similar productivity in a context of higher rainfall. Mango farmers in NTB use very few external inputs, but benefit from fairly dry weather conditions, especially in North Lombok district and Sumbawa Island. According to official data, during the 2009-11 period, NTB achieved an average annual yield of 10.9 tonnes per hectare, higher than the average for Central or East Java for that same period. The average productivity of mango farms in NTT, which also has a very dry weather and a relatively young tree population, was very high in 2009 and fairly consistent with the national average in 2010 and 2011.

Interestingly, mango yields increased in East Java and NTB in 2010, a year characterised by a prolonged rainy season and excessive rainfall levels. Official statistics show that the decline in production was a consequence of a reduction in harvested areas. It appears that farmers in East Java, NTB and other provinces did not harvest mangoes from trees or orchards that were most affected by rain.

2.2.4 Seasonality

The supply of mangoes in Indonesia is largely defined by rainfall patterns. As in other countries, the main flowering-to-harvest period coincides with months of low rainfall.

This is because rain at flowering causes fungal diseases that causes flower drop, while rain during the fruit development stages results in a high incidence of both pests and diseases. More than five or six rain days per month during the flowering and fruit setting stages will generally result in a poor crop.

In Indonesia, most mangoes are harvested in October and November, i.e. towards the end of the dry season and beginning of the rainy season. NTB has a late harvest, which peaks in November and December and continues until January or February, depending on the areas. In parts of Western and Central Java, many mango growers have adopted crop manipulation technologies successfully, having one or two early harvests between May and August and another during the peak October-November season. This is also the case of two-thirds of mango growers in Panangan, a village in Cirebon that was visited during the fieldwork. In Asemdoyong village of Pemalang, it was reported that 70 to 80% of mango farmers are early-season producers, harvesting up to 65% of their crop during the May-August period.

With a more pronounced and longer dry season, East Java and parts of NTB, including North Lombok, are more suited to an extended flowering and harvesting period. However, in both provinces farmers lack the technical know-how for successful development of early-season production. None of the producers interviewed in Situbondo, Probolinggo and North Lombok districts harvest more than 10% of their mango crop before October. It would be interesting to verify whether this is also the case in Pasuruan, a major mango producing district of East Java.

Table 11 presents an estimated seasonal distribution of mango production in Java and NTB. It is assumed, somewhat speculatively, that 30% of the West and Central Java production is harvested before October. For other parts of Java this figure is 10%. For NTB it is assumed that 15% is harvested between May and September and 10% in January and February. Clearly, any major change in the seasonal distribution of the harvest in Indonesia will require widespread adoption of early-season cultivation technologies in East Java.

Table 11 Estimated seasonal distribution of mango production in Java and NTB (tonnes)

	May-Sept	Oct-Dec	Jan-Feb	Total
East Java	75,000	675,000	0	750,000
West Java	105,000	245,000	0	350,000
Central Java	105,000	245,000	0	350,000
Banten	3,500	32,500	0	36,000
Yogyakarta	3,000	27,000	0	30,000
Jakarta	500	3,500	0	4,000
NTB	15,000	85,000	10,000	110,000
Total	296,000	1,314,000	10,000	1,620,000

Source: Fieldwork, 2012

2.3 Production Systems

2.3.1 Farm size

Mango is a smallholder crop in Indonesia. The vast majority of mango growers own less than 100 trees, i.e. they cultivate less than 1 hectare. There are a few large mango plantations in East Java that were established 15 to 20 years ago, but these account for a relatively small share of the province's total production. The research team had the opportunity to visit two such farms, one in Situbondo and another in neighbouring Probolinggo district. Both were facing difficulties due to poor orchard design and management, achieving much lower yields than surrounding small farms.

According to recent farm survey data presented in Qanti et al (2012) for two districts of East Java and two districts of West Java, marginal growers with 4 to 10 trees account for about 80% of mango farms, whereas small growers with 11 to 100 trees represent approximately 20%. While only 1% of mango farmers in survey districts fall under the medium-size category (more than 100 trees), they account for 20% of the tree population. Medium growers account for 40% of the survey tree population and small growers for another 40%.

Farm survey data for four districts of NTB, including North Lombok, provides a similar picture (Reardon et al, 2012). While the size of mango farms in NTB appears to be larger than in East or West Java, their distribution is still skewed towards the marginal and small grower categories: 28% of survey respondents have 10 trees or less, 60% between 11 and 100 trees, and 12% 100 trees or more. The average number of trees under each category is 7, 35 and 179, respectively.

As in Java, medium-size growers in NTB own a disproportionate share of mango trees: they represented only 12% of the survey sample but controlled nearly half of the survey tree population, with small and marginal growers accounting for 47% and 4%, respectively. More strikingly, in the survey year, medium growers were responsible for about two-third of total mango sales. Nearly 40% of marginal growers did not sell any mangoes. In NTB, more than in Java, a significant share of mango farm households earns very little income from their mango crop. In a context characterised by limited diversification opportunities this is a disturbing finding: of the 400 mango farm households surveyed, only 20% were employed in non-farm activities and only 3% earned a wage income as farm workers. Of greater concern, mango trees accounted for 62% of agricultural land belonging to survey households.

It should be noted that, in Java, tree ownership provides a misleading picture of the size of mango farms. The number of trees owned by a household often differs from the number of trees managed by that same household due to the widespread practice of renting out trees. Sharecropping, an arrangement where a farmer manages someone else's trees in exchange for a pre-agreed share of the harvest, is also practised. Some examples of tree rental and sharecropping agreements in West and East Java are presented in Natawidjaja et al (2009).

In a context where land is scarce and expensive, and where it takes five years for a newly planted tree to yield its first crop and at least ten years for it to start reaching its yield potential, tree rental and sharecropping have enabled many rural households to develop and expand mango cultivation. That was, indeed, the case of many farmers

and traders interviewed in Java. In North Lombok, where mango cultivation is much less commercialised, such arrangements are still fairly uncommon. This was confirmed during the focus group discussions and trader interviews in three villages.

2.3.2 Varieties

Arumanis is the main mango variety in Indonesia. Its dominance increased between 2002 and 2007, as shown in Table 12, although more recent data suggests that in some districts of East and West Java, most new plantings during the last five years have been other varieties (Qanti et al, 2012). In 2007, Arumanis accounted for three-quarters of East Java's mango production. In West Java, where Gedong Ginku has been planted in large areas, including 2,000 hectares developed in the late 1990s and early 2000s with Japanese funding, Arumanis still represented half of the total provincial harvest. In NTB, Arumanis accounts for nearly half of the fruit sold (Reardon et al, 2012). Manalagi and Madu are two other important varieties in NTB.

Table 12 Share of different varieties in mango production in West Java and East Java

Varieties	% of mango production			
	West Java		East Java	
	2002	2007	2002	2007
Arumanis	43	48	60	75
Gedong Ginku	20	28	0	0
Manalagi	3	3	6	8
Podang	n.a.	n.a.	9	10
Other (Indramayu, Golek, Madu, etc)	34	22	25	7
Total	100	100	100	100

Source: BPS data presented in Natawidjaja et al, 2009

Arumanis is a resilient and productive cultivar that performs well under low-input and variable climatic conditions. Its large fruit size, nice aroma, firm flesh, low fibre content, and sweetness are appreciated by consumers. (*Harum Manis* literally means "fragrant sweet" in Indonesian language.) Indramayu is equally easy to manage and produces an even better yield than Arumanis, but does not enjoy as large a market. This variety is often used in salads. Manalagi is another very productive cultivar, but fetches a low price in the market. Despite accounting for a significant share of domestic supply, Arumanis is generally retailed for a higher price than most other cultivars, as shown in Table 13. In NTB, Arumanis is more expensive than Madu, the second most important variety in that province (Perkasa et al, 2011).

Table 13 Retail prices of different varieties in different supermarkets and one market stall in Surabaya, 20 and 21 September 2012

Outlets	Price (IDR/kg)				
	Arumanis	**Manalagi**	**Indramayu**	**Golek**	**Madu**
Carrefour (Gembong)	24,900 grades A and B, clean	8,900 mixed grades some marks	17,600 mixed grades many skin marks	21,730 mixed grades, clean, different ripeness	22,900 mixed grades some skin marks
Carrefour (Ngagel)	18,900 grade B, relatively clean	8,900 mixed grades	17,900 reasonable quality	21,730 reasonable quality	19,900 reasonable quality
Hero (Gubeng)	34,990 grade A, clean	16,990 very clean	19,490 very clean	14,890 very clean	39,590 very clean
Total store	40,500 grade A, ripe on the tree, w/ stem, clean 37,800 grade B, ripe on the tree, w/stem, clean 35,100 grade C, ripe on the tree, w/ stem, clean 27,000 large, clean	16,500 Clean			15,900 clean
Market Retailer (Genteng Market)	± 25,000 large, clean 30,000 – 35,000 small, ripe-on-the-tree, clean	10,000 (large) 9,000 (small)		15,000 (large) 10,000 (small)	10,000 different ripeness (colour)

Source: Fieldwork, 2012

Gedong Ginku, a premium variety grown in West Java, particularly in Majalengka, Indramayu, and Cirebon districts, is a special case. This is one of the few yellow-skin varieties in Indonesia. When mature it has a nice orange-red blush. Gedong Ginku is more susceptible to pests and diseases than most local varieties, requiring intensive care. It is also more susceptible to boron deficiency, as confirmed during visits to some orchards in Cirebon. Key informants reported relatively low yields for Gedong Ginku: in a normal year, most farmers in Panangan village of Cirebon will harvest around 50 kilograms per tree, representing about half the normal Arumanis yield.

Gedong Ginku fetches the highest prices in the market. For example, on 5 September 2012, one kilogram was being sold at a Hero store in Jakarta for IDR 44,950, while large and very clean Arumanis mangoes were being retailed in the same store for IDR 34,990. Gedong Ginku currently accounts for approximately 5% of the Java harvest, whereas Arumanis has a 60% share or more. A significant part of the Gedong Ginku production is sold through modern retail outlets in greater Jakarta and other cities in Western Java. In East Java, consumers are not yet familiar with the variety. It remains to be seen whether this variety would still command a significant price premium in domestic markets if production was to increase two or threefold. West Java growers have enjoyed the advantages of first-comers, but farmers in Central Java and East Java may not be as fortunate if production is developed at scale in both provinces.

Podang is another local variety with yellow skin (and a nice orange-red blush). Like Gedong Ginku, the fruit is small in size, but has a larger seed. The demand for Podang, which is widely grown in Kediri district of East Java, is relatively small. Podang is mainly marketed in East Java during the months of October and November.

The Directorate-General for Horticulture (DG-Hort), the agency under the Ministry of Agriculture responsible for developing strategies and policies for the horticultural sector, has started promoting new varieties in coordination with provincial and district departments of agriculture. In several districts of East Java, including Situbondo and Probolinggo, Dinas Pertanian has started distributing seedlings of Grafita, a red-skinned variety. Twenty-three hectares have been planted recently in Situbondo. Seedlings were distributed free of charge to some farmers groups. Such interventions seem to be guided by a desire on the part of government to introduce cultivars with export potential, an issue discussed in Section 2.5 of this report.

2.3.3 Cultivation practices

Input use

Mango cultivation in Indonesia is undergoing a process of commercialisation, characterised by increased adoption of external inputs. This process is most advanced in Western and Central Java (Qanti et al, 2012). NTB is at the opposite end of the commercialisation spectrum, with mango farmers using few external inputs (Reardon et al, 2012).

In the early 2000s, mango growers in West Java already exhibited higher input adoption rates than their East Java counterparts, and this gap widened in subsequent years (see Table 14). According to BPS survey data, between 2003 and 2007 the share of mango farmers in West Java using irrigation rose from 25 to 45%, whereas in East Java it increased from just 8 to 10%. While the share applying fertilisers, growth

regulator, and fungicides doubled in both provinces, by 2007 a significant 35% was using all three types of inputs in West Java, compared to just 7% in East Java.

Table 14 Technology use by mango farmers in West Java and East Java, 2002 and 2007

Technologies	% of mango farms			
	West Java		East Java	
	2002	2007	2002	2007
Irrigation	25	45	8	10
Fertilizer, growth regulator and insecticide	18	35	3	7
Fertilizer and insecticide only	19	23	10	13
Fertilizer only	11	10	12	25
No chemical inputs	53	33	75	55

Source: BPS survey data presented in Natawidjaja et al, 2009

More recent survey data shows a more balanced picture (see Table 15). In 2009, 73% of West Java respondents used fertilisers, 30% growth regulator to induce flowering, and 41% pesticides; in East Java, adoption rates were 66, 25, and 37%, respectively. Based on these data, the study authors conclude that input adoption rates in East Java are only slightly lower than in West Java. Discussions with key informants in the two provinces suggest otherwise. The share of farmers using different types of inputs only provides a partial picture of input adoption rates. As shown later in this section, there are significant differences between the locations visited in East Java and those visited in West Java (and Central Java), both in terms of the amount of inputs applied and the way these are being used. In Cirebon and Pemalang, most farmers spray significant amounts of chemicals to manage pests and diseases during the first flowering and fruit setting stages so as to ensure a successful early harvest, which commands a very high price in the market. Levels of spraying in Situbondo and Probolinggo are much lower and occur later in the year.

Table 15 Technology use by mango farmers in West Java and East Java, 2009

Technologies	% of mango farmers	
	West Java	East Java
Fertiliser	73	66
Growth regulator	30	25
Pesticides	41	37

Source: Qanti et al, 2012

In NTB, mango farmers use very few external inputs. Recent farm survey data from four districts in this province, including North Lombok, shows extremely low input adoption rates amongst small and medium growers: only 14-15% using Urea, 6-7% using NPK (Nitrogen, Phosphorous, Potassium), 8-10% using pesticides, 1-5% using growth regulator, and less than 1% using fruit fly traps (Reardon et al, 2012).

Fertilisation

Field discussions revealed that mango farmers are applying fertilisers following local norms, without sufficient understanding of mango nutrition and soil composition. It appears that, as a result, fertilisation practices are failing to address critical soil nutrient deficiencies. For example, gum in the trunk of mango trees, a clear symptom of boron deficiency, was very noticeable during visits to orchards in Cirebon. More generally, it appears that in all areas visited, insufficient amounts of potassium are being applied. The farmers interviewed were using low rates of about 300 grams per tree during January, much of which is lost by the time it is needed at flowering and fruit set. Potassium deficiencies could be addressed through foliar spraying of potassium nitrate late in the wet season, with positive impacts on flowering, fruit set, and fruit size (Kali, 2012). Some mango growers are already adding pre-mix foliar nutrients to spray applications, so this would be a relatively straightforward innovation.

In contrast, it appears that excessive doses of nitrogen are being applied in many mango farms. Most of the farmers interviewed were using in excess of 1 kilogram of nitrogen per tree, whereas on Australian mango farms, according to the experience of one of the research team members, the standard rates are below 300 grams. Further amounts of nitrogen are then being added in the form of manure by the Indonesian farmers, where they are commonly applying 30 to 50 kilograms per tree. High doses of nitrogen impair fruit quality, causing a high incidence of jelly seed, an internal disorder where the flesh around the seed ripens before the outer flesh. It also increases the risk of diseases.

Pruning

In East Java and NTB, the mango research team observed many orchards along the road where trees had not been pruned and were too large for effective spraying and harvest. While the team could not access quantitative data for East Java, in the two districts of Lombok and the two districts of Sumbawa covered by the ACIAR-funded mango farm survey, only 55% of sample farmers prune their trees (Reardon et al, 2012). The percentage of medium-size growers pruning their mango trees (73%) is considerably higher than the average.

Pruning is particularly important as an orchard ages because without it, trees eventually grow into each other, shading out lower branches. This adversely impacts fruit yield and size. Fruit from very large trees is also more exposed to wind rub and prone to latex marks, as it becomes very difficult to harvest it without breaking the stem. According to research data collected in 2008-09 under an ACIAR-funded mango research project, 41% of the mangoes sampled from Bayan sub-district, North Lombok, 80% of the mangoes from Sekotong sub-district, West Lombok, and 37% of the fruit from Aikmel sub-district, East Lombok, presented field marks and blemishes (Zainuri, 2012). In Tanjung market, in North Lombok, 81% of the mangoes sampled had latex marks.

It should be noted that pruning can encourage excessive vegetative growth, which can also reduce flowering and yields. Application of Paclobutrozol, a plant growth regulator, in pruned trees counteracts this effect.

Crop manipulation

In Cirebon and Pemalang, many farmers are adopting crop manipulation technologies for early-season production. These consist of Paclobutrazol, a growth regulator that induces flowering, and spraying crop protection chemicals during the first flowering-to-harvest phase when rain can cause serious disease and pest problems. Adoption of crop manipulation technologies started in Pemalang in the mid-1990s, but it has only been in the last six or seven years that these technologies have been more widely mainstreamed in local production systems. Word-of-mouth has been the main technology dissemination channel. The spreading of early-season production technologies was a slow process, as most of the early adopters were somewhat secretive about the new technology. Syngenta also played a role. In 2003 and 2004, the company implemented a series of demonstrations in different parts of Western and Central Java to promote Cultar, its brand of Paclobutrazol. Since then, Syngenta has not implemented any mango farm demonstrations. The fact that cheaper Paclobutrazol brands are widely available in the market is a major disincentive for investment in promotional activities by Syngenta.

Key informants in Cirebon and Pemalang indicated off-season production as the main reason for using Paclobutrazol. It should be noted, however, that its application also increases and stabilises yields, while at the same time improving fruit skin colour and firmness (Kulkarni et al, 2006). Yield benefits should not be under-estimated. Mango trees are characterised by erratic flowering. In any given location, a good production year is often followed by a poor harvest. Irregular flowering is a major source of fluctuations in production, a pattern that is very evident in the district-level data presented in Table 1. While the harvest in East Java province has followed a fairly smooth upward trend between 2006 and 2009, this was certainly not the case in individual districts. In Situbondo, for example, mango production increased from 21,000 tonnes in 2007 to 43,000 tonnes in 2008, but then fell to 15,000 tonnes in the following year. Probolinggo experienced an even more erratic pattern: production increased from 36,000 tonnes in 2006 to 63,000 tonnes in 2007, dropped to 39,000 tonnes in 2008, and then reached 81,000 tonnes in 2009. Situbondo and Probolinggo are not special cases: drastic inter-annual fluctuations in production are equally common in other districts of East Java (see Table 1). Considerable variations in annual district production in NTB are also captured in official statistics (see Table 2).

In Cirebon and Pemalang, Paclobutrazol is applied in December or January to induce first flowering in February or March. In order to cope with high pest and disease pressures during these months, local farmers have developed very intensive spraying programs, with up to three or four spraying rounds per week over a two or three month period. The strategy appears to be working. Farmers in Pemalang and Cirebon harvest between 30 and 60% of their mango crop during the months of May to August. It is this ability of growers in those two districts to get an early premium harvest that sets them so apart from those in East Java.

There are many mango growers in Situbondo and Probolinggo who have been applying Paclobutrazol for several years. However, the technology is being adopted to improve fruit yields during the main season, not as part of an off-season cultivation strategy. Paclobutrazol is typically applied in February in these locations. While growers report heavy flowering in April, rain-induced fungal diseases cause flowers to

drop. One of the farmers interviewed in Situbondo sprayed the protective fungicide Antracol, but this proved ineffective under high disease pressure. Still, the trees treated with Paclobutrazol produce a good second round of flowering in June and July, with positive impacts on fruit yields during the October-December season.

The research team also met farmers in those two districts who had stopped using Paclobutrazol after one or two seasons, as well as farmers who had been exposed to the technology for the first time in 2011 or 2012. Cases of misuse were common amongst both categories. Some farmers poured Paclobutrazol onto cuts in the bark, with deleterious effects on tree health. Others were using wrong application methods that failed to produce a response, such as applying the growth regulator too far from the tree or spraying it, rather than pouring it onto the bottom end of the trunk in a circular band. A further group used it far too late to get an early flowering.

These examples illustrate the challenges associated with adoption of new technologies in contexts where farmers have poor technical knowledge and poor access to appropriate technical advisory services. Farm survey data for two districts of West Java and two district of East Java, reported in Qanti et al *(*2012), shows that farmers themselves are the main source of technical information: 79% of respondents learn about mango cultivation from other farmers, a much higher figure than that reported for government extension agents (17%) and chemical companies (8%). While these figures say nothing about the content and quality of information and knowledge flows, it is significant that none of the input dealers and government extension officers interviewed in Situbondo and Probolinggo were aware of the right technologies and management practices for successful off-season mango cultivation. One BPTP researcher implemented a Paclobutrazol trial some years ago but applied the growth regulator too far from the trunk. Unsurprisingly, the treatment and control plots yielded similar results. This failed experience contributed to a perception that climatic conditions in East Java are not conducive to off-season cultivation, a misguided claim heard in some of the key informant discussions in this study.

In short, in Situbondo and Probolinggo, mango growers applying Paclobutrazol correctly are satisfied with the yield impacts during the main October-November season, whereas those in Cirebon and Pemalang harvest an early crop during the May-August period and another in October-November. These very different outcomes reflect differences in pest and disease management strategies. In Cirebon and Pemalang, the fungicide Amistartop (Syngenta) is commonly used as an effective treatment for anthracnose and other diseases. Cabrio (Bayer) and Nativo (BASF) are less known amongst mango growers but equally effective fungicides. These chemicals are also widely available in input stores in Situbondo and Probolinggo, but local producers, even those managing hundreds or thousands of trees, are unaware about their effectiveness in mangoes. Pak Herman, for example, the largest renter in Situbondo, with 200 hectares under his management, has been using Paclobutrazol for many years but only harvests 10% of his crop before October. He sprays Antracol in April, but most of his trees fail to set fruit. He has never heard about the use of Amistartop for mango. Likewise, Pak Suli, a large trader in Probolinggo who rented 20 hectares of mango trees in 2011 and 5 hectares in 2012, was unaware that Amistartop can be used to address flower drop and fruit set failure during the early flowering period. These examples show that successful experiences in certain parts of the

country (West Java and Central Java) are not necessarily replicated in other parts of the country (East Java and NTB), a clear indicator that formal and informal knowledge transfer systems are performing poorly.

It should be emphasised that failure to produce an early crop cannot be attributed to local agro-climatic conditions, as implied by several key informants. Farmers in Cirebon and Pemalang are equally successful in using Paclobutrazol despite experiencing very different rainfall patterns. Moreover, ACIAR-funded trials in North Lombok have shown that Arumanis is very responsive to Paclobutrazol (see Table 16). Application during January brought the harvest forward by two to three months and resulted in a 33% improvement in yield. Yield gains were nearly twice as significant (63%) when Paclobutrazol was applied in February, but the crop was harvested during the main marketing season in Java, a scenario where no significant price benefits accrue to farmers. Application in December increased yields by "only" 18%, but all the crop was picked during the off-season months of July to September. Which of these three scenarios is more profitable for farmers will depend on seasonal price differences at the farm gate.

Table 16 Paclobutrazol trial results in Bayan, North Lombok, 2009

	Arumanis variety	
	Yield (Kg/tree)	**Harvesting months**
December application	93	Jul-Sept
January application	105	Aug-Oct
February application	129	Oct-Dec
Control	79	Dec-Jan

Source: Rahayu, 2012

In NTB, only a very small number of mango farmers use growth regulator, as indicated by input use data reported earlier in this section. Fieldwork findings are consistent with this data. None of the five input retail stores visited in Mataram and North Lombok were selling Paclobutrazol. According to the store owners, there is no demand from farmers. The team did meet two village traders in Bayan sub-district (North Lombok) that had just starting using Paclobutrazol in their mango farms, but this was supplied by a researcher from BTPT implementing crop manipulation trials under an ACIAR-funded mango research project.

Pest and disease management

During the fieldwork farmers consistently named pests and diseases as the second most important issue of concern, after low prices. The most common mango pests are: leafhoppers, which trigger flower drop; fruit borers, which lead to fruit drop; flattids, which cause sooty mould on fruit; and fruit flies, which result in ripe fruit breakdown. Anthracnose and stem end rot are the most common diseases. Both diseases accelerate fruit rotting at ripening. Anthracnose also causes flower drop.

Data collected in North Lombok in 2010 illustrates the significance of major pests and diseases (see Table 17). In October, 60% of fruit samples had sooty mould symptoms

at harvest and 38% were affected by caterpillars. By December, 67% of ripening fruit was affected by anthracnose, 23% by stem-end rot, and 20% by fruit flies.

Table 17 Pest and disease incidence in mangoes, Bayan, North Lombok, 2010

Pests and diseases	Percentage of affected fruit			
	June	August	October	December
	At harvest			
Flattids (sooty mould) (%)	55	13	60	0
Caterpillar (%)	54	40	38	15
Fruit borers (%)	21	0	0	9
	At ripening			
Anthracnose (%)	65	20	53	67
Stem end rot (%)	7	3	13	23
Fruit Fly (%)	9	0	0	20

Spraying is the most common pest and disease control strategy employed by farmers. Qanti et al (2012) found fact that 40% of mango growers in two districts of West Java and two districts of East Java owned a manual sprayer. Small, hand-held sprayers are affordable but not always very effective, as they cannot ensure proper coverage of large mango trees. Ownership rates for power sprayers were much lower, ranging from 4% for marginal growers and 18% for medium growers.

Interestingly, Qanti et al (2012) also found that very few farmers rent spraying equipment or services. Some may borrow a sprayer from a relative or friend, as noted by some key informants during the discussions with the mango research team, but renting the equipment or service is uncommon. The fact that farmers without a sprayer may be unable or unwilling to invest in disease and pest control, or simply renting-out their trees, are possible reasons for the lack of development of local markets for spraying services. It appears, therefore, that purchase of a sprayer is a first step in the adoption of pesticides and fungicides.

In Cirebon and Pemalang, most spraying is aimed at protecting the early, high-value harvest. In 2011, for example, Pak Akin, a farmer in Dronjong village of Pemalang, sprayed his mango trees 17 times, mainly during the February-April months. Pak Abdul, from Taman village of Pemalang, sprayed his crop 30 times. In districts such as Situbondo and Probolinggo, the use of fungicides and insecticides in mango farms is more and more common, particularly amongst larger growers and renters, but the levels applied are generally low. Seven growers were interviewed in Situbondo and Probolinggo for collection of farm gross margin data. Of these, three did not spray any chemicals, one sprayed his trees once, two sprayed them twice, and one sprayed them six times. In NTB, few farmers apply insecticides and fungicides, despite wide availability of a broad range of relevant chemicals in local stores, as these are also used for other crops, such as rice and vegetables. According to farm cost data collected in North Lombok, out of seven farmers, six did not spray their mango trees, although two reported some spraying by collectors purchasing their fruit on the tree. One farmer applied the pesticide Fastrac twice.

Key knowledge gaps on agro-chemical use were identified during the fieldwork. Effective control of specific diseases or pests requires using the right product at the right time. Often this is not the case. The case of one grower in East Java that sprayed Antracol during early flowering, with poor results, is a good example. Moreover, farmers are adopting inappropriate spraying strategies for controlling flattids. Instead of targeting the small population of nymphs during the early stages of the insect life-cycle, growers are spraying after large populations have had the time to develop. This strategy is ineffective, as the chemicals do not kill the adult insects. Farmers claim that flattids have developed resistance to insecticides, but incorrect timing of application is a much more likely explanation. This example shows the importance of understanding insect life cycles, monitoring insect populations regularly, and intervening at the right time.

Current strategies for controlling fruit flies provide another example of inappropriate pest management practices. Fruit flies are a particularly serious problem during the main harvesting months, when mangoes are becoming ripe and rainfall levels increasing. Methyl eugenol traps are widely used, but these only attract males, not egg-laying females. Hence, while such traps can be useful for monitoring fruit fly populations, they are ineffective as a control method. Bait spraying to trunks and branches do attract and kill females, but coordinated adoption by farmers within an area is required for successful control. This constitutes a major barrier to adoption.

Clearly, there is much scope for improving disease and pest management practices, while at the same time saving costs to the farmer. For example, systemic soil insecticides, such as Actara (Syngenta) and Confidor (Bayer), can be effective in controlling leafhoppers, scales, and other sucking insects (Thistleton and Baker, 2010). One application has an effective life of about six weeks, thereby replacing the need for several rounds of pesticide spraying. While serious concerns have been raised about the environmental impacts of these insecticides (Tennekes, 2012), it is unclear whether their use in mangoes poses greater risks to the environment and humans than the intensive spraying programs implemented by Cirebon and Pemalang growers.

More importantly, ACIAR-funded trials have shown that bagging improves fruit yields and quality for a relatively low cost (see Table 18). Bags provide considerable protection against all major pests, including sucking insects, fruit borer, and fruit flies. They also protect the fruit from rain, wind rub, and scratch marks. No spraying program can prevent field marks. In farms already using bags, spraying is only required to prevent flower drop during early-season flowering, when disease pressure is very high.

Table 18 Bagging trial results for Selegan, North Lombok, Sept 2010 – Jan 2011

	Fabric bags	Paper bags	Cotton bags	Control
Fruit drop (%)	6.4	6.4	12	27
Yield (kg/tree)	59	58	53	43
Defects (% of fruit)				
Caterpillars	11	15	25	24
Sooty mould	10	9	5	23
Lentilsell	4	9	5	4
Sap burn	12	8	15	8
Wind rap	3	4	1	24
Blemishes	2	4	2	4
Damage pressure	2	3	1	4

Source: Rahayu, 2012b

In Indonesia, bagging is common in guava and carambola farms, but much less so for mangoes. Still, the research team visited two mango plantations in East Java where this technology was being applied. Field data shows that the cost of locally purchased paper bags and farm labour to wrap the fruit is about IDR 130-150 per kilogram of fruit, much less than what Cirebon and Pemalang growers are spending in their intensive spraying programs, which varies between IDR 400 and IDR 600 per kilogram. Fruit bagging may appear laborious, but it may provide a cheaper alternative to spraying, while having no negative consequences for the environment and human health. It also provides employment opportunities for women involved in the production of bags.

Harvesting

The timing of harvest has a significant impact on fruit quality. The market has a clear preference for mangoes harvested at 80% maturity or more, i.e. fruit that is full and, in the case of Arumanis, with the lower beak or tip filled out. Fruit maturity, a measure of the life of the fruit on the tree before full ripeness, is therefore a key factor in farmers' choice of picking times. Mangoes are typically harvest at 70 to 90% maturity. During the early-harvest season, when supplies are limited, growers will tend to pick more immature fruit in order to take advantage of high prices and trader's less stringent quality standards. During the peak October-December season, farmers will be stricter regarding harvesting times to avoid a price penalty.

Harvesting methods also impact on fruit quality. Mangoes harvested with traditional picking poles snap the stem off the fruit, which releases latex, leaving brown marks on the skin. In Situbondo, the team observed modifications to traditional picking poles, whereby blades had been attached so that the fruit is harvested with the stem or part of the stem on. This reduces sap flow. Picking fruit with the stem on is critical for mangoes destined to export markets. In visits to wholesale markets, the research team found mangoes that had been harvested with both the stem on and no stem.

Some minor modification to current harvesting systems would reduce latex marks. Washing the fruit in soap or lime as soon as it is harvested or when the stem is removed neutralises sap flow. Separating fruit that has come in contact with sap at

harvest will also reduce latex marks. Farmers and village traders cannot detect latex marks on the skin as these take one or two days to appear and three or four days to fully develop, by which time the fruit has already been sent to destination markets.

Finally, in areas relatively close to major consumption centres, such as Jakarta and Surabaya, some mango growers specialise in ripe-on-the-tree (*masok pohon*) fruit, which is sold for a considerable premium. In September 2012, a market retailer in Surabaya was selling one kilogram of small but ripe-on-the-tree Arumanis for IDR 30,000–35,000, while retailing one kilogram of grade A Arumanis harvested at 80-90% maturity for around IDR 25,000. At Total's store in Surabaya, normal grade A Arumanis was being sold for IDR 27,000, compared to IDR 47,500 for the same grade and variety of fruit that was ripened on the tree. At one Super-Indo store in the same city, one kilogram of normal Gading mango was retailed for IDR 8,950, whereas the tree-ripe Gading fruit was sold for IDR 32,950. Despite these price differences, the production of *masok pohon* mangoes remains fairly limited due to consumers' reluctance or inability to pay very high prices for the fruit and the risks involved for farmers and traders. Tree-ripe mangoes are very susceptible to fruit flies, diseases, and compression losses during transportation.

2.3.4 Farm profitability

Farm revenue and cost data was collected from 16 farmers: two in Pemalang, five in Situbondo, two in Probolinggo, and seven in North Lombok. Gross margins are presented in Table 19 for Pemalang and Situbondo, two districts with very different production systems. For comparative purposes, farmers that harvest their mango crop (rather than selling the fruit on the tree) were selected for interview. It should be noted that 2011 appears to have been a poor production year for many growers in Situbondo, as three of the five farmers interviewed reported very low yields.

Probolinggo is excluded from the analysis because the two farmers interviewed reported in-season prices that were well above those consistently mentioned during discussions in villages and markets, which raises questions about the reliability of the data. Figures for North Lombok are not presented because in 2011 the mango crop failed in the two villages visited. That year, there was acute fruit set failure, with farmers earning a very small income from mango. Farmers experienced similar problems in 2012. During the fieldwork, the research team observed entire orchards along the North Lombok coast with excellent flowering but no fruit set. Closer inspection of the trees showed no insect attack on flowers. Fruit set was extremely poor even in orchards where an intensive spraying program had been implemented as part of ACIAR research trials. Fruit set failure was clearly unrelated to insects or diseases, even unusual ones like powdery mildew. Inland, higher elevation areas in North Lombok were reported to have had a good crop in 2011, but these were not visited during the fieldwork. It is possible that high temperatures experienced at pollination may be impairing pollen viability or that boron deficiency may be undermining pollen viability and pollen tube growth. It could also be a combination of both. This is a serious issue that needs to be properly researched.

As shown in Table 19, gross margins vary considerably from one farm to another, even within the same area. This is to be expected. Mango growers manage trees of different varieties and different ages, follow different cultivation practices, and experience

different weather conditions, thereby achieving different yields and producing fruit of different quality. Mango farmers also harvest their crop at different times, in a context characterised by significant weekly and monthly price variations, and sell to different buyers and through different market channels.

Table 19 Farm gross margins in Pemalang and Situbondo, 2011

	Pemalang (N = 2)		Situbondo (N = 5)
Yield (tons/ha)	10.5	25	1.7 – 7.5
Price (weighted average, IDR/kg)	7,900	5,600	2,000 – 4,900
Revenue (million IDR/ha)	83	140	6 – 34
Cultivation and marketing costs (million IDR/ha)	21	18	4 – 13
Net income (million IDR/ha)	62	122	4 – 21
Returns on household labour ('000 IDR)*	660	1,100	198 – 1,400

** The returns on household labour equal net income divided by the number of person days allocated by household members to cultivation, harvest, and post-harvest activities.*

Source: Field data, September 2012

In spite of these considerations, the gross margin data shows very clear differences in farm profitability between Pemalang and Situbondo. On a per-hectare basis, the two Pemalang farmers earned a net income of IDR 62 and IDR 122 million in 2011, around US$ 6,800 and US$ 13,500, respectively[7]. In Situbondo, net farm incomes ranged from IDR 4 million (US$ 450) and IDR 21 million (US$ 2,300). In North Lombok, net farm incomes per hectare varied between IDR 120,000 and IDR 6.2 million. It is important to highlight that the two farmers in Pemalang had an average profile in terms of scale of production: one owned 30 trees and managed another 40 under sharecropping; the other had 31 trees. Four of the five growers in Situbondo were in the same farm size category, managing between 16 and 85 trees. One had significantly larger operations, with 25 trees of his own and another 750 rented from local farmers.

Returns on household labour were high in Pemalang, but very variable in Situbondo. The two Pemalang farmers earned IDR 660,000 and IDR 1.2 million for each day spent on the farm. Three of the Situbondo growers had much lower returns, but these were still significantly higher than local wages paid to casual farm workers: they earned the equivalent of IDR 200,000 to IDR 350,000 per day spent on the farm, compared to a local farm wage rate of IDR 40,000-65,000. The two other sample farmers in Situbondo enjoyed high returns on their labour. Both relied to a large extent on hired labour, spending very little time managing their mango farms.

The example in Pemalang confirms that small mango farmers are able to develop intensive and very profitable off-season mango cultivation. During the early season, the two sample farmers in that district sold their mango for IDR 10,000-16,000 per kilogram, whereas those in Situbondo received only IDR 1,500-6,000 for their October-

[7] *IDR 1 = US$ 9,100 (2011).*

December crop. Sample farms in Pemalang were also found to be much more productive than those in Situbondo, a pattern that reflected higher investments in cultivation. Pemalang growers are more knowledgeable about mango cultivation, invest more resources in their mango farms, and harvest a high-value early crop as well as a main-season crop. Given the profit levels reported, it is unsurprising that mango farming is undergoing an expansionary phase in Pemalang. In contrast, many cases of farmers cutting down their mango trees to grow other, more profitable crops were reported in Situbondo.

Off-season cultivation also has significant employment impacts. In 2011, the two farmers interviewed in Pemalang generated US$ 715 and US$ 770, respectively, in wage income per hectare (see Table 20). This is significant and much higher than the values reported by three of the five Situbondo growers and the two farmers interviewed in Probolinggo. Two of the farmers in Situbondo hired a significant amount of non-family labour.

Finally, it should be noted that farm profitability is reflected in the market value of mango farms and the rental value of mango trees. Values of IDR 250 million to IDR 450 million per hectare were reported for mango farms in Asemdoyong village of Pemalang. In comparison, farmers and traders in Sopet and Ketowan villages of Situbondo stated that a one-hectare mango farm could be purchased for about IDR 40 million. Significant differences were also found in tree rental prices across the two provinces. In Asemdoyong village, farmers reported IDR 150,000 as the normal annual rent for one mango tree, compared to IDR 20,000-50,000 in Situbondo (and Probolinggo). Natawidjaja et al (2009) report tree rental values of IDR 50,000-100,000 for a farmer in Probolinggo and as much as IDR 0.5-1 million for one tree of the Gedong Ginku variety and IDR 200,000 for one tree of the Manalagi variety in Kuningan district of West Java . Within a village or area, trees may fetch very different rental prices, depending on the variety, age, condition, rental period, and whether rents are paid in advance or annually.

2.4 Demand

2.4.1 Product uses

In Indonesia mangoes are mainly consumed as fresh fruit or fresh juice. During the peak marketing season, fresh mango juice is widely available in cafes, restaurants, and hotels. It can also be purchased from street juice vendors. Some dried mango, mango candy, and other mango-based products can be found in urban shops and supermarkets, but in very small volumes. Most of these products are imported from Thailand, the Philippines, Malaysia, and Singapore. Several brands of locally processed mango juice can be found in shops and supermarkets, but the local product content is minimal: mango concentrate and pulp are imported, with some locally produced pulp added just for flavouring.

Table 20 Labour use in mango farms in Pemalang and Situbondo, 2011

	Pemalang		Situbondo					Probolinggo	
	F1	F2	F3	F4	F5	F6	F7	F8	F9
Labour used per ha (No. person days)	219	243	229	175	49	23	47	132	88
Family labour per ha (No. person days)	99	103	54	65	21	10	8	24	12
Hired labour per ha (No. person days)	120	140	175	110	28	13	39	108	66
Wage income per ha ('000 IDR)	6,514	7,000	8,750	6,500	1,312	567	1,940	4,320	2,190

** The returns on household labour equal net income divided by the number of person days allocated by household members to cultivation, harvest, and post-harvest activities.*

Source: Field data, September 2012

Clearly, the Indonesian mango processing industry is still at a very embryonic stage. In late 2007, according to information provided by the Ministry of Agriculture, there were only 12 enterprises processing dry mango, mango puree, mango sweets, and mango juice from fresh fruit in the whole Java Island (Morey, 2008). Kediri in East Java and Cirebon in West Java had the highest concentration of processors. Most were home-based enterprises. Such an industry structure is in stark contrast with that in the Philippines and Thailand, where there is a well-established, modern mango processing sector. The situation in Indonesia may have changed somewhat since 2007, but not drastically.

In Cirebon, the research team met with the owner and manager of Promindo Utama CV. In 2007, he received an in-kind grant from the government to start processing mango and, more recently, an award for having successfully developed a wide range of fruit-based products, including mango pulp and mango juice. He processes 40 to 50 tonnes of fresh mangoes, mostly Arumanis, during the October-December season, when fruit is widely available and prices are low. Some 80% is used for pulp, which is sold to juice companies, such as PT Surya Mitra Pasifik (Berri brand) and Unilever (Buavita brand). The remainder is turned into juice, which is marketed locally and in other parts of West Java. Last year, this processor conducted some commercial trials for mango puree as a fresh fruit drink at a university in Jakarta, and was encouraged by the results. He has also been contacted by a potential buyer from South Korea who was allegedly interested in buying 250 tonnes of mango puree per month, but he could not pursue this opportunity because the required volumes were well beyond his capacity. The processor is aware of three other family enterprises processing mango pulp and juice; two in West Java and one in East Java. He also mentioned that, in an attempt to replicate his success, the Ministry of Industry is currently providing free equipment to some potential processors in West Java, but does not believe the selected program beneficiaries have the required entrepreneurial skills to succeed.

In Bandung, the research team interviewed one staff from PR Sunrei, an American NGO with offices in Malang that has been working for five years already with one farmer group in a village of Kediri district (East Java), to develop a commercial dried mango product. During the October-December season, the group supplies Madu and Podang mango, two locally grown varieties. The fruit is then processed at a farmer's house by up to 30 women who are employed on a part-time basis during the three-month season. Five tonnes of fresh mango can be processed each season using the existing facilities and equipment, but in 2011 PR Sunrei only purchased half that amount from farmers because of difficulties in marketing the dried mango product. The product was being sold in 250 gram packs through a small mini-mart chain with three stores in Bandung, under the brand "Java Bite". Since late 2012, Java Bite dried mango can be purchased online for US$ 5.99 per pack or US$ 136 for a box of 34 packs, excluding shipping costs.

In Probolinggo, a small women's group producing dried mango, mango syrup, and mango candy was visited. The group was established five years ago by Ibu Lilik, the widow of a former BPTP researcher. Mango is processed at her kitchen with equipment provided by the government. The group also received technical training from BPTP. The production is sold in hotels and restaurants in Probolinggo town, mainly to visitors buying local specialty products to take back home. Some small volumes are occasionally sent to nearby Malang and Pasuruan. In 2011, the group processed 5 tonnes of fresh mango. When asked about other similar enterprises, Ibu Lilik replied that hers was the only mango processing business in the district. She faces no competition in local markets.

In Probolinggo, the research team also visited PT Suryajaya, a manufacturer of canned mushrooms and corn beef for the US and Japanese markets. Three years ago the company was approached by a Japanese client interested in importing one 20-tonne container of canned mangoes per week. A first trial container was exported, but the product did not meet the buyer's quality standards. The company's technical research department has since tried to develop a more stable product with longer shelf-life and more uniform size and colour, without success. According to the manufacturing manager, no company in Probolinggo is processing mango.

Finally, the research team interviewed members of a farmer association in Bayeman village, Situbondo, who were responsible for marketing mango jam, candy, syrup and juice produced by a local women's group. The group had benefited from government support under a business development program. It stopped processing mango in 2011 after facing difficulties in marketing its production in Situbondo town.

These examples show that limited domestic demand is certainly an important but not the only factor hindering the development of a mango processing industry in Indonesia. Supply-related factors also play an important role. First, processors can only afford to buy fresh mango during the short peak marketing season, when the fruit is widely available in local markets and therefore cheap. This inhibits investment in larger processing facilities, while at the same time imposing a cash flow burden on businesses that have to purchase and process mango during a very short period, but need several months or longer to sell their stock. Second, small informal enterprises are rarely able to break into the modern retail segment, which is critical for success in the market place. These businesses find it very difficult to comply with buyer's quality standards, their need for year-round supplies and support documentation, and delayed payment procedures. Third, processing enterprises supplying pulp to juice manufacturers face strong competition from cheaper imported substitutes, while those targeting the confectionery retail market have to compete with well-established exporters from other countries in the region. Finally, as illustrated by the example of PT Suryajaya, local agribusiness companies may be failing to take advantage of export opportunities because they lack the technical know-how required to develop quality mango-based products that meet international market standards.

2.4.2 Demand trends

The significant expansion of mango production during the last decade would not have been possible in a context of a sluggish domestic market. Mango growers in Indonesia have enjoyed relatively favourable domestic demand conditions as a result of strong economic and moderate population growth: since 2000, the national economy expanded at an annual average rate of 5.4%, while its population increased by 1-1.6% per annum (Trading Economics, 2013a; Indexmundi, 2013a). As in many other middle-income countries, the demand for fruits in Indonesia is responsive to changes in per capita income. According to an econometric study using 1996 data, cited in Abler (2010), in Indonesia, for every additional income unit, the demand for fruits increases by 1.39.

Demographic conditions will favour continued growth in domestic demand. While Indonesia is undergoing a rapid demographic transition, characterised by falling population growth rates, the country has a growing and increasingly urbanised population in working age (Indexmundi, 2013b). Future economic growth will be an even more important determinant of demand trends.

Despite these considerations, in a context of growing production, mango farm households are likely to continue experiencing very low prices during the peak harvesting months (see Section 2.6). Such scenario can only be inverted through significant changes in the timing of supply, i.e. widespread adoption of early-season cultivation technologies, and a major increase in exports.

2.4.3 Consumer preferences

Indonesian consumers show a marked preference for large and sweet mangoes with nice aroma, firm flesh, and little fibre content. The Arumanis variety combines all these traits, the reason why it is appreciated by many Indonesians.

Consumers also appreciate mangoes that are harvested ripe (*masak pohon*), but these are very expensive. Only relatively wealthy urban consumers can afford them. The fact that *masak pohon* mangoes are more susceptible to pests and diseases at farm level and losses during transportation makes them a risky option for both farmers and traders. Hence, mangoes are normally retailed green. After purchasing the fruit, consumers have the inconvenience of having to wait several days before it is ripe and ready to eat. The fresh produce manager for Hero and Giant sees an opportunity in ready-to-eat mangoes that have been subject to controlled ripening using ethylene, but at the moment he cannot find suppliers for this fruit.

Contrary to other countries, Indonesians have no marked preference for yellow-skin mangoes. They have grown accustomed to eating green-skin varieties and attach much greater value to taste than skin colour. Yellow-skin mangoes have been imported from Thailand and South Africa, but in very small quantities. Such imports are concentrated during the February-April period, when local mangoes are not available.

As highlighted by many traders, most Indonesian consumers are not particularly bothered about skin blemishes or marks. This may explain why these traits are not specified in standard mango grades. While some modern retailers catering for the top-end of the market require fruit with clean skin, in the traditional market channels (and in many modern retail outlets) variety and size are more important product attributes. In a context of rapid urbanisation and growing household incomes, the demand for quality will continue rising, but at present the average Indonesian consumer is not a particularly discerning consumer. S/he cannot afford to be. For most Indonesians, price is still the main determinant of their mango purchasing choices (Toiba et al, 2012).

2.5 International Trade

2.5.1 Exports

Indonesia has had a small export trade in mangoes since the early 1990s (see Table 21). During the last decade, exports varied between 425 and 1,908 tonnes per annum. The annual average for the period was 1,137 tonnes, less than 0.1% of domestic production. Annual export revenues averaged about US$1 million, peaking in 2002, a year of high export prices, at US$ 2.7 million. Export prices have been falling since 2005, but recovered in 2010.

Table 21 Mango exports from Indonesia, 2000-2010

	Volume (tonnes)	Value (US$)	Average FOB price (US$/tonne)	Production* (tonnes)	Share of production (%)
2000	430	402,000	935	876,027	0.05
2001	425	289,000	680	923,294	0.05
2002	1,573	2,672,000	1,699	1,402,910	0.11
2003	559	461,000	825	1,526,470	0.04
2004	1,880	2,013,000	1,071	1,437,670	0.13
2005	941	996,000	1,059	1,412,880	0.07
2006	1,182	1,161,000	982	1,622,000	0.07
2007	1,198	1,004,000	838	1,818,620	0.07
2008	1,908	1,646,000	863	2,105,090	0.09
2009	1,415	1,161,000	821	2,243,440	0.06
2010	999	1,065,000	1066	1,827,290	0.06
Average	1,137	1,170,000	985	1,563,245	0.07

Source: FAOSTAT, October 2012 and author's calculations

Discussions with several exporters confirmed that Singapore remains the main export destination, followed by the UAE. Occasionally, some mangoes are also exported to Malaysia and Hong Kong. Air freight costs to Singapore are much lower than to other regional markets, a key determinant of current export flows. Moreover, importers and consumers in Singapore are already familiar with the Arumanis variety, which has been imported from Indonesia for more than two decades. Malaysian consumers are also known to appreciate Arumanis, which is produced in Perlis Regency, but Indonesian exporters prefer to target the Singaporean market because of its less strict quality requirements, lower air freight costs, and higher prices.

Air freighting mangos from Indonesia is very expensive. Sending one tonne of mangoes from Jakarta to Singapore adds US$ 700 to the FOB export price, more than the cost of the fruit to the exporter, compared to just US$ 45 in the case of sea freight ex-Surabaya (see Table 22). The difference is even starker for more distant destinations: air-freight rates to Hong Kong and Dubai are in the US$ 1,000-1,700 and US$ 1,700-2,000 range per tonne, respectively, but if exporters were to use the sea-freight option, they would only pay about US$ 55 and US$ 100.

Table 22 Air-freight costs from Jakarta and sea-freight costs from Surabaya

	Air freight (US$/tonne)	Sea freight (US$/tonne)
Singapore	700	45
Hong Kong	1,000	55
Dubai	1,700 - 2,000	100

Source: Key informant interviews, September 2012

Dependency on air transportation constitutes a significant barrier to the development of mango exports. As discussed in Section 2.1, Indonesia enjoys strong export fundamentals due to seasonality and geography. In October and November, it has an abundant and very cheap supply of Arumanis at a time when other Asian countries have no local production and no access to nearby sources of mangoes (see Table 6). During those months, Indonesia faces no competition in Asian markets from major exporters in the region, such as India, Thailand, Pakistan or the Philippines. These are also major mango consuming countries and therefore potential additional export markets. India alone consumes more than 15 million tonnes during its mango harvest season. Brazil does export significant volumes late in the year, but mainly to the US and the EU. The country is not competitive in Asian markets due to distance.

Indonesian mango exporters have so far failed to fully optimise the use of sea freight because they lack the required knowledge of post-harvest technologies for preserving fruit quality. Post-harvest trials have shown that anthracnose, stem-end rot, and fruit flies, all of which have a very negative impact on the quality and shelf-life of the fruit, can be largely addressed by dipping the fruit for two or three minutes in a cold water solution containing fludinoxinol or azoxystrobin (Thistleton and Baker, 2012). At 15ºC, these treatments ensure a shelf-life of more than 14 days, allowing for sea transportation to Southeast Asia: Singapore is just two or three days away from Surabaya by sea; Hong Kong, Kuala Lumpur and Bangkok can be reached within five to seven days; and Ho Chi Minh is eight or nine days away. None of the fruit exporters consulted knew about these simple and affordable post-harvest treatments.

A shift to sea transportation would lead to a significant reduction in the CIF cost of Indonesian mangoes. This would boost demand in current destination markets and could potentially generate some interest in other regional markets. Higher gross margins along the whole export chain, in turn, would provide the incentives, as well as the means, for an upgrading of quality management systems from the farm to the port. Finally, cheaper sea freight would extend the export season, as exporters would be able to procure more expensive fruit.

In the short to medium term, exporters would be able to expand supplies to current markets, particularly Singapore, Malaysia and Hong Kong. Vietnam and Thailand are potential markets, but may require bilateral market access protocols. Chennai can be reached within nine or ten days, but it is likely that Indonesia would need to develop and sign a quarantine agreement with India for access to this market. Access protocols are also required for exports to China. These take time to develop: they have to be negotiated government to government and supported by research proving the effectiveness of post-harvest pest management technologies. Indonesia already has pest lists for mango, the starting point for negotiations. For most countries, fruit fly will be the pest of concern. HWT at 55ºC will likely be the most cost-effective Phytosanitary treatment, as both Arumanis and Gedong Gincu have been shown to have high heat tolerance (Thistleton and Baker, 2012). VHT is a very expensive alternative required by Japan and South Korea, and needed for varieties sensitive to heat damage. Radiation is required for access to the North-American market, but this is too far from Indonesia.

The international mango trade is based on yellow- and red-skin varieties. The fact that Arumanis has green skin when ripe is often perceived as a major reason why mango exports from Indonesia have failed to develop. The research team considers that this issue has been somewhat overstated. First, recent air-freight trials to Hong Kong,

Singapore, and Kuala Lumpur have shown a favourable market response to Arumanis provided the quality of the fruit can be assured (Thistleton and Baker, 2012). Consumers in Singapore and Malaysia are already familiar with this variety, which is appreciated for its large size, firm flesh, and sweet taste, qualities that could also generate interest in other export markets, especially in a context where quality mangoes are delivered by sea at very affordable prices.

Second, skin colour would be more of an issue of concern if Arumanis was competing with other yellow- and red-skinned mangoes, but this is not the case. Arumanis is exported when few competing supplies are available in the region. Finally, not all mangoes exported are sold in fresh fruit markets, where colour is an important determinant of consumers' purchasing decisions. In Hong Kong, for example, there is a relatively large market for food service mangoes, which command a good price. There is also a significant market for fresh mango juice, for which Arumanis is very suitable, although this is a low-quality, low-price segment of the market.

The Indonesian Government's interest in new varieties seems to be driven by a perception that skin colour is a major impediment to export development. While there is always a role for varietal development and diversification, the research team's view is that this should not be the main focus of a mango export development strategy for Indonesia, at least in the short to medium term. It will take many years for new varieties to be developed and adopted. Achieving critical mass for the export market is an even longer process. As highlighted by farmers and traders in Cirebon, it took more than a decade for Gedong Ginku to become widely available in Jakarta and other cities of West Java. But this is still a niche variety: as an example, in 2011, the Hero and Giant chains sold 2,800 tonnes of fresh mangoes, of which 2,400 tonnes were Arumanis and only 120 tonnes Gedong Ginku. This variety is exported to the Arab States, where consumers are familiar with Alphonso, an Indian cultivar with very similar appearance, but current volumes are very small. In Singapore, Hong Kong or Malaysia, consumers seem to prefer the larger-sized Arumanis.

Other concerns should be raised about the development of new varieties for export. First, these will need to be well adapted to Indonesian growing conditions. Indonesia is unusual in that mangoes are not subject to a cool period to initiate flowering, and for this reason many foreign varieties may under-perform under local climatic conditions. It is quite possible that they will not perform as well as Arumanis in terms of yield, resistance to pests and diseases, and response to growth regulator.

Second, export varieties must be able to tolerate Phytosanitary treatments and have suitable shelf-life for long sea freight. Consumer acceptability in current and potential export markets is equally critical. As far as the research team is aware, these export traits are not being mainstreamed within national varietal selection programs, although one of their explicit aims is to introduce cultivars with strong acceptance in export markets.

Finally, no variety will be adopted at scale unless it can succeed in domestic markets. Only part of the production will meet the strict quality requirements of the export trade; the rest will have to be sold domestically. It will not be easy for yellow- and red-skinned mangoes to gain widespread market acceptance in a country where consumers have grown so accustomed to cheap green-skin mangoes. New varieties may add little to a market that is well served by Arumanis and other local varieties.

2.5.2 Imports

Mango imports increased significantly between 2000 and 2007, but from an exceptionally low base, stabilising thereafter around 800 to 1,100 tonnes per annum (see Table 23).

Table 23 Mango imports in Indonesia, 2000-2010

Year	Volume (tonnes)	Value (US$)
2000	64	95,000
2001	186	131,000
2002	254	172,000
2003	348	329,000
2004	689	446,000
2005	869	437,000
2006	966	627,000
2007	1,088	725,000
2008	969	604,000
2009	821	555,000
2010	1,129	817,000

Source: FAOSTAT, October 2012

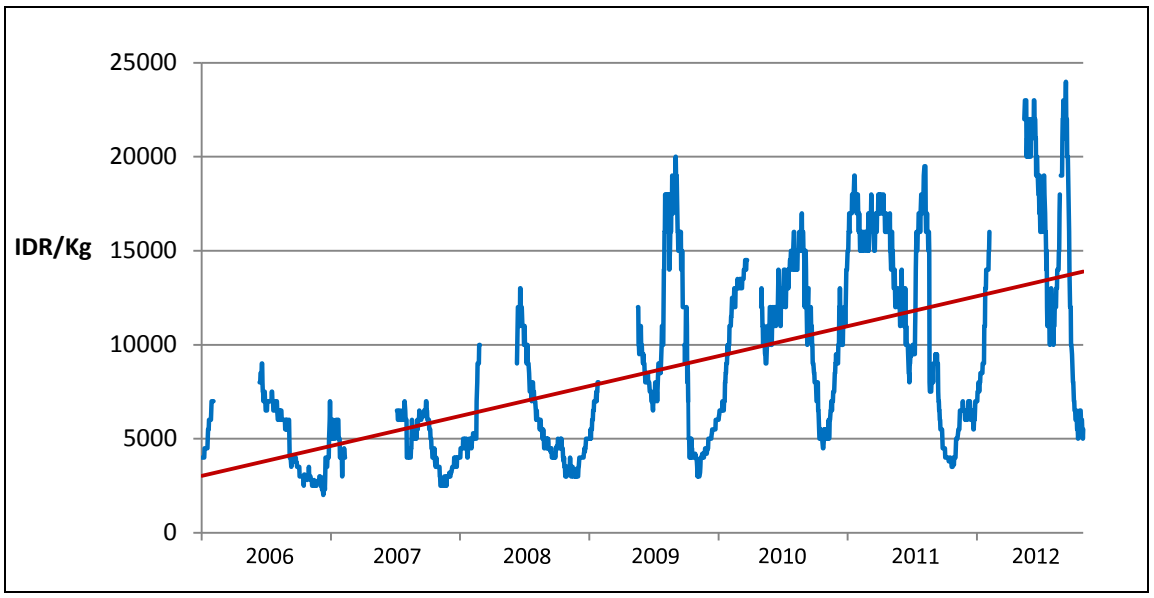
Most imported mangoes are retailed in supermarkets and specialised fruit stores in the larger urban centres. High retailing prices and a marked preference for local varieties constitute a major deterrent for Indonesian consumers.

Despite government concerns, which have led to a temporary ban on mango imports for the first six months of 2013 (DAFF, 2013), these pose no real threat to Indonesian mango growers. Volumes imported from Thailand, South Africa or the Philippines are very small and concentrated during the February-May period, when no local supplies are available. Between June and January, imported mangoes cannot compete with local produce because of the high level of natural protection afforded by geographical distance and Indonesians' strong preference for local varieties.

2.6 Prices

2.6.1 Price trends

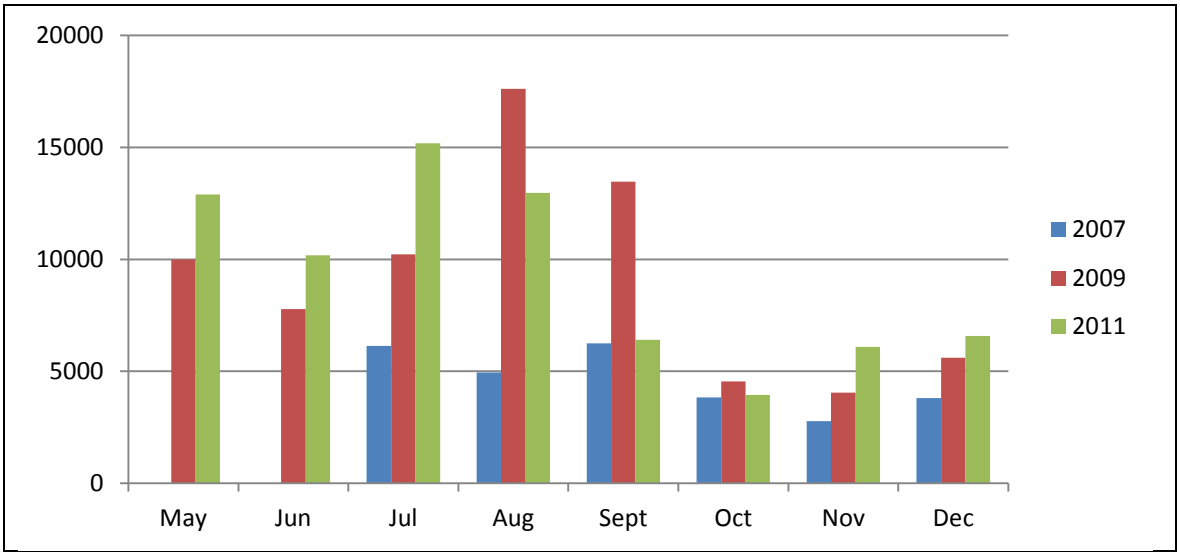
Figure 1 shows the price of grade A Arumanis in Kramatjati market, Indonesia's largest wholesale market for fresh produce, between 1 January 2006 and 23 October 2012. A simple visual analysis shows that mango prices have been increasing over time, which in a context of rising production is a strong indication of growing domestic demand.



Source: Management Board of Kramatjati Wholesale Market

Figure 1 Wholesale price of grade A Arumanis mango in Kramatjati market, Jakarta, 1 January 2006 – 23 October 2012

However, an analysis of price trends by month provides a more nuanced perspective (see Figure 2). It is true that, for most months, there is a positive price trend. But that is not the case of October, a month when a significant part of the mango crop is harvested and sold. Average nominal prices in October 2011 were lower than in October 2009, a record production year, and basically the same as in October 2007. The comparison would be even more unfavourable once inflation is accounted for. It is not surprising, therefore, that all the farmers interviewed complained so much about low prices.



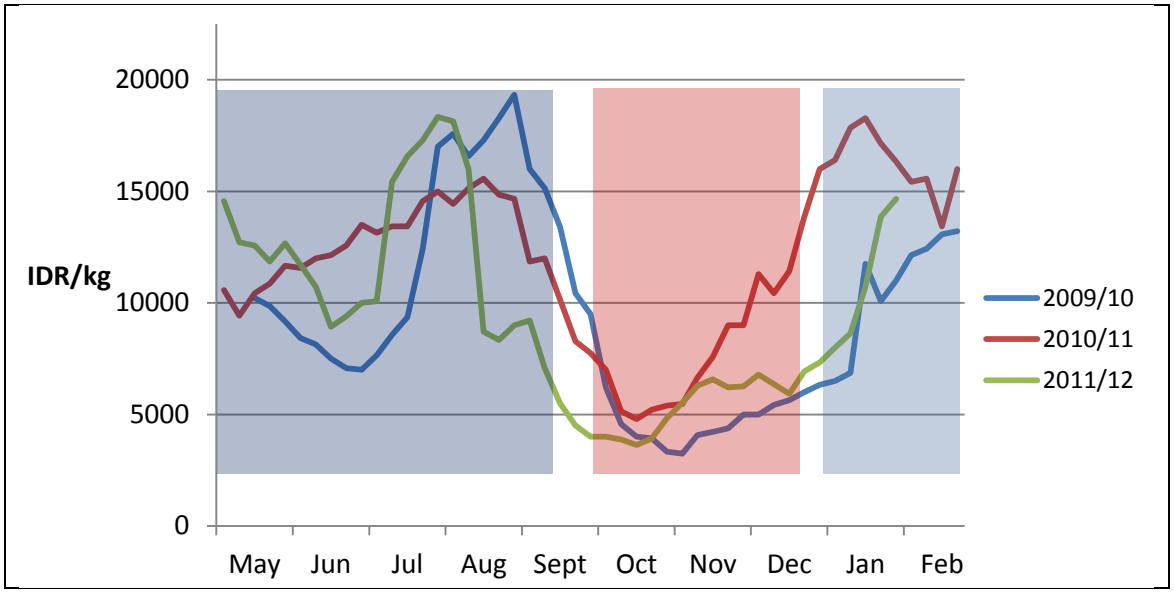
Source: Management Board of Kramatjati Wholesale Market, 2012

Figure 2 Average monthly price of grade A Arumanis (IDR/kg), Kramatjati market, Jakarta

2.6.2 Price seasonality

Intra-annual price variations reflect the seasonal distribution of supply, with prices following a U-shape curve (see Figure 3). Mango prices are generally high between May

and mid-July, when only West Java and Central Java are supplying the market. Deliveries from these two provinces start dwindling towards the end of July, resulting in several weeks of rising prices. After an August peak, prices fall steeply, with a very clear dip in October and November, when the market is literally flooded with mangoes from Eastern, Central and Western Java. In mid- to late November, as the Java harvest is coming to an end, prices start rising. That is when mangoes from Bali and NTB are exported to Java.



Source: Management Board of Kramatjati Wholesale Market, 2012

Figure 3 Average weekly prices for Arumanis (grade A) in Kramatjati market, Jakarta

In October and November, mango is sold in Kramatjati for one-fourth to one-half of the May-September prices (see Table 24). Such striking seasonal price differences explain why growers in Cirebon and Pemalang place such emphasis in getting as much of an early crop as possible. Understandably, traders and farmers consistently mentioned low prices during the main harvesting season as the issue they are most concerned with.

Table 24 Monthly price ratios for October and November*, 2009-2012

	October price ratios					November price ratios				
	Oct/May	Oct/ Jun	Oct/ Jul	Oct/ Aug	Oct/ Sept	Nov/ May	Nov/ Jun	Nov/ Jul	Oct/ Aug	Oct/ Sept
2009	0.46	0.59	0.38	0.26	0.34	0.40	0.52	0.40	0.23	0.30
2010	0.53	0.45	0.40	0.37	0.54	0.70	0.60	0.52	0.49	0.72
2011	0.31	0.39	0.26	0.30	0.62	0.47	0.60	0.40	0.47	0.95
2012	0.26	0.31	0.43	0.39	0.41	**	**	**	**	**

** The ratios presented in this table are calculated as the average monthly selling price in Kramatjati wholesale market for October or November divided by the average monthly price in that same market in May, in June, in July, and so on.*

*** November price ratios for 2012 could not be determined because the time series price data for Kramatjati market ends in 23 October 2012.*

Source: Author's calculations based on daily wholesale price data for Kramatjati market in Jakarta

3 The Fresh Mango Value Chain in Situbondo and North Lombok

3.1 Spatial Product Flows

Natawidjaja et al (2009) provides a good description of mango trade flows within Java and between this and other islands. The study shows that most of the mango harvest in Java is consumed within the island. An estimated 20% is exported to other islands, particularly Sumatra and to a lesser extent Kalimantan. Small volumes are imported from Sumatra in March and April and from Bali and NTB from November to January.

Jakarta is a major destination for mangoes from East, Central, and West Java. It represents a large consumption market and is a strategic distribution centre for surrounding urban areas and Sumatra. Mango wholesalers in Jakarta have close links with wholesalers in Bekasi, Tanggerang, and different cities in Sumatra. Cibitung market in Bekasi, Tanah Tinggi market in Tanggerang, and Caringin market in Bandung also attract significant volumes from major production areas across Java. These three wholesale markets are not only located in urban centres with a large population but also supply nearby districts and cities in Sumatra (Natawidjaja et al, 2009). Surabaya is the largest urban market in East Java and an important transit point for Kalimantan. Mangoes consumed in Surabaya or exported to Kalimantan are mainly sourced within East Java (Natawidjaja et al, 2009).

Key informant interviews show that most production in Situbondo is channelled to urban centres outside the district and the province. Jakarta stands out as the main destination, followed by cities such as Bandung, Yogyakarta, Surabaya, and Malang. Mangoes from Situbondo are also sent to Kalimantan.

Mangoes from NTB are consumed within the province and exported to Bali and Java. According to Suudi et al (2010), inter-island trade accounts for some 75 % of provincial production. This trade starts in mid-November, as the harvest in East Java is coming to an end, and continues until January. The other 25% of production is consumed within NTB. Mataram is the main consumption market in the province.

Variety is an important determinant of spatial product flows. The fact that Arumanis accounts for most production in Situbondo is an advantage, as this variety enjoys strong demand in large cities across Java and Sumatra. Some districts in East Java are not as fortunate. Kediri, for example, is known for its Podang mango, a yellow-red variety with large seed and high fibre content that is mainly consumed within the province. In NTB, most of the mango trade with Java is also focused on Arumanis (Suudi et al, 2010). Other commercial varieties, such as Madu and Manalagi, are mainly consumed within Lombok, although some are also sent to Bali and Java.

3.2 Characterisation of the Mango Value Chain in Situbondo

3.2.1 Chain structure and product flows

Mango value chains in Situbondo are structured and organised according to spatial product flows. Small village collectors and district wholesalers are key actors in intra-

district chains, depicted in Figure 4, but play a relatively marginal role in inter-province chains, represented in Figure 5. In these longer chains, the product collection function is essentially performed by larger village or sub-district traders, who buy from farmers and collectors and send the fruit directly to urban markets outside the district, without the involvement of local wholesalers.

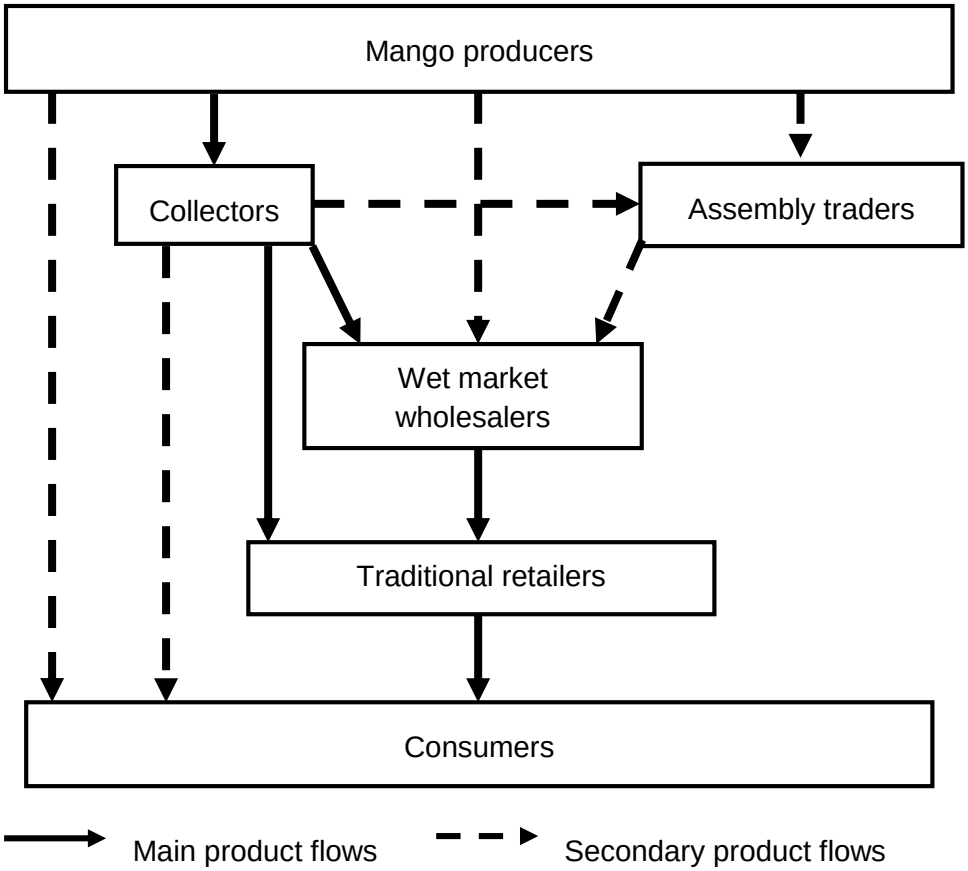


Figure 4 Simplified intra-district mango value chain in Situbondo District

Local mango chains absorb relatively small volumes of lower-quality fruit, thereby offering limited upgrading opportunities. Significant improvements in local production and marketing systems will have to be driven by developments in chains linking farmers to large urban centres outside the district and the province and to export markets.

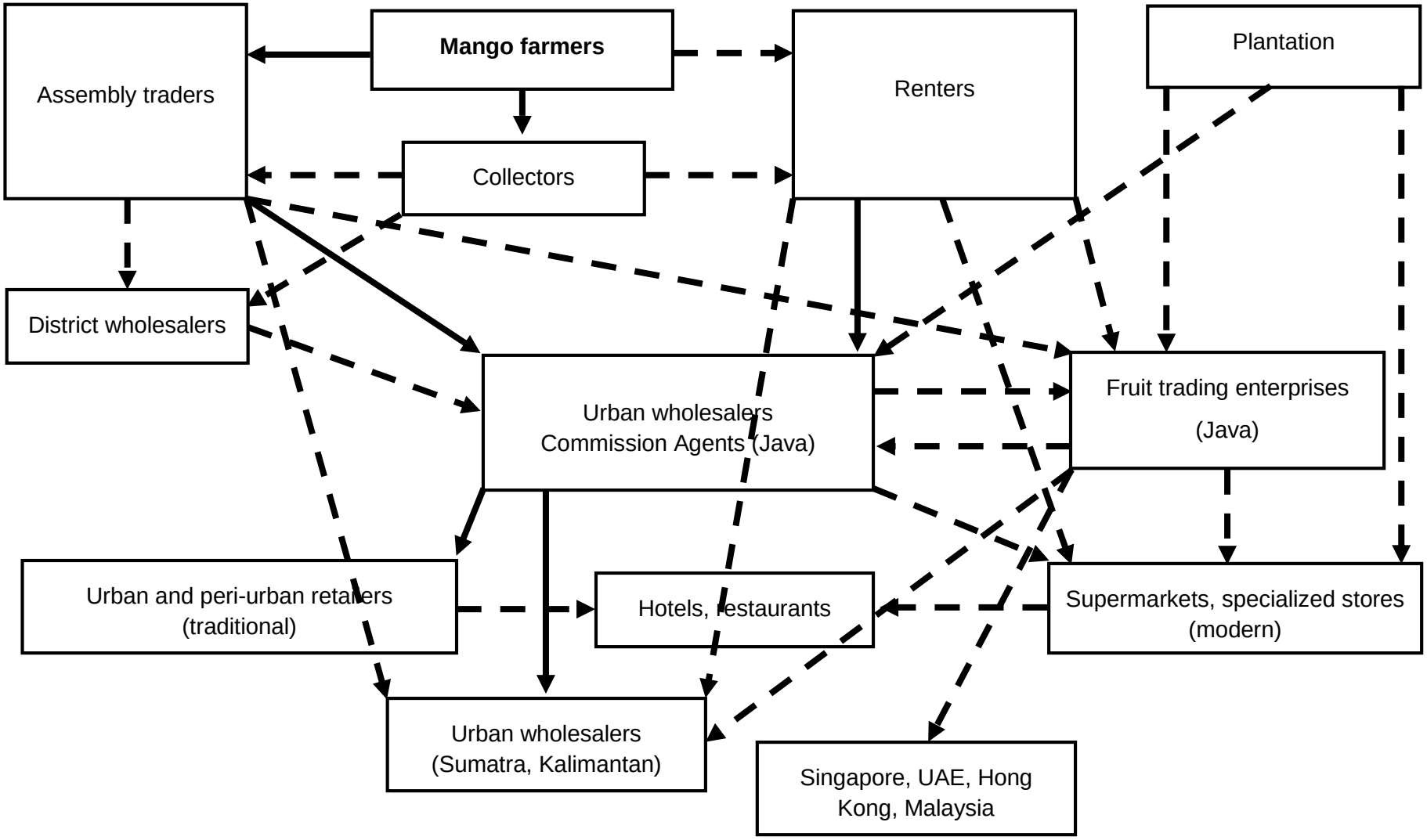


Figure 5 Simplified inter-regional, inter-island and export mango value chains from Situbondo

Most mangoes in Indonesia are sold through traditional market channels. Situbondo is no exception. Most of the local harvest is channelled to traditional retailers through primary and secondary wet market wholesalers operating in large cities. Still, some chain actors in Situbondo are linked to the modern retail segment. For example, Trigatra Rajasa, a plantation with 130 hectares under mango, sells about 60% of its production to different modern retail chains, including Carrefour, Super-Indo, Ramayana, Sinar and Lotte. Five farmer groups in Sopet, one of the villages visited during the fieldwork, are selling mangoes to Pak Suli, a trader in Probolinggo who supplies Indo Mart. In 2011, Pak Suli marketed 395 tonnes of fresh mango, of which 64 tonnes (about 15%) were channelled to this retailer. Kramatjati market accounted for nearly 50% of total sales. Pak Suli also sent 80 tonnes to Singapore and 68 tonnes to one wholesaler in Medan.

While hypermarkets, supermarkets, and convenience stores have literally mushroomed across Java, Sumatra, Bali, Sulawesi and Kalimantan (Suryadarma, 2011; Rangkuti and Slette, 2010; World Bank, 2007), the modern retail segment still accounts for a fairly small share of the mango retail market. Mango is one of the leading local fruits in the portfolio of hypermarkets and supermarkets, alongside bananas, oranges, mangosteens, and pineapples, but imported fruit accounts for a larger share of their turnover (Rangkuti and Slette, 2010; Natawidjaja et al, 2009; World Bank, 2007).

Previous estimates attributing a 20% share of the mango retail market to the modern segment (Natawidjaja et al, 2009) seem exaggerated. That share is more likely to be around 5% in Java and lower in other parts of the country. According to unpublished survey data[8], only 9.2% of households in Surabaya, Bogor, and Surakarta (Solo) cities purchase most of their mangoes from hypermarkets, supermarkets and convenience stores (Wendy Umberger, pers comms, October 2012). Over 90% rely mainly on traditional wet markets (47.8%), semi-permanent stands (25.1%), peddlers (11.1%), small shops (5.7%), and other outlets (1.1%). It should be noted, moreover, that this household survey was conducted in medium-to-large, relatively affluent cities[9]. Smaller urban centres have a much less dense network of modern retail outlets. Many, such as Situbondo town, do not even have one single hypermarket or supermarket. And as of 2010, nearly half (46%) of Indonesian households were still classified as rural (Indexmundi, 2013c), having no daily access to a hypermarket or supermarket store.

Qanti et al (2012) provide further evidence of the relatively small size of the modern retail sector. Only 3% of mango farm households in two districts of West Java, the most densely populated and urbanised region of Indonesia, sold to specialised or dedicated wholesaling enterprises supplying supermarkets, restaurants, hotels, processors, and exporters. In the two survey districts in East Java, the figure was even lower (1%). The proportion of mango growers in those four districts supplying the modern channel increased to 10% once indirect sales, i.e. sales to suppliers of “modern” wholesalers, were considered. However, as illustrated by the example of PT Sumber Buah in Cirebon, a significant proportion of mangoes flowing to “modern” wholesaling enterprises are subsequently sold to traditional wholesalers.

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[8] This data was collected between November 2010 and January 2011 from 1,180 urban households, as part of an ACIAR-funded market research project.

[9] With a population of 2.8 million, Surabaya is Indonesia’s second largest city (City Population, 2013). Bogor and Surakarta have a population of 890,000 and 506,000, respectively.

PT Sumber Buah, a family-owned business in Cirebon, is the largest mango exporter in Indonesia. In 2011, this enterprise marketed 2,400 tonnes of fresh mangoes: 1,200 tonnes were sold to traditional wholesalers in Sumatra; 500 tonnes were sent to traditional wholesalers in Kalimantan; and 600 tonnes were exported to Singapore and the UAE. Only 100 tonnes, less than 5% of the total sales volume, were channelled to Carrefour, a market leader in Indonesia, with nearly 50% of the hypermarket segment turnover (Rangkuti and Slette, 2010). Pak Suli in Probolinggo provides a similar example: he is a supermarket supplier, but relies on traditional channels for most sales. He also exports small quantities of fresh mangoes.

Pak Hadi from Sumber Buah mentioned several reasons why a large mango trading enterprise cannot rely on modern retailers for a significant share of its business. First, an enterprise catering for this segment of the market needs to be very selective in its fruit purchases, as hypermarkets and supermarkets tend to have stricter quality standards than buyers in mainstream markets. Second, that enterprise needs to have contracts with many different chains and stores because each will purchase relatively small quantities from individual suppliers. In a context of formalised transactions and rather inflexible contracts, this entails significant transaction costs. Finally, excessive reliance on modern retailers is problematic because of strict penalties for non-compliance and late payment procedures.

Data provided by the Hero/Giant chain is presented as further evidence of the small size of the modern retailing segment as far as mango sales are concerned. Giant, which targets medium-income households and accounts for about 18% of the total sales turnover in the hypermarket segment, and Hero, a supermarket chain from the same group that targets high-income customers and commands a 15% share of the supermarket segment (Rangkuti and Slette, 2010), sold 2,850 tonnes of fresh mangoes in 2011, equivalent to just 16 tonnes per outlet. That same year, Pak Lukman Hakim, one of the largest wholesalers in Kramatjati market, sold more than 4,000 tonnes to secondary wholesalers in Jakarta and other cities in West Java, Sumatra, and Kalimantan.

3.2.2 Chain structure and product flows

Input distribution

Mango growers in Situbondo have good physical access to inputs. They normally have several input retail stores within relatively short distance selling a wide range of fertilisers, sprayers, insecticides, and fungicides. Inputs are typically purchased by male members of mango farm households and paid for at the time of purchase. Input suppliers may sell on credit to some regular customers they know well. No interest is charged on these transactions.

Input retailers source their products from distributors or input retailers in Situbondo town. Many are visited regularly by sales staff from different seed and chemical companies stationed in the district, whose main role is to promote and provide some simple information about the company's products. Input retailers also access information about specific insecticides or fungicides from product leaflets distributed by chemicals companies and during product launching events or annual meetings organised by these companies. Product leaflets are commonly available in shops for distribution to farmers. The focus is on applications in rice, maize, and vegetables, not mangoes, which are regarded by chemical companies as having limited business development potential. Generally, input retailers in Situbondo have little, if any, access to technical information

about mango. When asked about the use of Paclobutrazol in mango trees, one input shop owner in Situbondo town, who is also a Dinas Pertanian staff, explained that this should be sprayed, a method that will fail to induce flowering. He explained that he learned about this application method from one BTPT staff.

Different brands of Paclobutrazol can be purchased at the village, sub-district, and district levels. Avocet, Get Well, and Goldstar are the most commonly used by farmers in Situbondo. These brands are much cheaper than Cultar. Avocet can be ordered from the distributor in Surabaya for home delivery. The company has also produced posters advertising the product. The research team saw one such poster in a mango tree just outside a house in Ketowan village. The distributor of “Get Well”, another Paclobutrazol brand, is organising meetings with farmers to introduce their product. In 2012, after having participated in one such meeting, 40 farmers in Sopet village purchased Get Well from the agent in Situbondo town. They were only required to pay 40% of the cost upfront. The other 60% were to be paid after the harvest.

Larger chemical companies, e.g. Syngenta, Bayer and BASF, implement farm demonstrations as part of their product promotion strategies. Farmers and some input retailers are invited to attend field days. As mentioned, however, these activities focus on pest and disease management for rice, maize and vegetables. Ten years ago, Syngenta implemented a program of demonstrations targeting mango farmers in West Java. The main aim was to promote Cultar, its own brand of Paclobutrazol. This was a one-off initiative, however, as many cheaper brands have since become widely available in the market.

Messages about safe storage and safe application of chemicals are often conveyed during farm demonstrations and more informal interactions between company staff and farmers. Occasionally, samples of protective masks, clothing, and gloves are distributed. Chemical companies also disseminate some extension messages about application dosages. Excessive use of insecticides is a problem for those companies because it leads to pest resistance, thereby undermining the effectiveness (“shelf-life”) of their product solutions. Despite these efforts, farmers do not use any protective gear and continue to apply excessive amounts of chemicals to their crops. Men are particularly affected as they are the ones spraying the crops. Changing such entrenched habits appears to be a daunting task. When asked about the use of masks and gloves, mango farmers participating in focus group discussions usually laughed. The most common reply was that they would not be able to smoke if they were wearing protective masks. On a more serious note, farmers mentioned that wearing masks, gloves, and long sleeves is very uncomfortable in a hot climate such as Indonesia’s.

Production

In Situbondo and Probolinggo, as in Cirebon and Pemalang, the research team only interacted with male farmers. This does not reflect a bias in sampling. Rather, it is a consequence of the fact that mango farming in Java is an activity carried out by men, irrespective of farm size. The involvement of women as farm managers or farm workers is minimal. The purchase of inputs, the spraying and pruning of trees, weeding, irrigation, harvesting, and marketing are usually carried out by men.

There are five different categories of mango producers in Situbondo. These are not static, as some producers may at times decide to disengage from mango cultivation while others may follow the opposite strategy. These different categories are described below:

- Backyard farmers. A very significant number of mango farmers have just a few trees around their houses or farm plots. These farmers use very few (if any) external inputs. Many simply rent out their trees to other farmers or traders, or sell the fruit on the tree, a system known as *tebasan*.
- Marginal farmers. There are many farmers with 10 to 20 trees. These may rent-out their trees, sell the fruit on the tree, or harvest and market it themselves. Marginal farmers tend to fertilise their trees. They may or may not apply some fungicides and insecticides. Many will hire some labour, especially during the harvest. Few will use growth regulators to stimulate flowering. The crop is normally sold to collectors and village assembly traders.
- Small farmers. In the main mango producing areas within Situbondo, each village will have many farmers with 20 to 100 trees. Some may rent their trees to others or sell the crop on the tree, but many will harvest the fruit themselves. Some will rent trees from other farmers. Hiring of labour to fertilise and spray mango orchards and harvest the crop is common. An increasing number of small mango growers are starting to use Paclobutrazol. Often, mango collectors and assembly traders are also small mango growers.
- Medium farmers. There are not many mango producers in Situbondo with 100 to 500 trees. Most producers under this category are mango traders. Rented trees around houses, farms, and in small orchards will typically account for most trees under their management. Medium growers fertilise and spray their mango crop, relying on hired labour to perform such tasks and harvest the crop. However, the amount of inputs used is relatively small, especially when compared to growers in Cirebon and Pemalang, even those managing just 40 or 50 trees.
- Large producers. There are very few producers in Situbondo with more than 500 mango trees under their management. The team interviewed one assembly trader and head of a farmer group who rents 3,000 trees, as well as the largest renter in the district, who manages about 20,000 trees scattered across different parts of East Java. The team also visited a 130-hectare mango plantation. Large renters employ teams of permanent farm workers but also hire casual labour during certain periods of the year. They have one or more packing houses, depending on the scale and geographical dispersion of their business, and supply wholesalers in large urban centres. Some also supply modern retail chains. Using Cirebon and Pemalang farmers as benchmarks, it is clear that the two large renters interviewed follow low-input production strategies. The viability of their business model rests on their ability to rent a large number of trees for a low price and to sell their harvest directly to buyers in major consumption centres, not on their capacity to achieve high yields and produce an off-season crop that can be marketed for a high price. Some renters also earn an income marketing the production of other farmers. The plantation visited focuses on the production of high-quality, in-season fruit for the modern retail segment. This enterprise faces serious production problems, in part because of poor orchard design.

In Situbondo, there are 26 mango interest groups supported by Dinas Pertanian. Bayeman village, in Arjasa sub-district, has three mango groups. Sopet, a village of Jangkur sub-district with some 400 hectares under mango, has six. Ten farmers in this

village, belonging to two groups, one with 38 members and the other with 46 members, were represented in a discussion facilitated by the research team.

Most groups in Situbondo have between 20 and 40 members. Some will have a larger membership. Groups tend to aggregate small growers with 20 to 100 trees each. The Chairman and committee members will often manage a larger number of trees. Most group members sell their fruit after harvest, not on the tree. According to Dinas Pertanian, more than 800 farmers in Situbondo, managing an area of at least 500 hectares, belong to mango interest groups.

These groups have been formed by government as vehicles for delivery of extension services and financial assistance, a very similar context to that described in a study on supermarkets and horticultural development in Indonesia (World Bank, 2007). Most groups have an office and some equipment paid for by government. Equipment such as sprayers is often rented to members. These may also purchase some inputs, such as Paclobutrazol or fertiliser, collectively. Usually, the Chairman will be an assembly trader who buys the harvest from group members. Committee members may also have their own mango trading businesses.

These groups have little chances of evolving into successful collective enterprises. They lack the necessary vision, cohesion, self-reliance, and market-orientation. Furthermore, group leaders have little incentive to share the profits from mango trading with members. External assistance is unlikely to change these fundamentals to an extent where groups evolve into competitive cooperative enterprises. Despite these considerations, mango interest groups provide a good focal point for interventions aimed at facilitating innovations in the production and marketing sphere.

As highlighted by many key informants, mango farmers often sell their fruit to motorbike collectors and local assembly traders when their trees are flowering or setting fruit. Some sell the fruit later, just a few weeks before harvest or around harvest time. According to estimates by Natawidjaja et al (2009), 78% of the 2002 harvest and 72% of the 2007 harvest in East Java was sold on the tree. In West Java, the estimated shares for those two years were 56 and 71%, respectively. The sale of fruit on the tree provides a clear indication that, for many farmers, mango is not a priority crop.

For fruit sold on the tree, the value of the transaction will be influenced by expectations about yield, fruit quality, and market prices. Farmers normally receive an initial deposit when the transaction is agreed, but some may be paid in full around that time. Early payment is one of the main reasons why so many farmers opt to sell fruit on the tree. The payment modality will influence the outcomes of the negotiation with the buyer: the higher the proportion of the transaction value advanced the lower the price. The timing of sale will also influence prices, as the earlier the transaction the higher the implicit loan provided, and the production and marketing risks incurred, by the buyer. While purchases of fruit on the tree increase traders' exposure to risk, this system often generates higher profits than the alternative of purchasing the fruit after harvest (Natawidjaja et al, 2008).

Growers selling the fruit after this has been picked will normally be paid at the time of the transaction or a few days later. These farmers rarely receive input credit or seasonal loans from buyers. None of the traders interviewed in Situbondo (and in Probolinggo) provides in-kind credit or cash loans to mango farmers. This finding is consistent with recent research showing that only 11% of medium mango growers, 5% of small growers, and 3% of marginal growers in four districts of East Java and West Java receives advances or

input credit from buyers (Qanti et al, 2012). However, within the small sub-sample of farmers participating in the modern channel, 80% receive some form of credit from buyers.

Mango farmers in Situbondo also receive limited technical information from buyers. This is not surprising. In Situbondo, village and district traders generally have poor knowledge of mango cultivation. In addition, it could be argued that may lack the incentives for transferring technical know-how, as they can benefit from having a large clientele of rather passive farmers willing to rent-out their trees for a low price or sell their fruit on the tree cheaply. This perceived lack of incentives to support an upgrading of mango production systems may also explain, at least in part, why assembly traders rarely provide credit to farmers. Working capital constraints are likely to play a role as well.

Transfer of technical know-how by research and extension staff is also limited. The study team came across some examples in Situbondo where incorrect information about Paclobutrazol had been provided on the basis of findings from poorly designed farm demonstrations. More generally, government extension and research services have played a relatively minor role in technology adoption in the mango sub-sector in Java (Qanti et al, 2012).

Given this context, farmers in Situbondo rely mainly on each other for information about mango cultivation. However, the knowledge base sustaining farmer-to-farmer learning is very poor. Incorrect information, for example about Paclobutrazol application methods and the impact of growth hormones on tree health, is often exchanged. Farmers also have limited knowledge about fertilisation and pest and disease management.

Assembly

All village assembly traders met by the research team in Situbondo and other districts were men. This seems to be an almost universal pattern. Those traders play a critical market linkage function, assembling local supplies from farmers and collectors and sending these to large urban markets outside the district and the province. Small volumes of lower-grade mangoes tend to be marketed locally.

Most assembly traders in Situbondo handle between 100 and 200 tonnes per season, including their own production. That is the case of the two traders interviewed in Ketowan village, Arjasa sub-district. A trader and farmer group leader interviewed in Kesambi Rampak village has a much larger mango trading business, in part because he is also a large renter. In 2011, he sold about 300 tonnes from his own production and another 300 tonnes or so that were purchased from farmers and collectors. Smaller assembly traders often share trucks with other local traders. These are flexible arrangements based on opportunity and need. The sharing of trucks reduces transportation costs and allows traders to tailor consignments to the specific orders from buyers.

Most assembly traders have close links with one or two wholesalers or commission agents in one to three different markets. Most have been conducting business with their buyers for many years. These relations are often underpinned by family and friendship connections. For example, the research team met one trader in Ketowan village that sends most of his mango supplies to an old school friend who had moved to Kalimantan, where he established himself as a fruit wholesaler. A small assembly trader in Probolinggo supplies a supermarket in Bali through a relative and sells to a friend in Malang who has a mango wholesaling business.

In traditional agricultural marketing systems, where transactions are highly personalised, i.e. based on informal agreements, and where legal action is not an option, trust developed through social networks and long-standing business relations is an essential ingredient in long-distance trade. Trust reduces transaction costs and risks (see, for example, Faschamps, 2006; Fafchamps and Minten, 2002; Kherallah and Kirsten, 2001). It minimises the time spent searching for buyers or suppliers, negotiating volumes and prices, agreeing on quality standards, inspecting product quality, resorting consignments, and so on. It also minimises the risk of default on buyer credit and the risk of default on payments by buyers.

A closer look at the anatomy of mango transactions helps understanding why the two parties avoid dealing with “strangers”. Wholesalers often advance large sums to renters and village traders, which are then repaid throughout the mango marketing season, sometimes later. Transactions are coordinated by phone. Assembly traders are responsible for sorting and grading the fruit according to buyer specifications. They are normally paid through bank transfer, two to three days after a consignment has been delivered.

The distribution of power between assembly traders and wholesale buyers is rather balanced. The fact that both parties have fairly good access to spot market information and much to lose from a breakdown in their relationship provides strong incentives for good and fair behaviour on both parts.

Assembly traders have developed interesting strategies to minimise marketing risk and protect their interests and position. Market diversification is one: assembly traders normally supply more than one market. This improves access to market information and allows traders to shift supplies between markets on the basis of the prices offered and the quality requirements of buyers. Refusing to accept seasonal working capital loans from wholesalers or commission agents is another strategy: some of the assembly traders interviewed in Situbondo and Probolinggo prefer to rely on their own funds and bank loans, as this gives them more freedom of manoeuvre in the market place. Finally, the research team met a village trader in Situbondo who pays one person in Kramatjati during the two or three-month harvesting season to oversee his consignments and collect price information from the market.

Wholesalers, in turn, rely on a diversified portfolio of suppliers and supplying areas. Interest-free, seasonal advances are provided to preferred suppliers. Credit serves a dual purpose: it provides a mechanism for accessing large volumes throughout the season and rewarding or penalising suppliers. Those who perform poorly or default on their agreements with the wholesaler are denied credit; those who meet his expectations and needs are able to access increased amounts of finance over time, if they so wish.

Wholesaling

Most mangoes from Situbondo are marketed through large urban wholesale markets. Two categories of traders operate in these markets: wholesalers and commission agents. These provide similar market intermediary services, or functions. However, wholesalers take full ownership of the fruit, whereas commission agents charge a fee equivalent to 10 or 12% of value of the transaction with the next actor in the chain.

Traditional wholesalers and commission agents, especially those operating in large cities, such as Jakarta or Bandung, play a pivotal role in the mango marketing system. Their main strength lies in their ability to quickly shift large volumes of perishable and variable

quality fruit from different areas, at any given point in time. Wholesalers in Kramatjati market typically handle between 1,000 and 5,000 tonnes of fresh mangoes per annum. These traders have the ability to find supplies to meet new orders from buyers, often located in different parts of the country, and buyers for new deliveries. The strength of their marketing networks and self-financing capacity are major sources of competitive advantage in the market place.

In major urban wholesale markets, traders buy from districts across Eastern, Central, and Western Java, where they have on one or two regular suppliers, normally an assembly trader or large renter. They also purchase mangoes from other known suppliers but on a less regular basis. Linkages with downstream markets are based on similar networks: wholesale traders have a stable portfolio of regular clients within the city, surrounding areas, and other urban locations, while also selling to more random customers.

As mentioned, credit is a key ingredient in the relationship between primary wholesale traders and preferred suppliers. Own savings are the main source of funds, but many wholesalers also rely on working capital loans from banks. Wholesalers are willing to advance funds to suppliers because they need to ensure regular deliveries without having to spend much time searching for supplies. Large mango wholesaling businesses must be able to supply clients on a continuous basis. Furthermore, their profitability depends on the scale of their business, as margins are not high.

Having a diversified portfolio of supplying locations is critical for the success of large mango wholesaling businesses. This enables access to a range of different varieties, minimises the risks associated with crop failure in particular locations, and extends the trading season. The wholesalers interviewed expressed a particular interest in accessing supplies between May and September. At the moment, these are mainly sourced from Western and Central Java. The two Kramatjati traders interviewed claimed that an increase in off-season supply would enable them to expand the scale of their mango trading businesses. Moreover, off-season mangoes can be sold very easily and for a higher margin than in-season fruit. Wholesalers are not in a position, however, to advise preferred suppliers about off-season cultivation technologies because, as confirmed during the interviews, they lack the necessary technical know-how.

Trading enterprises with premises outside traditional markets also perform wholesale marketing functions. These enterprises do not differ much from more traditional wholesalers in their procurement systems and the financial services provided to suppliers. However, they tend to have higher quality requirements because they supply modern retail outlets. Some also export. Still, these two channels cannot absorb large volumes, for which reason many “modern” trading businesses also supply secondary wholesalers in traditional wholesale markets in major cities of Java, Sumatra, and Kalimantan. They often sell much larger quantities through traditional than modern market channels.

Retailing

As mentioned, the majority of households in urban and peri-urban areas purchase mangoes from market retailers, street vendors, and peddlers. Price, a key determinant of consumers’ choice of retail outlet, is a major reason why the traditional retail sector is still so dominant: traditional outlets are widely perceived by consumers as more affordable (Toiba et al, *2012)*. Moreover, and perhaps surprisingly, a significant share of urban consumers still regards traditional retailers as the best source for quality and safe fruit (Toiba et al, 2012). Culture and tradition may also play a role: for many urban households,

wet market retailers seem to offer a more enjoyable food shopping experience than the more impersonal modern stores (Suryadarma, 2011).

Stark distinctions are often made about the quality of fruit sold through traditional and modern retail channels (see, for example, Natawidjaja et al, 2009, and World Bank, 2007). Supermarkets and specialised fruit stores are usually perceived as selling higher-quality, higher-priced mangoes to discerning consumers with higher purchasing power, with traditional retailers supplying lower-quality produce to lower-income consumers. While there is some truth in these statements, such dichotomy is somewhat misleading or simplistic. Visits to supermarket stores and traditional retail outlets in Jakarta and Surabaya revealed significant variations in the quality and price of mango fruit sold in different outlets. Some hypermarket and supermarket stores had rather poor-quality mangoes in display, while some market stall retailers were selling fruit with excellent appearance, including ready-to-eat (*masak pohon*) mangoes. In other words, there is considerable heterogeneity within the modern as well as the traditional segment.

Key informant interviews and store visits reveal very different market segmentation strategies within the modern retail sector. Hero, for example, has positioned itself in the upper-end segment of the market, selling top-grade and fairly clean mango fruit to relatively affluent consumers. Its outlets in West Java rely on a centralised distribution centre (DC). Mangoes are procured from a small number of suppliers, in accordance with specific standards regarding fruit size and appearance. In contrast, Carrefour caters for less affluent consumers. This is reflected in its procurement and quality control systems. At the time of the fieldwork, Carrefour store managers could choose between relying on the DC as the source of supplies or buying directly from listed suppliers and managing that relationship themselves. Such a decentralised system is conducive to variable quality standards across outlets, as confirmed during visits to a few Carrefour stores in Jakarta and Surabaya.

Modern retailers source mangoes from a small number of suppliers. These include large renters, specialised wholesale trading enterprises operating outside traditional markets, and large wet market wholesalers who handle fruit of different qualities and can cope with the strict conditions imposed by modern retail chains. According to Natawidjaja et al (2009), modern retailers in Greater Jakarta and Bandung rely mainly on specialised suppliers, with traditional wholesalers accounting for only 15% of mango purchases. In Surabaya, according to the same source, wholesale markets account for a higher share of supplies, estimated at 35%.

Modern retailers are less engaged with upstream chain actors than traditional wholesalers. The biggest difference – and a very significant one – lies in the fact that those retailers provide no credit to suppliers. Moreover, their relationship with suppliers is governed by written contracts with clear rules and sanctions for non-compliance, whereas in the traditional sector business relationships are much more personalised, informal, and flexible. While many modern retailers have stricter quality standards than the typical traditional wholesaler, they do not engage with suppliers to help them meet those standards. That is not their area of competence. Moreover, it is very expensive for supermarkets to provide technical assistance to suppliers, especially in a context where the quantities of specific items purchased are relatively small.

Some experiences in the development of shorter, dedicated supermarket chains during the early 2000s, when some farmers were starting to develop the production of “customised” fruits and vegetables for the modern retail sector, particularly in West Java,

are described in the most detailed study to date on supermarkets and horticultural producers in Indonesia (Word Bank, 2007). Carrefour was particularly active in the development of direct sourcing schemes, working with “new-generation” trading companies to develop the supply of specific products under contract farming. A small number of elite farmers belonging to the upper strata of the rural population were benefiting from participation in these short, high-value chains, but in many cases the relationship between producer groups and specialised suppliers was discontinued after some time. Difficulties in coordination, quality management problems, and breach of contractual agreements by farmers were some of the reasons indicated for the breakdown of innovative, private-sector driven chain upgrading initiatives.

In the same World Bank study, it is mentioned that retail chains such as Hero had some producers registered as suppliers, although these accounted for a fairly marginal share of their supplies. Provision of supplier upgrading services, such as credit or technical assistance, was rare. In the specific case of mangoes, it is mentioned that Matahari and other retail chains faced difficulties in developing direct sourcing from production areas. These retailers were being out-competed by traditional wholesalers, who not only provided credit to village traders and renters, but were also able to absorb large volumes of different-quality fruit, thereby having privileged access to supplies. It should be noted, moreover, that supermarket chains can access superior-quality mangoes from modern or traditional wholesalers without having to rely on resource-intensive vertical coordination arrangements with village suppliers.

Finally, it is important to note that modern retail chains hold significant power in their relationship with suppliers. Delaying payment by one or two months after a consignment has been delivered is standard practice. Penalties for contract default are high. If suppliers fail to deliver the volumes agreed they will have to incur the cost of purchases from a different source. Failure to meet agreed quality standards may lead to exclusion from the retailer’s list of suppliers. Discount sales, which are common for mango, are reflected in the price paid to suppliers, not in the retailer’s margin. Despite these conditions, and the relatively small volumes involved, modern retailers have no shortage of willing suppliers. This is because they pay considerably higher prices than buyers in the traditional segment.

3.3 Characterisation of the Mango Value Chain in North Lombok

The North Lombok mango value chain is depicted in Figure 6. Farmers typically sell their mango crop to collectors residing in their village or a neighbouring village. As in East Java, these transactions are typically carried out by men. Men are also responsible for managing mango farms.

In all three villages of North Lombok visited mangoes are sold on the tree. Even larger tend to sell their crop on the tree. Entire orchards or backyards are either “sold” several weeks or even a few months before harvest or at harvest time. Farmers selling their crop well in advance of the harvesting season will normally receive a partial payment at the time of the transaction, say 30 to 50% of the value agreed with the buyer, with the balance being settled at harvest or very soon after. These findings are consistent with the evidence presented in Perkasa et al (2011) and Suudi et al (2010).

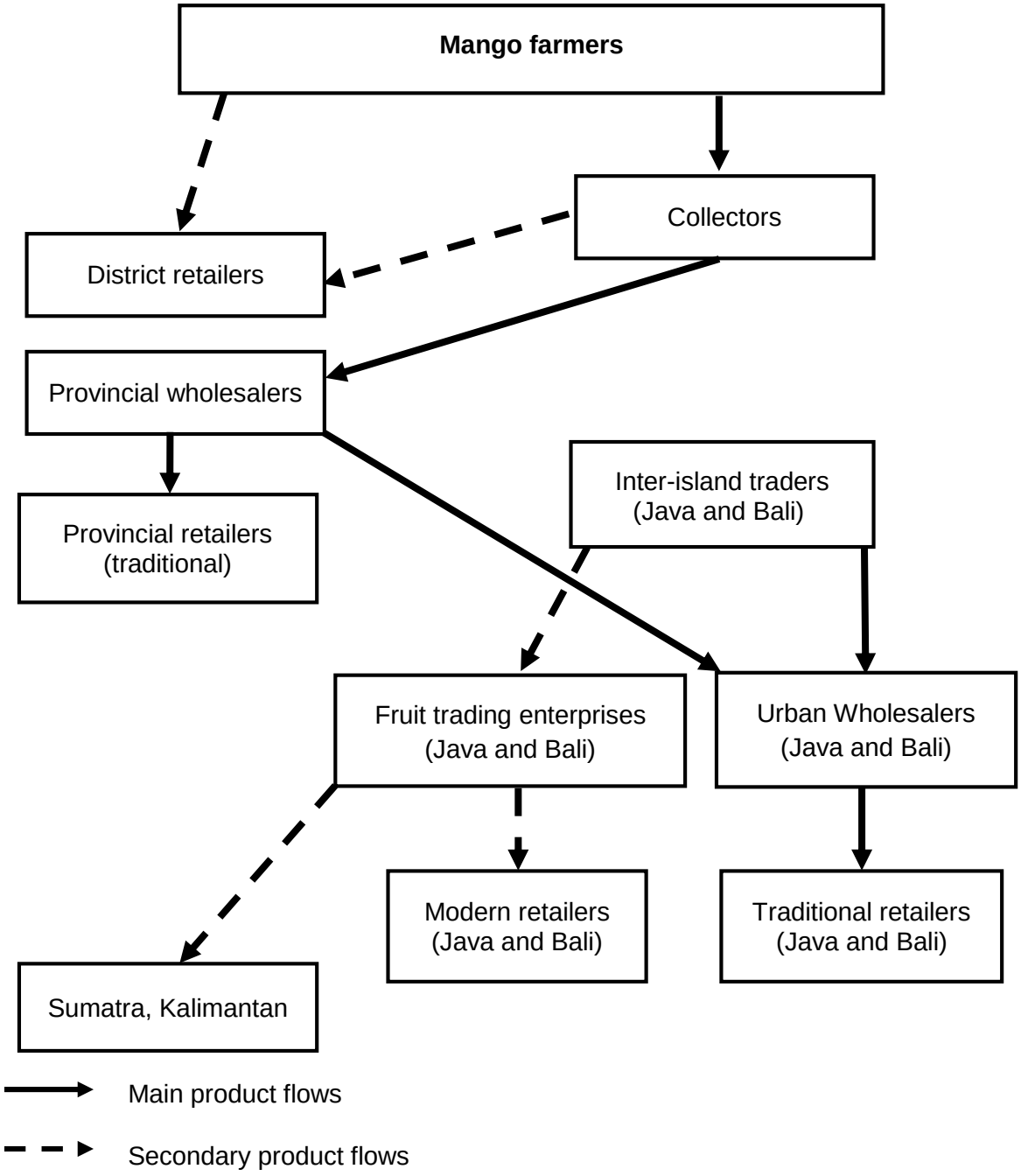

Figure 6 Simplified mango value chain from North Lombok

As in East Java, no farmer participating in the focus group discussions mentioned provision of input credit, cash loans, or technical information and advice by collectors, a finding that is corroborated by another study of the mango value chain in NTB (Suudi et al, 2010). In the absence of embedded service provision, business interactions between farmers and collectors are largely restricted to the sale of fruit on the tree. Farmers therefore have no special commercial bond with particular collectors.

Mango orchards, even larger ones, are left with minimal maintenance and care. The team was particularly surprised by the very low levels of fertilisation and chemical spraying, despite the fact that these inputs are available locally. Collectors themselves use very few inputs in their own mango farms and in orchards and trees where fruit has been purchased several months before harvest time. Perkasa et al (2011) also found little

evidence that traders in North Lombok are introducing or adopting technology to improve production.

The passivity of mango chain actors in North Lombok cannot be overemphasised. Mangoes may be sold for cash but are not being managed as a commercial crop. Neither farmers nor collectors are pursuing intensification strategies or, with some very few exceptions, renting trees or growing mangoes in a sharecropping system to expand the size of their farms. Low market prices, typically ranging from IDR 800 to IDR 1,500 per kilogram, are certainly a major reason why both farmers and collectors pay such low attention to mangoes. Local chain actors have very poor understanding of technical upgrading options and the potential impacts of different innovations on the profitability of mango farming.

Most mangoes from North Lombok are channelled to Java and Bali. The quantity retailed within the district and province is relatively small by comparison. Two main actors are involved in the inter-island trade: visiting traders from Java and Bali who set-up temporary packing sheds in the district, and who may operate independently or act as purchasing agents for large outside traders, and wholesalers in Mandalika market, Mataram. Both buy from village collectors in the main production areas of North Lombok, particularly Bayan and Kayangan sub-districts. Advance of working capital funds is common practice, providing the glue that binds collectors to specific traders and ensuring regular supplies throughout the season. The sorting and grading of mangoes is carried out by outside traders and wholesalers, not collectors.

Seasonality is the main factor driving inter-island trade: the harvest in North Lombok normally peaks between mid-November and mid-December, a period when mangoes from Bali and major production areas in Java are becoming increasingly scarce. But there are other reasons why the district is a preferred source of off-season supplies for Java and Bali. Variety is one: Arumanis accounts for a significant share of the mango harvest in North Lombok. Fruit quality is another: North Lombok has a much drier climate, and therefore produces much better fruit, than other districts within Lombok (Thistleton and Baker; 2011; Baker, 2008).

3.4 Quality Standards and Management Systems

Grades

In Indonesia, mangoes are graded according to size. Grade A mangoes weigh 450 grams or more and grade B between 400 and 450 grams. These are the two grades most commonly traded in large urban markets. Smaller fruit, classified as grade C, is typically traded in rural areas and small- and medium-size towns. Small quantities of grade C mangoes are absorbed by the processing sector. Larger-sized Arumanis, harvested at relatively high maturity rates and with a fairly clean skin, are marketed as Super A. This type of mangoes are exported and sold by traditional and modern retailers in large cities catering for a more affluent and demanding clientele. Grade classifications are not fixed, however. During the off-season months, when supplies in the market are limited, grade B mangoes may be sold as Grade A.

The share of different grades in local production is largely determined by weather and cultivation practices. The research team found considerably higher variations in grade percentages across farms than across production areas. A local assembly trader in Cirebon estimated that 40% of the fruit he purchased fell under the grade A category, with

grades B and C accounting for 30% each. A local assembly trader in Situbondo estimated that grade A corresponded to approximately half of his supplies during the main season, grade B to 30%, and grade C to 20%. In Probolinggo town, one trader with a stand along the main road who also supplied urban wholesalers estimated that 40 to 60% of his peak-season sales were of grade A, with grade B accounting for approximately 20-40% and grade C for 10-20%. One wholesaler in Mandalika, the main fruit wholesale market in Mataram, reported a 40-percent share for grade A and another 40% for grade B. According to him, the share of grade A in the supply from North Lombok is higher than 40%.

The grade of the fruit has significant influence on mango prices. For example, in early September 2012, one wholesaler in Kramatjati market was selling grade A Arumanis for IDR 18,000 per kilogram, but charging only IDR 10,000 for grade C. Fruit for supermarkets was packed in cartons (Super A) wholesaled in that market for IDR 25,000. Around the same time, one kilogram of (clean) grade A Arumanis mangoes was being retailed in one Hero Jakarta store for IDR 35,000, while in one Carrefour outlet in the same city the price of (not so clean) grade B Arumanis was IDR 18,000. Similar patterns were observed in late September in Surabaya. It should be noted that these observations were carried out in September, towards the end of the mango off-season. During the peak marketing months, i.e. October and November, differences in the price of different fruit grades are even greater, particularly for grade C, as this is often difficult to sell in a context of over-supply in the market.

Existing survey data also shows considerable variation in the price paid to farmers for different grades (Qanti et al, 2012). In 2009, in four districts of Java, the average farm-gate price of grades “1” and “2” Arumanis sold to the traditional channel was US$ 0.88 and US$ 0.68 per kilogram, respectively. For Arumanis mangoes sold to the modern channel, the average farm-gate price was US$ 1 for grade “1” and 0.8 for grade “2”. For ungraded mangoes, the average farm-gate price in the traditional and modern channels was US$ 0.79 and US$ 0.41, respectively.

As found by Qanti et al (2012), relatively few mango farmers sort and grade their fruit. Only 17% of the mango households surveyed graded their mangoes, and the proportion was twice as high in West Java than in East Java. It was also found that most farmers marketing graded mangoes were selling directly to urban wholesalers or to the modern market channel, not to village traders. Hence, as also found during discussions with farmers and traders in Java and NTB, grading is normally carried out at the local assembly stage, i.e. by traders in production areas. In Situbondo, local assembly traders perform this function. In North Lombok, grading is normally carried out by visiting inter-island traders.

Some of the fruit or entire consignments may then be re-sorted at the wholesaling level, depending on the market situation at the time and the requirements of specific clients. Exporters must necessarily re-sort the fruit delivered at their packing house, as only the best quality can be exported. Much of the fruit received will always be sold in domestic markets, however, as it will not meet export specifications, even when suppliers have been asked to deliver the best quality mangoes, including fruit that has been picked with the stem on to prevent sap flow.

Based on the fact that most farmers sell ungraded mangoes, Qanti et al (2012) conclude that producers in Java are capturing very little of the quality price differentials in the market, thereby having limited price incentives for investment in quality. The qualitative

evidence gathered by the research team provides a more nuanced picture. It is true that farmers are likely to be more rewarded for quality when selling graded fruit, but this does not mean that the price received is not influenced by the quality of the fruit sold. Discussions with farmers in Java, including Situbondo, suggest that at least some of the growers selling ungraded fruit after harvest are aware of the proportion of different grades supplied to buyers and likely to use this knowledge to influence negotiations. The case of farmers selling fruit on the tree is a very different one, however.

Quality defects

Most traditional wholesalers are not particularly concerned with sooty mould stains, sap burn and other skin marks, as these are not key purchasing criteria for most Indonesian consumers. Fruit trading companies supplying higher-end stores and export markets do need to follow stricter standards. Large and clean fruit with few or no marks must be selected for export markets and high-end stores. In some cases, women are employed to wash sooty mould stains.

For fruit picked with the stem on, latex marks could be minimised at the assembly level or export end. Washing the fruit with soap or lime as the stem is removed will neutralise sap flow. The traders and exporters interviewed were unaware of this simple procedure. Washing mangoes by hand is a labour-intensive process, however, so it can only be justified for fruit sold in premium retail and export chains. In more mainstream segments of the market, consumers are unwilling to pay a significant price premium for mangoes with few or no latex marks and no sooty mould stains.

Mangoes are typically packed in 40- or 50-kilogram wooden boxes and bamboo baskets, which are then loaded in 5-ton and 12-ton trucks, depending on the distance to the destination market and its size. Carbide is applied as a ripening agent just before transportation to primary or secondary wholesale markets. Controlled ripening using ethylene is not yet done for mangoes, despite potential interest from supermarkets for ready-to-eat fruit. Compression and rub marks during transportation result in significant physical damage to the fruit, which is why mangoes sold to supermarkets and specialised retail stores are usually packed in 10-kilogram, single-layer cartons. The research team saw some mangoes in Kramatjati that were sold in cartons, but these accounted for an insignificant share of the total supply in that market. The use of single-layer cartons entails an additional cost of about IDR 1,200 per kilogram, which is rather high; more so during the peak marketing season, when mango prices are very low.

Shelf-life and product losses

During November and December, anthracnose and stem-end rot infection rates in single consignments of 70% or more are not uncommon due to high rainfall levels just before harvest. During those months, a significant percentage of mango fruit will also be hosting fruit flies.

Anthracnose and stem-end rot can be controlled after harvest by dipping the fruit in a water solution mixed with Amistartop or Scholar. Scholar is not yet registered in Indonesia, but Amistartop has been available for many years. Adding Kanon (dimethoate) into the solution will largely address the fruit fly problem. These simple and low-cost treatments extend the shelf-life of mangoes by at least two weeks, but mango traders are unaware of the technology. Surprisingly, none of the exporters interviewed are familiar with these post-harvest dip treatments.

In January 2011, researchers from Mataram University conducted some post-harvest trials (Zainuri, 2012). Fourteen days after harvest, 66% of the control fruit kept at ambient temperature was affected by anthracnose and/or stem-end rot diseases. The incidence of these two diseases on fruit also kept at ambient temperature but subject to water dip treatments using Scholar, hot water, and Amistartop were 23%, 13% and 9%, respectively.

Wholesalers interviewed in Jakarta and Surabaya reported average throw-out rates around 3 to 5% during the peak marketing season. Similar average losses were reported by traditional retailers in Surabaya, although some fruit, say 5% of the total mangoes traded, may deteriorate to a point where it has to be sold to consumers or juice vendors for a heavy discount. Generally, traders in Java experience the highest losses during the October-December season, a period characterised by over-supply and high incidence of pests and diseases. However, some of the losses may be a consequence of transportation of the fruit in overloaded trucks rather than fruit flies and diseases.

Within Java, post-harvest losses caused by anthracnose, stem-end rot, and fruit flies are not so high because mangoes generally reach the consumer within one week after harvest. It takes longer for infected mangoes to start rotting. Physical losses in longer-distance inter-island trade, for example from East Java to western Sumatra via Jakarta wholesalers, should be higher. Still, many of the post-harvest are likely to be felt by consumers rather than wholesalers or retailers. This has a negative impact on consumer demand for mangoes.

Exporters avoid exporting during rainy periods in November and December, when up to 15% of the fruit may be rejected in the destination market or purchased at a heavy discount. Exports are a risky venture in a context characterised by poor quality management systems along the whole chain, and where fruit quality cannot be properly assessed at the packing house because it takes at least one week after harvest for any symptoms of anthracnose, stem-end rot, and fruit flies to start emerging. This explains why exporters are so cautious in the selection of mangoes for overseas markets and so reluctant to expand sales to these markets.

The use of cool storage in domestic mango chains could extend fruit shelf life but is some time away. The investment is not justified in a context where most mangoes reach consumers within a week after harvest. Furthermore, the negative effects of high temperatures on skin colour development do not matter for green-skinned varieties, such as Arumanis. For sea-freighted mangoes, however, the use of refrigerated containers and existing supermarket cool chains will become important.

Some concluding remarks

Domestic and export chains are characterised by fairly unsophisticated quality management systems. Fruit size is the most-valued product quality feature in the traditional mango trade and an important determinant of product flows: most grade C mangoes can be found in local markets and small urban centres; in cities, many consumers are able to afford larger and therefore more expensive fruit. Mangoes exported to other countries are sorted according to much stricter criteria, and may even be washed for sooty mould stains, but current volumes are too small. Likewise, suppliers selling to higher-end retailers tend to follow stricter procurement and sorting practices, but this remains a niche market.

Post-harvest washing of fruit to prevent sap flow would improve fruit quality in higher-value domestic and export chains, but the actors involved are unaware of this simple technology. More significantly, the adoption of simple and affordable post-harvest treatments for diseases and fruit flies could have a major impact on export chains, and significant impacts on inter-island trade, but traders are unfamiliar with the technology. In domestic chains, post-harvest losses are relatively small, especially up to the wholesale level, despite high levels of fruit fly infestations and high incidence of fruit-rotting diseases. Mango value chains, especially within Java, are structured and organised to ensure that the fruit reaches consumers soon after harvest, before rotting becomes a serious problem.

3.5 Margins

Collection of gross and net margin data along mango chains are fraught with problems. These chains often spread over wide geographical areas, making it difficult to collect the necessary data within the few days required for the fruit to travel from the farm to terminal markets. Collecting the necessary price data within such a short period is important because of considerable short-term price volatility in mango markets. The complexity of the whole exercise is exacerbated by wide variations in fruit quality and prices at the farm level and in major urban markets at any given point in time, even within the same market segment. The fact that many farmers sell their fruit on the tree, not by kilo, adds another element of complexity.

In order to provide a meaningful snapshot of the range of gross and net margins practised along selected chains in a particular moment in time, research teams would need to follow particular consignments from the farm all the way to retailers in terminal markets, and repeat the exercise a few times. Ideally, different chains (traditional and modern) would need to be surveyed. Comparative analysis for different months and seasons would be equally insightful. According to key informants, traders command higher net marketing margins during the off-season months. This has implications regarding the incentives for actors in the chain to support innovations that can enable off-season cultivation.

The survey team was unable to collect the data required for estimating margins along Situbondo and North Lombok chains. Visits to these two districts were carried out in September, before the mango harvesting season. None of the local growers interviewed had started harvesting their crop, although two key informants in Situbondo were packing and loading mangoes for Kramatjati market. The team did interview two wholesalers in this market during the first week of September, prior to visits to production areas, but neither of them had mangoes from Situbondo or North Lombok at the time. Likewise, none of the wholesalers approached in Surabaya were selling mango fruit from those two districts.

Secondary data for traditional and modern mango chains in NTB is however available from a relatively recent ACIAR-funded study (Suudi et al, 2010). It should be noted that the data presented is not disaggregated by production areas or districts, and that data for inter-island chains, which are dominant in North Lombok, was not collected during the study. As expected, the data shows that farmers participating in the supermarket chain fetched much higher prices than those selling through traditional market channels (see Table 25).

The net marketing margin, or value added, from sales to supermarkets was also higher than in the traditional wholesale trade. However, the profits associated with fruit collection

at the village level were higher in the traditional chain. This is because these collectors take full ownership of the fruit, whereas those participating in the modern chain act as purchasing agents for the supermarket supplier, receiving a commission for every kilogram of fruit delivered at her premises.

These findings may suggest that the modern chain generates significant benefits to participating farmers. In the case of NTB, at least, this is not the case. There is only one supermarket chain outlet in the whole province (Hero in Mataram City). According to the main mango supplier for Hero Mataram, this store sells about 18 tonnes of fresh mangoes between October and December, the peak sales period. This is equivalent to two hectares under production. They buy most of the fruit from one single supplier in the city. While some farmers may fetch a higher price when selling mangoes to Hero through this supplier, such sales account for a very small share of their total marketed volumes. In other words, the volumes absorbed by the supermarket chain in NTB are too small to have any visible impact on the incomes of mango farmers in the province.

Table 25 Gross and net margins along the Mataram modern and traditional mango chains, 2010

	Traditional chain						Modern chain (Hero)				
	Selling price	Goss margin		Net marketing margin			Selling price	Goss margin		Net marketing margin	
	IDR/kg	IDR/kg	%	IDR/kg	%		IDR/kg	IDR/kg	%	IDR/kg	%
Farmers	1,250					Farmers	2,000				
Collectors	2,500	1,250	17.9	965	13.8	Collectors	2,500	500	5.6	215	2.4
Wholesalers	5,000	2,500	35.7	1,582	22.6	Supermarket supplier	6,000	3,500	38.9	2,498	27.8
Retailers	7,000	2,000	28.6	1,705	24.4	Supermarket	9,000	3,000	33.3	1,945	21.6

Source: Natawidjaja et al, 2010 and author's calculations

3.6 Value Chain Constraints

A series of value chain constraints and problems were identified during this study. Those considered by the research team as most important are listed in Table 26 and discussed in this section.

Table 26 Barriers to upgrading mango chains in Situbondo and North Lombok

Chain actor	Key constraints
Farmers	• Lack of knowledge on early-season cultivation technologies • Poor knowledge of fertilization and pest and disease management • Poor access to finance and limited risk-taking capacity
Assembly traders and wholesalers	• Lack of knowledge on early-season cultivation technologies • Lack of knowledge on post-harvest pest and disease management
Exporters	• Lack of knowledge on post-harvest pest and disease management • Poor access to quality fruit • No access to large, yellow and red-skin mangoes • Indonesia cannot access some Asian markets, such as China, because market access protocols have not been negotiated with the respective country governments
Processors	• Short mango season • Limited product development and marketing expertise • Financial constraints • Limited domestic demand • Strong competition in domestic and international markets from well-established processing industries in other Asian countries.

Knowledge gaps were identified as the most important barrier to pro-poor innovation in mango chains. Three significant knowledge gaps are discussed in this section: knowledge of crop manipulation for early-season production, knowledge of mango cultivation practices more generally, and knowledge of post-harvest treatments for addressing pest and disease problems.

Financial constraints and poor risk-taking capacity limit the ability of many mango farm households to intensify production, while also explaining, at least in part, why so many prefer to sell their fruit on the tree. Still, the evidence presented in this report indicates that low prices during the peak mango season and poor technical knowledge in areas such as early-season production, fertilisation, and pest and disease management are even more determining factors.

Successful application of crop manipulation technologies for early-season production has significant positive impacts on yields and farm-gate prices. The levels of investment associated with such technologies are certainly within the reach of many mango farm

households in Situbondo. The potential returns are very high. The fact that even large renters and one plantation in Situbondo, and village collectors in North Lombok, are failing to take advantage of this opportunity reflects serious knowledge gaps.

Adoption of better fertilisation and pest and disease management practices would raise farm yields and improve fruit quality. Although mango growers often sell the fruit ungraded, qualitative evidence gathered during the fieldwork indicates that product quality has some influence on farm-gate prices. Furthermore, quality improvements in whole villages attract buyers linked to higher-value market channels to the area. Farmers selling through these channels receive higher prices than those supplying less quality-conscious buyers.

Government advisory services are poorly equipped to transfer know-how in these areas because extension staff lacks critical expertise. More importantly, essential information and knowledge are not flowing along the Situbondo and NTB chains, even though chain actors (other than farmers) have much to gain from the development of early-season cultivation and adoption of improved cultivation practices. Input retailers would benefit from increased sales of Paclobutrazol and agro-chemicals, but cannot provide relevant information and advice to mango growers because they lack the necessary expertise. Assembly traders and wholesalers would be able to access off-season supplies, but have little new information and knowledge to offer to farmers.

Limited development of mango exports provide another clear example of missed value chain upgrading opportunities because of acute knowledge system failures. Exports can drive the development of more productive, higher-value mango chains, with benefits to all chain participants, and if developed at scale can have a positive impact on market prices during the critical peak-season months. Indonesia enjoys unique competitive advantages in Asian markets on account of its geographical location, the timing of its main mango harvest, and very low mango prices during the peak season. Yet, despite these very favourable conditions, the mango export sector has never graduated from its early infancy stages. Exporters' inability to make the transition from air to sea freight has been a major impediment to the development of exports, an inability that reflects very poor know-how in the post-harvest disease and pest management spheres.

The research team is aware that there are other factors constraining exports. For example, the exporters interviewed complained about the difficulties to access high-quality fruit that meets the requirements of importers. They have to be very selective about the fruit sent to Singapore, Hong Kong, or the UAE. Only larger-size mangoes can be exported. The fruit cannot have compression or sap burn marks. Sooty mould stains can be washed, but this is a very laborious task.

Phytosanitary protocols with some countries and business linkages beyond the current export markets will also need to be developed in order to overcome key market access constraints, i.e. the lack of a legal framework for export to certain markets and the lack of business networks in (and knowledge of) new markets. It should be noted, however, that addressing these barriers will be largely futile unless quality management systems along the whole export chain are upgraded.

Finally, variety is one factor constraining export growth: Arumanis is not particularly favoured by consumers in Asian markets, especially because of its green skin. Still, the research team sees scope for growth in the export of Arumanis, which have other appreciated traits, including low price, good taste, large size, and low fibre content.

A discussion on value chain constraints would be very incomplete without mention of the numerous challenges and barriers that mango processing enterprises face. These include poor product development and marketing expertise, financial constraints, a short peak mango season, relatively limited domestic demand for processed mango products, and strong competition in domestic and international markets from well-established processing industries in other Asian countries. Thailand and the Philippines are particularly dominant in the world market for dried mango, whereas India has established itself as a leading exporter of mango pulp.

4 Pro-poor Chain Development Opportunities

4.1 Opportunities for Pro-Poor Intervention

4.1.1 Development of early-season cultivation

Successful adoption of early-season production technologies provides the most obvious opportunity for increasing the incomes of mango growers in East Java and NTB. In most years, correct application of Paclobutrazol and spraying of appropriate fungicides during the early flowering and fruit setting stages will produce an early, high-value crop equivalent to 25-50% of the total annual harvest. The use of a growth regulator will also have positive impacts on farm yields.

The fact that off-season cultivation technologies have been widely adopted in Western and Central Java, with significant financial benefits to farmers, but not in East Java and NTB, where many growers remain trapped in a low-price, low-input equilibrium, reflects huge imperfections in formal and informal knowledge transfer systems. AIPD-Rural is well positioned to address this policy and market failure.

In North Lombok, the development of off-season cultivation will present greater challenges than in a district such as Situbondo. AIPD-Rural would need to target villages where farmers are not facing acute fruit set failure, an issue discussed in Section 2.3.4. In areas where this is a serious problem, its causes would need to be researched and addressed before exposing farmers to off-season production and marketing opportunities. This may take two or three years (seasons). Furthermore, there may be a need for market linkage interventions, as village collectors currently sell to inter-island traders from Bali and East Java, who only come to the district during the October-January months.

Crop manipulation technologies are relatively affordable and within the reach of many mango farm households (see Table 27). The cost of Paclobutrazol and a fungicide such as Amistartop, plus the cost of hiring labour to apply these and harvest the additional production, amounts to approximately IDR 45,000 per tree. A household with a small orchard of 20 trees (0.2 hectares) would need to spend about IDR 860,000 or just under US$ 90. About 25% of the cost would be incurred around February-March (application of Paclobutrazol) and another 30% around April-May, during the early flowering and fruit setting stages. The remaining costs would be incurred during the July-September period (first harvest) and the October-December months (second harvest).[10] Most likely, the household crop manipulation technologies would be adopted gradually: in 10 trees during the first year, for example, in 15 trees during the second year, and in the entire orchard during the third year.

[10] *Off-season cultivation strategies that target an even earlier first harvest, say June or July, as in Cirebon and Pemalang, are not recommended, at least during the initial stages in the transition towards off-season cultivation, because farmers would need to cope with extremely high rainfall levels at flowering and during the initial fruit setting stages. This would entail additional risks and require further investments in fungicides and pesticides.*

Table 27 Cost of Paclobutrazol and Amistartop application

	Unit	Unit cost (IDR)	Amount per ha	Cost per ha (IDR)	Cost per tree (IDR)
Paclobutrazol	250 ml	160,000	6	960,000	9,600
Amistartop	250 ml	150,000	8	1,200,000	12,000
Hired labour	Person-days	50,000			
Paclobutrazol			1	50,000	500
Amistartop			2	100,000	1,000
Harvest (additional)			20	2,000,000	20,000
Total	n.a.	n.a.	n.a.	4,310,000	43,100

Source: Key informant interviews, September 2012

Crop manipulation costs are particularly low when compared to potential income gains (see Table 28). A household producing on average 60 kilograms per tree before adoption, enjoying a 20% increase in yield after adoption, harvesting 30% of production early and 70% during the main season, and selling the in-season harvest for IDR 2,500 per kilogram and the early-season crop for IDR 7,000 per kilogram, would earn around IDR 145,000 in additional income per tree - three and a half times the amount invested. Assuming that household manages 20 trees, an investment of US$ 90 would generate US$ 300 in additional net farm income.

Table 28 Estimated average net income per tree for seasonal and off-season growers

	In-season cultivation	Off-season cultivation (Paclobutrazol + Amistartop)		
		Early season	Main season	Two seasons
Yield (kgs/tree)	70	25	55	85
Price (IDR/kg)	2,500	7,000	2,500	4,100
Revenue (IDR/tree)	150,000	175,000	137,500	312,500
Production costs (IDR/tree)	90,000	-	-	133,100
Net income (IDR/tree)	60,000	-	-	179,400

Source: Key informant interviews, September 2012

Not all potential impacts are accounted for in this simple exercise, as shown in the impact logic diagram below (Figure 7). The experience of Cirebon and Pemalang shows that significant increases in the profitability of mango farms provides farmers with the incentives, as well as some means for further on-farm investment in areas such as fertilisation, pruning, irrigation, and pest and disease management. Successful development of early-season production is a first critical step towards greater intensification of mango farming.

Off-season cultivation systems also have significant indirect impacts. Adoption of crop manipulation technologies and subsequent farm intensification processes generate new employment opportunities, as additional labour is required to carry out various farm operations. Much of these activities would be performed by small and marginal farmers and landless rural workers hired as wage labourers. Improvements in the profitability of

mango farms, in turn, raise the value of mango trees in local rental markets, benefiting households that rent-out their backyards or orchards to farmers and traders.[11]

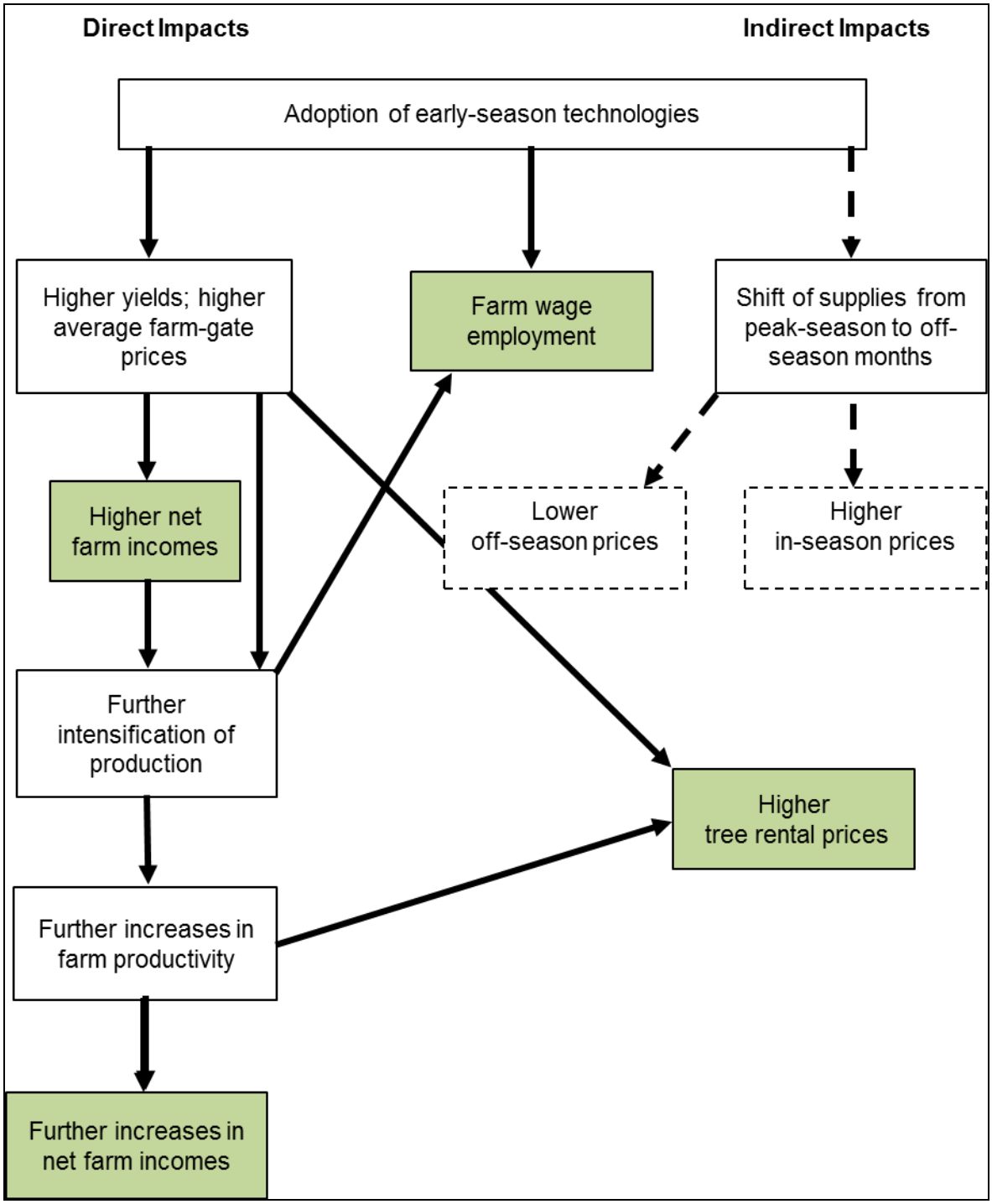

Figure 7 Adoption of early-season cultivation technologies: impact logic

A comparison between two small, high-input farms in Pemalang and three small, low-input farms in Situbondo illustrates the significant employment effects associated with crop intensification (see Table 20). On a hectare basis, 243 person-days were allocated to one of the Pemalang farms, of which 140 person-days corresponded to hired labour. Wage costs per hectare were equivalent to US$ 770. Hiring of labour was similarly high in the

[11] *Rental of mango trees is common in East Java, but not in NTB.*

other Pemalang farm. By comparison, in three mango farms in Situbondo, labour use varied between 23 and 47 person-days per hectare, the number of paid work days between 13 and 39, and wage incomes between US$ 60 and US$ 213.

A comparison between Pemalang and Situbondo shows that farm profitability is a major determinant of tree rental prices: values of IDR 150,000 per tree are common in Pemalang, compared to just IDR 20,000-50,000 in Situbondo. Indeed, an increase in farm profitability raises the demand for rented trees, as an increasing number of growers seek to expand the size of their mango farms. At the same time, there is a contraction in the supply of trees for rent, as many households decide to become directly involved in the management of their trees in order to take advantage of off-season opportunities. Over time, moreover, households renting-out their trees become increasingly aware of changes in the productivity and profitability of their farms, and start demanding higher rents as a result.

Finally, widespread adoption of early-season production technologies in East Java would result in a significant shift of supplies from the October-November months to the July-September period. Prices during these months would fall, whereas prices during the peak harvesting season would increase. Non-adopters, i.e. in-season growers and households renting-out their trees, would be benefit from an increase in prices during the October-December months. Mango growers in Western and Central Java selling mangoes during the July-September period would be affected by falling prices during those months, but would benefit from higher prices later in the year. The net impact on the income of these farmers would depend on the revenue lost from July-September sales and the additional income earned from the main-season crop.

It is highly unlikely, however, that AIPD-Rural interventions would have an impact on seasonal prices. This would require a systemic shift in seasonal supply curves, which cannot be achieved through intervention in just one or two districts of East Java and one or two districts of NTB. A relaxation of geographical coverage to include districts with large areas under mango, such as Probolinggo, Pasuruan, and Kediri, in East Java, or Sumbawa Besar, in NTB, would enhance outreach and impacts.

Table 29 presents a projection of first-round farm income impacts from early-season interventions in Situbondo and North Lombok. This is a speculative exercise, as these impacts will depend on many variables, including the number of farmers adopting crop manipulation technologies successfully, the resulting yield gains, how much of the crop is harvested early, and the prices fetched during the main season and the off-season months. In the projection presented in Table 29, it is assumed that 3,000 households in Situbondo and North Lombok, managing an area of 1,000 hectares, adopt off-season cultivation technologies successfully over a five-year period. Based on the assumptions used in Table 28 to estimate net income gains per tree, an intervention by AIPD-Rural in those two districts would generate US$ 1.5 million in additional net farm income per annum, i.e. about US$ 500 per beneficiary. While significant, direct impacts could be increased exponentially if other major mango producing districts in East Java and NTB were to be targeted.

Table 29 Projected first-round net farm income impacts from early-season cultivation

	Annual farm income	
	IDR	US$*
1,000 ha	19,250,000,000	1,964,286
Average per grower (0.33 ha)	6,416,667	655

** US$ 1 = IDR 9,800*

4.1.2 Development of exports

The transfer of appropriate post-harvest technologies, the coordination of trial shipments by exporters, the sharing of initial risks associated with a transition to sea freight, the provision of strategic export market information, and the facilitation of business linkages with importers in current and potential markets could make a significant contribution to the emergence of a sizeable mango export industry in Indonesia.

A shift to sea freight would enable considerable growth in export volumes. Significant reductions in transportation costs would boost the demand for Indonesian mangoes and widen export time windows, i.e. the period during which procurement of mangoes for export markets is profitable. Domestic gross margins would increase. Additional value would need to be shared between exporters and upstream suppliers, as both local traders and growers would need to have clear financial incentives to invest in quality upgrading.

As shown in Figure 8, local impacts would be felt through increases in prices for farmers selling to exporters through village traders, improvements in the productivity of their farms as a result of better farm management practices, and new employment opportunities created as a result of more intensive crop management systems and improved harvesting practices. The fact that mangoes for export markets need to be cleaned and carefully sorted, graded, and packed before loaded into refer containers would also create employment opportunities. Likely spill over effects to domestic chains should also be considered: exporters could adopt post-harvest treatments for fruit sold to supermarkets or sent to other islands.

Wider impacts on farm-gate prices during the export season are unlikely to materialise. Indonesia could feasibly develop an annual export turnover of 50,000 tonnes within the next ten years or so if key constraints are addressed through strategic public interventions. This would be a remarkable development in a country that currently exports 1,000 tonnes per annum and cannot realistically aspire to access the US and EU, the two largest export markets, due to distance. Access to the US market is also difficult because the required post-harvest irradiation treatments are very expensive. An export turnover of 50,000 tons would place Indonesia as the world's eighth largest exporter, behind Pakistan, which benefits from its relative proximity to the Middle East and Europe, and ahead of Ecuador (see Table 5). However, such volumes would still represent less than 5% of the estimated mango supply in Java during the October-December months (see Table 11). Annual exports of at least 100,000 tonnes would perhaps be required for significant impacts on domestic market prices, unless supplies during the peak harvesting season are being significantly reduced through widespread adoption of off-season production technologies, particularly in East Java.

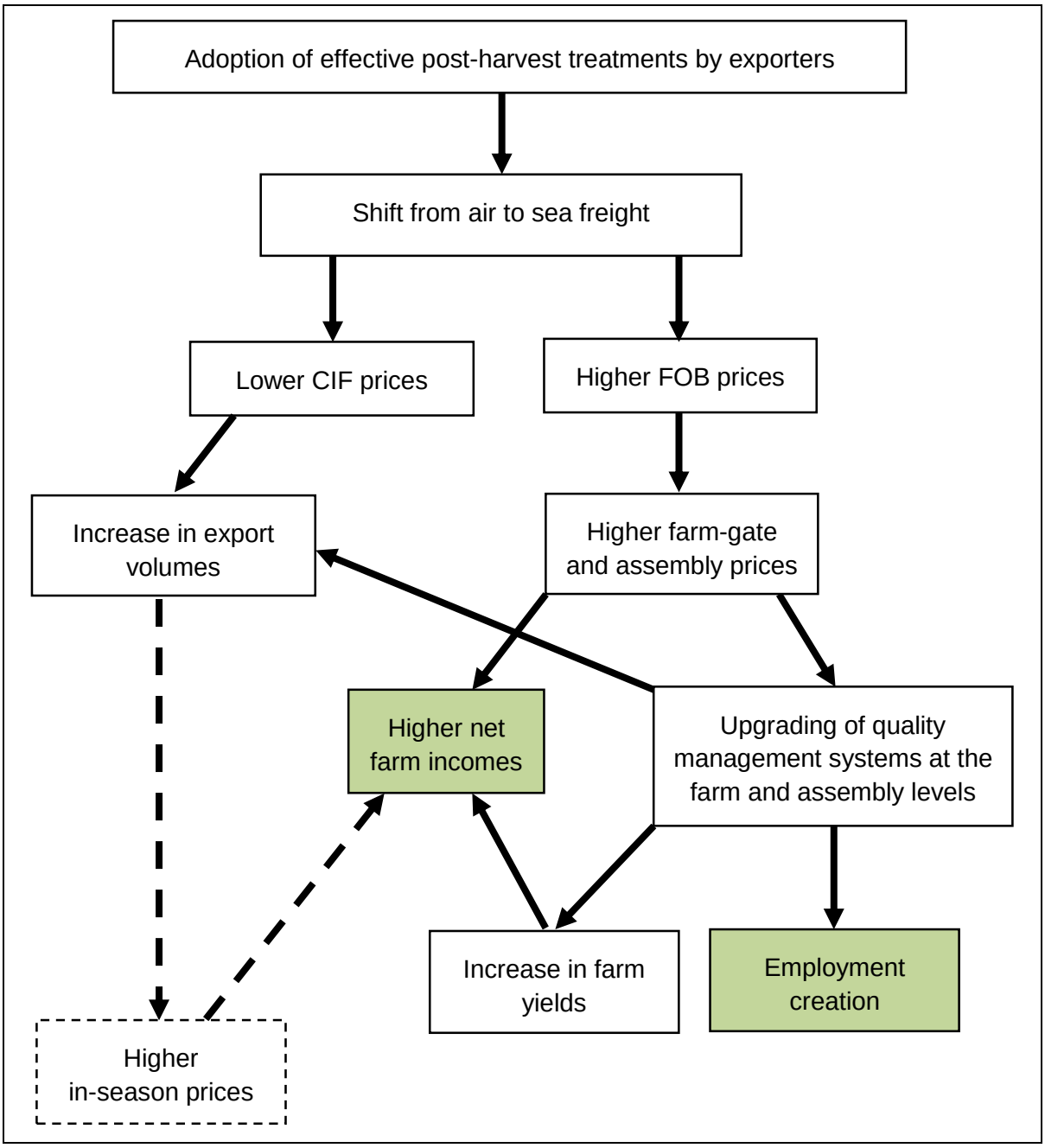

Figure 8 Adoption of improved post-harvest technologies in the export mango chain: impact logic

Interventions aimed at enabling a shift to sea freight by exporters raise some important questions for AIPD-Rural, which has a very clear geographical targeting. Most of the impacts from these interventions would be felt outside project districts, as mangoes for export markets would be procured from different provinces and different districts within each province. Quality upgrading and market linkage interventions in project districts are required to ensure that local farmers share the benefits from export growth. These interventions are discussed below.

4.1.3 Upstream development of export and other quality chains

An upgrading of quality management systems at the farm level can deliver significant income benefits to mango growers through higher yields and higher prices. The impact logic behind interventions aimed at addressing critical knowledge gaps in the cultivation

sphere and linking participating farmers to quality-conscious buyers, through village traders, are similar to the one presented in Diagram 4 for off-season interventions.

The rationale for implementing production and market linkage interventions in tandem is twofold. First, farmers are much more likely to invest in new technologies and adopt improved management practices if they know that their harvest will be sold to buyers linked to premium markets and willing to offer a remunerative price for quality fruit. Second, it makes sense to link local traders buying from these farmers to exporters, as this would assist a shift to higher-volume sea-freight, one of the proposed interventions, while also enabling local mango growers to benefit from export development processes facilitated by the project. In other words, a market linkage component would ensure that upstream impacts from export development flow to target project beneficiaries.

It should be noted that the impacts of the proposed market linkage interventions should not be confined to the export chain. Exporters also supply the modern retail segment and inter-island markets. In addition, farmers in AIPD-Rural districts could also be linked (though local traders) to “modern” trading enterprises that do not export but have an interest in accessing quality mangoes.

4.1.4 Processing

During the fieldwork, many key informants along the chain expressed the view that the development of a mango processing industry would go a long way in addressing the main issue of concern to value chain actors: depressed prices during the main marketing season. A reduction in the supply of fresh mangoes would trigger an increase in market prices during the critical peak-harvest months. Impacts on the price of grade C fruit would be particularly significant. Current support by government to small processing groups or enterprises reflects this thinking, as well as a desire to promote value addition activities that can generate employment opportunities in rural areas, especially for women.

Yet, in the foreseeable future, the mango research team cannot envisage a processing sector in Indonesia with a scale that can generate significant employment and income benefits. The market for processed mango products in Indonesia is small and characterised by strong competition from imports. The development of a large processing sector is further hindered by short harvesting seasons. Success in international markets, which are well supplied by competitive firms in countries such as Thailand, Singapore, and India, is unlikely. Indonesia does enjoy strong competitive advantages in regional fresh mango markets due to seasonal and geographical factors, but these do not play a role in markets for processed mangoes, which have a long shelf-life.

While AIPD-Rural may want to pilot the development of processing groups with a membership drawn from resource-poor rural households and strong participation of women, it should be aware that the rate of success is likely to be low due to the numerous challenges involved. The mango research team does not see potential for leveraged impacts from such interventions.

Successful processing groups may purchase 5 to 15 tonnes of fresh mango per season. Let’s assume an optimistic scenario where ten group enterprises are developed successfully in a district such as Situbondo, with assistance from AIPD-Rural. After several years in operation, these groups will be processing 50 to 150 tonnes of fresh mangoes in a district that produces, on average, 24,000 tonnes per year, of which at least 5,000 are grade C fruit. Let’s also assume that these ten groups have an average

membership of 15 women (a small membership is a necessary condition for the development of cohesive and well-functioning processing group enterprises). A total of 150 women would benefit from the intervention. To achieve these (uncertain) outcomes, AIPD-Rural would need to spend considerable time and resources facilitating group formation, transferring skills and knowledge, supporting market linkage development, and mentoring the groups along the way. Considerable technical support in areas such as group formation, group leadership, management and record-keeping systems, product development, legal registration, and marketing would be required.

Likewise, the successful development of larger and formal processing businesses would create some employment opportunities for women and men, but this sector is unlikely to develop to an extent where systemic impacts can be envisaged, at least within the lifetime of AIPD-Rural. Let's consider, for example, an enterprise in a high-production district of East Java that processes 15 tonnes of fresh mango per day over a three-month period. Let's also assume that this enterprise would procure grade C mangoes from the district where it is based and three other nearby districts with high production; say, from an area with an annual harvest of about 150,000 tonnes, including 35,000 of low-grade fruit. The enterprise would absorb less than 5% of the local supply of grade C. Still, AIPD-Rural could consider supporting existing or new firms, such as PT Suryajaya in Probolinggo, to develop the production of processed mango products at scale for the domestic and/or export market as a demonstration, i.e. to encourage replication or crowding-in. Such interventions should focus on addressing key capacity gaps within the enterprise itself, including product development expertise, knowledge about export market requirements and opportunities, and linkages with international buyers.

4.2 Enabling Early-Season Cultivation

4.2.1 Demo trials

Carefully designed farm demo-trials with large participation of mango growers, collectors, and assembly traders provide the most obvious avenue for addressing the knowledge constraints currently hindering adoption of crop manipulation technologies. Learning on the farm with strong outside expert input should result in widespread adoption of early season technologies due to the potential income gains for participating farmers.

Regular field interactions at key moments in the early-season cultivation cycle – for example, at the time of application of growth regulator, at the time of fungicide spraying, some weeks before harvest, and during and after harvest – will be necessary to maximise learning and develop the necessary confidence in the technology amongst potential adopters. Participation of chemical companies, input dealers, local extension officers, and researchers in field days is also recommended, as it would enhance the ability of service providers to promote target innovations.

Demo-trials have a relatively localised impact. Several should therefore be implemented within the same year in order to enhance outreach and develop the necessary critical mass for wide adoption of the technology. Moreover, in each location, farm demo-trials should be implemented over three years, which is important for validation of the technology. Different results will be achieved in different areas and different years. In locations showing poor results, activities should be extended for at least another year, perhaps two, so that possible causes can be determined and addressed in subsequent demo-trials. In other words, an iterative approach to the design and implementation of

demo-trials, with strong stakeholder participation, is required for fine-tuning technologies to local agro-climatic conditions.

Farmers belonging to groups are an obvious target group. Such farmers manage a minimum number of trees up to harvest time, as they pick the fruit themselves before selling it to collectors or assembly traders. Groups also provide a good entry point for technology transfer and have at least one trader in their ranks. Other farmers with a similar profile should also be targeted. The selection and mobilisation of target farmers, in accordance with certain guidelines, should be the responsibility of local traders with whom AIPD-Rural could partner for implementation of early-season cultivation demo-trials. These traders know farmers in their area well and can identify potential early adopters within local communities.

Selected chemical companies could contribute to the cost of the intervention and be responsible for the implementation of at least some demo-trials, with outside expert advice. Syngenta, Bayer and BASF, the companies selling Amistartop, Cabrio and Nativo, respectively, are three potential partners. These companies have large field staff networks working on crops such as rice, maize and vegetables, which could be easily mobilised. Syngenta also sells Cultar, one of the products containing Paclobutrazol available in the market, but this is more expensive than other brands. Hence, the use of Cultar in demo-trials is not recommended. Still, Syngenta may have an interest in collaborating with AIPD-Rural if it recognises the opportunity for increasing sales of a fungicide such as Amistartop and sees such collaboration as part of its corporate social responsibility.

4.2.2 Exchange visits

Exchange visits to Cirebon, Pemalang, and other districts in Western and Central Java where mango farmers are adopting early-season technologies successfully are highly recommended. These visits provide an excellent learning experience for farmers and traders in target districts. Participants should be carefully selected to ensure that they have the capability to become early adopters. Local traders, rather than Dinas Petanian or BPTP, should be involved in the selection of farmers involved in exchange visits.

4.2.3 Information products

Appropriate information products can contribute to addressing existing knowledge constraints at the farmer level. AIPD-Rural should consider working with Syngenta, Bayer and BASF to develop company-specific leaflets providing technical information about the use of Amistartop, Cabrio, and Nativo for dealing with mango diseases. This would be a very-low cost intervention. AIPD-Rural would simply need to provide technical expertise for leaflet content development.

AIPD-Rural could also consider delivering training to these chemical companies on pest and disease control for mangoes. Staff at headquarters and in the field could be involved in training. Partner companies could perhaps pay for the costs of curriculum development and expert trainers. There could be further opportunities for cost-sharing in training input retailers, an activity that could be led by the chemical companies themselves.

4.3 Export Development

4.3.1 Export trials

The transition from air to sea freight is a very risky one. Exporters will have to send 15 tonnes of fruit per shipment, the capacity of the smallest reefer containers, rather than the current 0.5 - 2 tonnes. Importers will be initially reluctant to receive such volumes for fear that the fruit will not stand longer freight times or will need to be sold quickly and for a heavy discount to avoid physical and quality losses at the wholesale or retail levels. This would result in financial losses to the parties involved and cause serious damage to the reputation of the exporter and the Indonesian mango industry as a whole. The reluctance of exporters and importers to shift from air to sea transportation, an innovation that could deliver significant financial benefits to both parties, is therefore understandable.

Export trials will significantly reduce these risks. Such trials will enable exporters to develop the necessary technical and market know-how for successful sea freight and, at the same time, build the necessary confidence in import markets that Indonesia can consistently deliver large volumes of quality fruit in by sea. It is recommended, therefore, that AIPD-Rural implements a series of trial shipments with strong participation of current and potential exporters.

Some potential private sector partners have been identified during the fieldwork. This includes current exporters, such as PT Sumber Buah in Cirebon, PT Alamanda in Bandung, and PT Sumber Bumi in Probolinggo; companies and traders with long experience supplying mangoes to supermarkets, such as Bimandiri in Bandung and Ibu Lily or Uidjaya in Pasuruan; fruit exporters not yet involved in the mango trade, such as PT Angu Mustika in Jakarta; and export businesses with an interest in diversifying their product portfolio, such as Global Exports[12], an handicraft and forward-freight company in Mataram that would like to start shipping mangoes to Hong Kong.

There is a critical lack of expertise in Indonesia on mango export technologies. Outside expertise will therefore be required for proper trial design, implementation, and evaluation. Researchers at Mataram University with previous export trial experience could also be valuable sources of expertise. Expert input will be necessary to ensure that the right post-harvest practices are strictly followed; to evaluate fruit quality on arrival and commercial shelf-life; to assess the response of import markets to sea-freighted Indonesian mangoes; and to determine the economics of sea-freight shipments. Experts will also need to play an important role in identifying the source of any problems experienced before, during and after transportation, and feed those lessons into the design of subsequent trials. Trial shipments will sometimes fail. Failure is a great way to learn, provided exporters are not unduly exposed to losses and the causes of failure are identified and taken into account in future shipments. A flexible, iterative approach to export trials is strongly recommended.

Cool chains were identified as a critical factor in a recent sea-freight trial from NTB. The lack of a cool chain to Surabaya compromised fruit quality on arrival in Hong Kong. Short-term hire of refrigerated containers on site would address this problem. Exporters could also rely on existing cool chains for supermarkets and vegetable exporters. The cost of hired refrigerated containers is not high.

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[12] Global Exports was the only company that participated in an ACIAR sea-freight export trial for mangoes from North Lombok. The fruit was shipped to Hong Kong.

Appropriate sea-freight packaging will also need to be developed. The cartons currently used in the mango trade are designed for air freight. Sea freight requires stronger packages that can stand a load of up to 16 cartons high, or 120 kg compression, with bottom and side venting for best airflow. There are a large number of carton manufacturers in Surabaya and ample carton designs available that can be copied. Some Surabaya manufacturers have access to high-quality, high-strength virgin paper.

Export trials should be implemented over a three- to four-year period to maximise outreach and develop the necessary confidence amongst exporters and in target markets. Repeated trials to the same export destination are advisable. It is also recommended that several trials be carried out within each mango season. Involving several private sector participants in each trial, whereby three to five exporters would share a container, is important. Exporters are not used to assembling 15 tonnes of export-quality mangoes and would find it difficult initially to fill a container on their own. Sharing a container also reduces exposure to losses.

Several risk-sharing options could be considered. For initial shipments, exporters could meet the cost of fruit and packaging, with AIPD-Rural covering sea freight and any financial losses. Over time, project subsidies could be reduced and eventually phased out. Participation in a few trials should enable exporters to develop the necessary technical competence, knowledge about the market, and confidence.

Easier and more accessible markets, such as Singapore, Malaysia and Hong Kong, should be prioritised initially. All can be reached within one week from Surabaya port. New markets that do not require access protocols, such as Vietnam, could be considered after the technology for sea freight has been tested and refined, its profitability proven, and some commercial transactions in conducted successfully without project involvement. More difficult but potentially large markets, such as Thailand and the Philippines, could be targeted at a later stage.

4.3.2 Export market visits

Exporter visits to target markets should be organised alongside trial shipments. The opportunity to visually assess fruit quality on arrival is important for confidence building. As importantly, enterprises participating in these visits will have the opportunity to meet with importers to discuss a range of issues, including fruit quality, market demand, consumer preferences, prices, and potential business opportunities. These interactions will improve current understanding of export markets and help exporters develop critical linkages with importers.

4.3.3 Export market studies

A series of export market studies should be carried out during the early intervention stages. These studies would serve two strategic purposes. The first would be to improve exporters' understanding of current and potential markets. Exporters are somewhat familiar with Singapore and Dubai, but their knowledge of each of these markets is largely based on transactions and interactions by telephone or e-mail with one or two importers. Exports to Hong Kong and Malaysia are much smaller and more sporadic. Exporters have very limited information, if any, about other markets.

Exporters will need to understand various market dimensions in different countries in order to develop successful mango exporting businesses, including market size, market segmentation, consumer preferences, supply seasonality, competition from local and

imported mangoes, logistics and transportation costs, prices in different market segments, tariff and non-tariff entry barriers, and the structure of the mango import trade. Information about importers, including their contact, would be useful as well.

The second purpose of the market studies would be to inform strategies for access to markets that require quarantine protocols. The studies could assist the mango industry and the Indonesian government in the selection of priority countries for negotiation of Phytosanitary agreements. These will take several years to develop. Government-to-government negotiations take time and must be supported by research demonstrating the effectiveness of the fruit fly treatment proposed. Disinfestation research also takes time and resources.

Hence, Indonesia's government should be very careful and selective when initiating negotiations for quarantine agreements with specific countries. Those that offer the greatest export opportunities should be prioritised. This criterion is likely to exclude Japan and Korea, which have small domestic markets, very expensive quarantine requirements, and very strict MRL regulations. Thailand and the Philippines are more likely choices. India may also offer interesting opportunities.

4.3.4 Product promotion and market testing

AIPD-Rural could consider working with exporters and importers in markets such as Singapore, Malaysia, and Hong Kong to promote Arumanis and Gedong Ginku in modern retail outlets and test the market. The objective would be to raise consumers' awareness of Arumanis and Gedong Ginku and evaluate their response to Indonesian mangoes. This would provide a better understanding of the marketing potential of these varieties in current markets.

4.4 Upstream Development of Export and Other Quality Chains

4.4.1 Demo trials

It is recommended that AIPD-Rural implements a series of participatory demo-trials and trainings for testing and promotion of on-farm technologies and practices with potential to improve fruit quality and productivity. Fruit bagging, systemic insecticides for control of sucking insects, pruning, improved harvesting practices, and on-farm washing of sap flow are some innovations that could be promoted as part of a demo-trial program.

A similar strategy to that proposed earlier for early-season demo-trials is recommended. Local traders should play a leading role in the design and implementation of demo-trials, alongside BPTP and Dinas Pertanian, under the technical guidance of outside experts. Exporters and other modern mango trading enterprises could also be involved, as this will contribute to strengthening linkages along quality chains.

4.4.2 Facilitation of market linkages

The development of linkages to exporters and other quality-conscious mango trading enterprises will provide strong incentives for quality upgrading at farm level. The project can play an honest broker role by introducing dynamic traders in target areas to buyers supplying high-quality, high-value markets. The latter could also be involved in the demo-trials implemented with project assistance.

4.4.3 Information products

Pests and diseases have significant impacts on fruit yield and fruit quality. An intervention strategy focused on addressing systemic knowledge constraints through the development of appropriate information products for wide distribution via input retailers could reach a large number of mango farmers for a relatively low cost.

Pest and disease calendars and charts showing fruit defects, as well as their causes and solutions, would be particularly useful to farmers and other chain actors. Again, chemical companies such as Syngenta, Bayer, and BASF could be approached to sponsor these generic information products because they sell some of the most effective product solutions available in the market.

5 Key Findings and Conclusions: Poverty, Gender and Environment

5.1 Poverty

Mango development processes in districts such as Cirebon and Pemalang show that mango can be a vehicle for poverty reduction and improved rural livelihoods. Small farmers in these districts are earning high incomes from mango cultivation and generating significant on-farm wage employment.

In 2011, Pak Abdul, one of the two farmers interviewed in Pemalang, earned a net income of US$ 2,300 from 36 mango trees, i.e. from less than 0.4 hectares. He spent 36 days working on his mango farm and paid US$ 258 in wages to casual farm workers. That same year, having achieved an exceptionally high yield of 25 tonnes per hectare, Pak Akin, the other farmer interviewed in Pemalang, earned more than US$ 4,000 from his 30 Arumanis trees (about 0.3 hectares). He allocated 31 days of his own time to his mango crop and paid approximately US$ 231 in wages. He also made an additional income from 40 mango trees rented from other farmers in his area. Abdul and Akin are certainly not poor. Like them, many other small growers in West and Central Java are earning a decent living from mango farming. Their ability to produce an early harvest that is sold for a high price has turned mango into a high-value crop.

Situbondo and North Lombok present a very different picture. In these two districts, nearly all the fruit is harvested in October and November, when the market is literally flooded with mangoes. The crop is sold for a very low price. Mango farm households in those two districts are somewhat trapped in a low-price, low-input, low-income equilibrium.

In Situbondo, for instance, Pak Nor earned a net income of US$ 312 from his 2011 mango harvest. He spent 13 days managing his 20 trees and paid US$ 143 in wages. Pak Herman spent 9 days managing his 16 Arumanis trees. He hired a significant amount of labour per tree, generating US$ 154 in wage income, and earned a profit of US$ 367. Pak Asgianto, a renter from Situbondo, made a net income of US$ just 312 from his 26 mango trees. He only spent 2 days working in his farm and hired labour for just 10 days during the entire season. He also managed 750 rented trees, but the research team did not collect revenue and cost data for his rented orchards and trees. Pak Asgianto is not a poor farmer as he manages a large number of trees. Whether or not Pak Herman and Pak Nor are poor is unclear, as their families have other sources of income besides mango. What is very clear is that they and many others like them could earn significantly higher incomes from their mango farms if only they were able to replicate the experience of Akin and Abdul in Pemalang. In the process they would generate valuable employment opportunities for others in their villages, including marginal and landless households.

At the moment, farmers in Situbondo and North Lombok cannot produce an early-season and very profitable crop because they lack the required knowledge about crop manipulation. AIPD-Rural is well positioned to address this constraint. In so doing, it would be raising the incomes of mango farmers and farm workers in districts where a large segment of the population is poor or earning an income just above the poverty line. In North Lombok, 43% of the population lives below the poverty line, and an estimated 80% are either poor or near poor (Collin Higgins Consulting Group, 2012). Situbondo has a

poverty rate of 16%, but this figure jumps to 52% of the population when the poverty line is multiplied by a factor of just 1.5 (Collin Higgins Consulting Group, 2012).

Situbondo has a has a dualistic mango sector, with a relatively small number of renters controlling hundreds or thousands of trees and a majority of mango farm households owning a small number of trees. The latter rent-out their trees for a fairly low value or manage them with minimum care. For most, mango farming is a relatively marginal occupation. The targeting strategies adopted by AIPD-Rural in Situbondo district will need to ensure that small mango growers with a commercial orientation, rather than medium or large renters, are the main beneficiaries of project interventions. Involvement of large numbers of households with 20 to 100 trees in the innovation processes proposed in this report will be necessary to ensure that interventions have the desired socio-economic impacts.

North Lombok has a fairly dry climate and limited irrigated land. Farmers in the district enjoy few livelihood diversification opportunities, both on- and off-farm. In the main mango production areas, such as Bayan sub-district, the crop accounts for a significant share of agricultural land. Mango has clear socio-economic relevance in North Lombok, a district with a much less diversified and developed rural economy than Situbondo. Currently, the ability of farm households in North Lombok to earn a reasonable income from mango is severely undermined by a generalised lack of investment in cultivation and very low prices. These reflect the timing of the harvest, a system where the fruit is sold on the tree, and long distances to destination markets.

The local context in North Lombok is particularly challenging, especially in low-lying areas along the coast, where farmers have had to endure acute fruit set failure for two consecutive years. AIPD-Rural could consider funding research specifically aimed at identifying the source of fruit set failure and working with local traders and farmers to address the problem. In the meantime, the project could facilitate the transfer of critical know-how on early-season cultivation in areas that are not being affected by this problem.

5.2 Gender

The mango farming landscape is dominated by men. Generally, women play no role as farm managers or workers. Likewise, fruit collection, assembly, and wholesaling activities are normally performed by men. A few trading enterprises exporting mangoes and selling to higher-end customers in the modern retailing sector hire women to clean and sort the fruit. Members of mango processing groups and a large share of the labour force working for mango processing firms are women, but these enterprises form a very small segment within the mango sub-sector. In short, women's participation in the mango value chain is largely confined to the traditional retail trade: many women are involved as market and street vendors.

While the development of processing activities would create employment opportunities for women, the research team is somewhat sceptical about the medium-term prospects for the mango processing sector. An upgrading of quality management systems along export and domestic chains offers greater employment opportunities for women, as many of the enterprises supplying higher-quality markets employ female labour.

5.3 Environment

Given their deep roots and perennial nature, mango trees provide an effective barrier against soil erosion, a major cause of soil degradation, especially in farms on sloped land. From this perspective, mango trees are a much better option than short-term crops such as maize or vegetables, and annual crops, such as cassava. Furthermore, the pruning of mango trees produces wood that can be used for fuel and other purposes. The research team came across farmers who sold the branches or used them as payment to the labour hired to prune the trees.

Mango is much less damaging to the environment than crops in which large amounts of fungicides and insecticides are applied, e.g. vegetables. In areas such as in Situbondo and North Lombok where mango is not yet very commercialised, farmers apply very few chemicals. Many do not even use any fungicides or pesticides. However, in areas characterised by more intensive mango cultivation systems, such as Cirebon and Pemalang, the use of chemicals is a problem, not only for the environment, but for human health as well. This has been identified as the most serious environmental issue in the Indonesian mango chain.

- There is a high probability of Maximum Residue Limit (MRL) violations due to the frequency and quantity of product sprayed in those two districts, with negative consequences for the health of consumers.
- Perhaps more worryingly, in a context where protective clothes, masks and gloves are rarely (if ever) used, farmers and farm labourers are directly exposed to high dosages of insecticides and fungicides.
- The overuse of broad spectrum and selective insecticides kills beneficial insects and leads to pest resistance.
- In an environment where awareness about chemical use is very limited, there is much scope for abuse: highly toxic S7 chemicals, for instance, were readily available in input stores with virtually no information on the product label about risks and their management.

These issues will become increasingly relevant in areas outside West and Central Java where mango production systems are undergoing a slow but steady process of commercialisation. This is certainly the case of many districts in East Java, including Situbondo, although the process in this district is still at a fairly initial stage. Unfortunately, it is very difficult to change deep-rooted behaviours and attitudes on the part of farmers. Multinational chemical companies have spent time and resources raising awareness about these issues, but overdosing remains widespread and use of protective equipment a rare exception.

By encouraging farm intensification, the proposed interventions will have some negative impacts on the environment. However, some of the technology options presented, particularly fruit bagging, would significantly reduce farmers' need to rely on chemicals to manage pests and diseases. As mentioned previously, fruit bagging significantly reduces fungicide use and eliminates the need for pesticides. Soil-applied insecticides are less benign: these offer a cheaper alternative to spraying against sucking insects, but their impact on the environment and human health needs to be better understood and compared with the impact of conventional fungicides and pesticides. Post-harvest treatments for controlling diseases and fruit flies, in turn, should pose no risk to

consumers: research findings in Australia suggest that chemical residues from application of recommended dosages of Amistartop and Kanon are below international (Codex) MRLs (Thistleton and Baker, 2011).

Interestingly, research at University Mataram (UNRAM) is looking at Paclobutrazol as an adaptive strategy for climate change. Higher wet-season rainfall and higher dry-season temperatures as climate change occurs will be less conducive to good mango crops. Paclobutrazol can produce a crop even in years of lower than average rainfall and higher than average temperatures. This is very important for poor farmers, especially in North Lombok, who have few income generation alternatives. Paclobutrazol gives a more reliable crop, even if it may not always be early. This was demonstrated in farm trials implemented in 2010 in NTB (Thistleton and Baker, 2011).

Finally, the continued use of wooden crates for packaging mangoes, which are used only once and consume a lot of timber, is an issue but one that is difficult to resolve. A returnable crate system is complex and expensive to implement. And moving to single-layer cartons may not be a sound move from an environmental perspective.

6 Key Research Gaps: Implications for AusAID and ACIAR

6.1 Export Development

There is a poor understanding of export markets and the challenges associated with the development of sea-freight. This is reflected in the interventions proposed, which have strong learning and adaptation elements. For example, there is a need to improve current understanding of the response of Arumanis and Gedong Ginku to different post-harvest treatments, their performance under sea-freight conditions, the response of consumers in different export markets to sea-freighted mangoes, the commercial shelf-life of the fruit, and the economics of sea-freight shipments. Any fruit quality problems experienced need to be carefully assessed so that their causes can be properly identified and addressed. More also needs to be learned about different export markets, the opportunities they offer to Indonesian exporters, and the access barriers these will face in each of those markets. Answers to these questions should be provided during the implementation, monitoring, and evaluation of the proposed export development interventions, and in the context of future ACIAR-funded projects.

6.2 Farm Technologies

Much emphasis is given in this study to on-farm technical innovations for early-season production, improved productivity, and an upgrading of fruit quality. These are critical but under-researched areas. ACIAR has funded some important work on mango farm technologies in NTB, but much more needs to be done in order to fine-tune technologies and farm management practices, identify the options that can deliver maximum benefits to farmers, and assess which are more likely to be adopted by resource-poor households in different regions. As in the case of exports, interventions by AIPD-Rural to promote adoption of crop manipulation technologies and improved quality management systems at farm level offer opportunities for learning about technology adaptation and fine-tuning. This will be critical for the success of proposed interventions.

6.3 Varieties

Current knowledge about varieties is very poor. The research team has not seen any study comparing the profitability of Arumanis and Gedong Ginku in West Java, any evaluation of these two varieties by consumers in major markets, such as Jakarta and Surabaya, or any data on the agronomic performance of Gedong Ginku in East Java. Such type of research is essential for determining the opportunity to introduce Gedong Ginku in East Java, and could be addressed under future ACIAR projects.

Moreover, there is a clear need to develop a much better understanding of the agronomic performance of yellow- and red-skin varieties that are being selected under government research programs, under different agro-climatic conditions. These varieties should also be carefully evaluated in terms of their response to Paclobutrazol and post-harvest treatments, shelf-life, and acceptability in domestic and export markets. At the moment this is not being done. Only varieties that meet key agronomic and market performance criteria should be commercially released and promoted.

6.4 Processing

The development of mango processing has clear strategic relevance due to potential impacts on prices during the main season, employment, and rural development more generally. It is surprising, therefore, that little research has been conducted to characterise the sector, assess its performance, and identify constraints and development opportunities. In-depth case studies of existing processing enterprises and research on domestic markets for processed mango products would go some way in addressing this important research gap.

6.5 Value Chain Margins

Data on gross and net margins along mango value chains in different provinces would complement and improve the findings from the current study. Such research would provide important quantitative evidence about employment and incomes in the chain, the efficiency of marketing systems, the distribution of value or benefits across different chain actors, the profitability of different market channels, and opportunities for efficiency gains and value creation. In addition, a structured survey for collection of farm gross margins in different districts and provinces would provide more robust evidence about employment in mango farms and the profitability of different production strategies.

6.6 Other Gaps

Three further issues warrant special attention in light of the study findings and recommendations: price incentives for on-farm investments in quality, in a context where farmers sell their mango fruit ungraded; business models of modern wholesalers and exporters in different parts of Java, including in districts such as Pasuruan, which was not visited by the research team; and production data gaps.

A better understanding of incentives for investment by farmers in improved quality management systems has clear relevance in the context of interventions targeting such type of innovation. More information about modern wholesalers and exporters is required for identification of enterprises that could potentially partner with AIPD-Rural for implementation of interventions aimed at developing export and other quality chains with strong participation of farmers in project areas. Finally, the research team could not access any data on production areas in study districts and the number of mango farm households across different size categories. This is important data for a project that needs to assess the impact potential of different interventions in the mango sub-sector and develop appropriate targeting strategies.

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8 Annexes

Annex 1: Field work schedule

Dates	Location	Purpose
2 September	Jakarta	Team meeting
3–6 September		Interviews with fruit exporter, supermarkets, agro-chemical company, wholesalers in Kramatjati market, DG Hort, and visits to supermarkets
6 September	Bogor	Visit to Bogor Agricultural University
7-8 September	Bandung, West Java	Interviews with supermarket supplier, mango exporter, mango processor
9-10 September	Cirebon, West Java	Interviews with farmers, local traders, mango exporter, and mango processor
11-12 September	Pemalang, Central Java	Interviews with farmers, local traders, input retailers, and Paclobutrazol distributor
13 September	Travel to Situbondo	
14-16 September	Situbondo, East Java	Interviews with Dinas, farmers, plantation, mango processors, local traders, input dealers
17–19 September	Probolinggo, East Java	Interviews with Dinas, farmers, plantation, local traders, mango exporter, mango processors, input dealers
20-22 September	Surabaya, East Java	Interviews with modern retailers, traditional wholesalers and retailers, potential exporters, and visits to supermarkets
23 September	Travel to Mataram	
23-24 September	Mataram, NTB	Discussion with researchers at BNPT and Mataram University Interviews with traditional retailers and wholesalers Visit to supermarket
25-27 September	North Lombok, NTB	Interviews with input retailers, farmers and traders
28 September	Mataram, NTB	Interviews with Dinas and one input retailer

Annex 2: Checklists

Input Suppliers	
1. Background information	▪ Location/address/contact ▪ No. and location of field staff (if agro-chemical company) ▪ Product portfolio (if agro-chemical company) ▪ Other background information
2. Technical know-how	▪ Knowledge of mango cultivation and post-harvest systems, incl. agro-chemicals, their pros and cons ▪ Sources of technical information and knowledge about mangoes ▪ Knowledge gaps and weaknesses
3. Agro-chemical sales	▪ Inputs sold to mango growers (including brands) ▪ Gaps in product portfolio (e.g. growth hormones) and reasons ▪ Importance of mango growers as clients ▪ Main barriers to an increase in input sales to mango growers ▪ Strategies to increase input sales
4. Prices	▪ Selling price for key agro-chemicals used in mango cultivation and post-harvest treatments
5. Environment and human health	▪ Environmental and human safety issues associated with different agro-chemicals? ▪ Are farmers aware of these issues? ▪ Are these issues discussed with farmers?
6. Linkages with suppliers	▪ From whom does the retailer purchase agro-chemicals? ▪ Services provided by suppliers (training, trials and demos, technical information, samples, credit, etc.) ▪ Strengths and weaknesses in the relationship with suppliers
7. Linkages with buyers	▪ Profile of buyers (farmers versus traders, gender, location, etc.) ▪ Services provided to buyers (technical information and advice, trials and demos, product samples, credit, …) ▪ Strengths and weaknesses in the relationship with buyers
8. Constraints, opportunities and interventions (wrap-up)	▪ Key constraints faced by the retailer (w/ranking) ▪ Opportunities for increasing agro-chemical sales to mango growers ▪ Does the key informant see any opportunities for collaboration with a development project intervening in the mango sub-sector? If yes, what are the opportunities for collaboration?

Farmers (Focus Group Discussions)	
1. Background information	▪ Village / district ▪ Number of households living in the village
2. Socio-economic importance of mangoes	▪ Ranking of crops in terms of area and income ▪ Importance of livestock ▪ Ranking of household income sources (farm and non-farm) ▪ Approximate contribution of mango to household income: < 10%; <20%; … ▪ How typical or atypical is the village as far as the socio-economic importance of mango is concerned?
3. Mango development processes	▪ Timeline of mango production and marketing development in the village; comparison w/ other villages
4. Typology of mango growers (number of trees)	▪ Approximate % of households in the village with mango trees ▪ Approximate % of mango growers with more than 4 trees ▪ No. of relatively large mango growers in the village and number of trees owned by these growers ▪ No. trees typically owned by an average mango grower in the village ▪ Changes in number of mango trees per household (last 5 years)
5. Mango production systems	▪ Mango varieties grown in the village, ranking of varieties, and differences with other villages in the area ▪ Reasons behind varietal choices ▪ Harvesting months for different varieties ▪ Irrigation, fertilization, disease and pest control, crop manipulation, and other cultivation practices ▪ Harvest and post-harvest practices ▪ Farm and post-harvest management by traders purchasing fruit on the tree ▪ Hiring of labour by mango growers ▪ Key changes in cultivation and post-harvest practices (last 5 years) ▪ Possible improvements to current production and post-harvest systems ▪ Factors driving or hindering technology adoption (e.g. price incentives, technical know-how, physical access to inputs, cost of inputs, other)
6. Gender (production)	▪ Use of male and female labour throughout the mango cultivation calendar ▪ Gender composition of hired labour ▪ Gender roles in input purchases and mango fruit marketing ▪ Changes in gender roles over the past 5 years and reasons
7. Environment and human safety	▪ Key environmental issues in mango cultivation ▪ On-farm use of chemicals; storage and handling of agro-chemicals

8. Input purchases	▪ Input suppliers (profile and location) ▪ No. of input dealers in the area and distance ▪ Input payment procedures (prompt/delayed payment; payment in kind) ▪ Provision of technical information and advice by input suppliers ▪ Other services provided by input suppliers (e.g. credit, trials and demonstrations, free product samples) ▪ Constraints/problems in access to inputs (price incentives, technical know-how, physical access, cost, credit, etc.)
9. Buyers and transactions	▪ Buyers of fresh mango and their relative importance ▪ Number of mango collectors/buyers in the area ▪ Stability in farmers-buyer relationship ▪ Changes in the type and number of mango buyers (last 3 years) ▪ Sale of fruit on the tree *versus* sale of harvested fruit *versus* renting of mango orchards ▪ Forms of payment (advance payment, on the spot, delayed payments) ▪ Services provided by collectors and other buyers (inputs, credit, technical know-how, market information, …) ▪ Information flows between farmers and buyers ▪ Strengths and weaknesses in the relationship with buyers
10. Product quality	▪ Quality standards of buyers ▪ Farmers' awareness and assessment of the quality of their mangoes
11. Prices	▪ Price trends (farm-gate, last 3 years) and expectations about future prices ▪ Price seasonality (farm-gate) ▪ Price differences between different varieties, grades, and qualities ▪ Price determination processes (negotiation, competition between buyers, visual assessment of trees, …)
12. Sources of technical information	▪ Main sources of technical information (ranking and gender differences) ▪ Assessment of different sources (regularity of interaction, type of information provided, and reliability of the information provided) ▪ Knowledge gaps (cultivation and post-harvest, incl. gender differences)
13. Sources of market information	▪ Main sources of market information (ranking and gender differences) ▪ Assessment of different sources (regularity of interaction, type of information provided, and reliability of the information provided) ▪ Strengths and weaknesses in farmers' knowledge of markets (incl. differences between men and women)
14. Credit	▪ Sources of credit for households in the village (formal and informal) ▪ Ranking of credit sources in terms of their importance ▪ Advantages and disadvantages of different sources of credit ▪ Changes in access to credit over the past 5 years ▪ Gender differences in access to credit

15. Constraints and opportunities	▪ Key problems and constraints (production and marketing) ▪ Key opportunities (production and marketing) ▪ Barriers to access to these opportunities ▪ Recommendations for intervention: what type of interventions would enable farmers to improve mango production and marketing? Please prioritise…

Collectors and Assembly Traders	
1. Background information	▪ Location/address/contact ▪ Number of years trading mango
2. Fresh mango sales	▪ Tons of fresh mango sold in the last 3 years ▪ Distribution of sales within the year and changes over the past 3 years ▪ Challenges and strategies to increase mango sales
3. Varieties	▪ Varieties sold ▪ Share of different varieties in mango sales, and reasons ▪ Recent changes in variety portfolio, and reasons ▪ Assessment of different varieties (agronomic performance, seasonality, appearance, eating quality, consumer demand, export potential, price)
4. Own mango production	▪ Involvement in mango production (area, number of trees) ▪ Production in own land versus rented land/trees ▪ Mango varieties grown ▪ Reasons behind varietal choices ▪ Timing of harvest for different varieties ▪ Farm technology (irrigation, fertilization, disease control, pest control, use of growth hormones for inducing flowering, harvesting) ▪ Post-harvest practices (sorting, grading, packaging, other) ▪ Changes in cultivation and post-harvest practices during the last 5 years ▪ Key production problems ▪ Factors driving or hindering technology adoption (price incentives, technical know-how, physical access to inputs, cost of inputs, other)
5. Production systems in the area	▪ Cultivation and post-harvest practices ▪ Productivity of local mango orchards and fruit quality ▪ Changes over the past three years and reasons ▪ Innovations with greatest potential to increase farm productivity and income, and barriers ▪ Environmental issues associated with local mango production systems
6. Purchases of mango before, after harvest	▪ % fruit purchased on the tree, changes in the last 3 years, and reasons ▪ Cultivation, post-harvest practices for green mango purchased on the tree ▪ Post-harvest practices for fruit purchased from farmers
7. Inputs	▪ Input suppliers (type and location) ▪ Input payment procedures (prompt payment versus delayed payment; payment in kind; interest on input credit) ▪ Services provided by input suppliers (e.g. advice, credit, product samples) ▪ Constraints in access to inputs (including price incentives, technical know-how, physical access to inputs, cost of inputs, other)
8. Sources of technical information	▪ Main sources of technical information for mangoes (ranking) ▪ Assessment of different sources (regularity of interaction, type of information provided, and reliability of the information provided) ▪ Gaps and weaknesses in technical know-how

9. Linkages with suppliers	▪ Villages from where the trader procures mangoes ▪ Number of farmers supplying mango to the trader ▪ Profile of farmers selling mangoes on the tree and after harvest ▪ Does the trader buy from the same farmers in different years? ▪ Services provided by the trader to farmers (e.g. input credit) ▪ Information flows from the trader to farmers, and vice-versa ▪ Purchasing conditions set by the trader (variety, quality, pricing, payment procedures, other) ▪ How does the trader coordinate purchases from farmers? How is the negotiation process conducted? ▪ Strengths and weaknesses in the relationship with farmers
10. Linkages with buyers	▪ Main buyers, their profile (location, legal status, scale, gender) ▪ Changes in the last 3 years and reasons ▪ Stability in the relationship with buyers ▪ Functions performed by buyers (e.g. sorting, grading, packaging, …) ▪ Services provided by buyers (e.g. advances) ▪ Services provided to buyers ▪ Information flows from the trader to buyers, and vice-versa ▪ Conditions set by buyers (quality, volumes, delivery times, pricing, payment procedures, other) ▪ Contractual relationship with buyers, coordination of supplies, negotiation of transactions… ▪ Strengths and weaknesses in the relationship with buyers
11. Quality management systems	▪ Quality grades and standards applied by the trader and buyers ▪ Quality management systems by the trader, upstream suppliers and downstream buyers (e.g. sorting, grading, packaging, transportation) ▪ Coordination systems for compliance with quality grades and standards ▪ Sanctions for non-compliance ▪ Strengths and weaknesses in quality management systems ▪ Typical quantitative and qualitative product losses experienced ▪ Strategies to improve quality management and challenges
12. Sources of market information	▪ Main sources of information about mango markets (ranking) ▪ Assessment of different sources of market information (regularity of interaction, type of information provided, and reliability of the information) ▪ Gaps in market information and market know-how
13. Services	▪ Key external services for a successful mango collection business ▪ Who provides these services? ▪ Main weaknesses and gaps in service provision; how can these be addressed?
14. Gender	▪ Gender of suppliers ▪ Gender of collectors and assembly traders ▪ Gender of buyers ▪ Changes over the past 5 years, and reasons

15. Prices	▪ Price trends, expectations about future prices, and reasons ▪ Differences in the prices paid by different buyers ▪ Price seasonality ▪ Current mango purchasing and selling prices for different varieties and different grades
16. Costs	▪ Main marketing costs (variable and fixed) ▪ Costs per ton sold
17. Business environment	▪ Assessment of the policy and regulatory environment ▪ Assessment of support infrastructure ▪ Assessment of other business environment dimensions
18. Constraints, opportunities and interventions (wrap-up)	▪ Opportunities for the development of the mango collection business ▪ Strategies and barriers to develop or access these opportunities ▪ Key challenges and constraints (w/prioritization) ▪ What should be done to address challenges and constraints? ▪ Recommendations for public and project interventions aimed at enabling these developments ▪ Does the trader see any opportunities for collaboration with a development project intervening in the mango sub-sector? If not, why not? If yes, what are the opportunities for collaboration? How would s/he rank them?

Wholesalers / Inter-island Traders	
1. Background information	▪ Location/address/contact ▪ Range of fruits traded ▪ Number of years trading mango
2. Fresh mango sales	▪ Tons of fresh mango sold per annum ▪ Distribution of sales within the year ▪ Different market channels and their relative importance ▪ Growth trends in different market channels/segments ▪ Challenges and strategies to increase mango sales
3. Varieties	▪ Varieties sold ▪ Ranking of different varieties according to sales, and reasons ▪ Differences in varieties traded per market channel or type of client ▪ Key changes in the variety portfolio (last 3 years) and reasons ▪ Assessment of different varieties in terms of agronomic performance, seasonality, appearance, eating quality, consumer demand, export potential, and market prices
4. Supplying areas	▪ Relative importance of different provinces / districts, and reasons ▪ Differences between supplying areas in terms of variety and quality ▪ Changes in the relative importance of different supplying areas, and reasons
5. Linkages with suppliers	▪ Type and profile of suppliers, and relative importance ▪ Services provided by the trader to suppliers (e.g. advances) ▪ Information flows from the trader to suppliers, and vice-versa ▪ Purchasing conditions set by the trader (variety, quality, pricing, payment procedures, other) ▪ Does the trader have a contractual relationship with suppliers? If yes, what are the terms of the contract? If not, how does s/he coordinate with suppliers? How is the negotiation process conducted? ▪ Strengths and weaknesses in the relationship with suppliers ▪ Trader's strategy to address weaknesses in the relationship with suppliers
6. Linkages with buyers	▪ Main buyers: location, legal status, and scale ▪ Changes in buyer portfolio during the last 3 years, and reasons ▪ Services received from buyers (e.g. advisory, market information, …) ▪ Information flows from the trader to buyers, and vice-versa ▪ Conditions set by buyers (quality, volumes, delivery times, pricing, payment procedures, other) ▪ Does the trader have a contractual relationship with buyers? If yes, what are the terms of the contract? If not, how does s/he coordinate with buyers? How are transactions negotiated? ▪ Strengths and weaknesses in the relationship with buyers and strategies to address weaknesses

7. Quality management systems	▪ Quality grades and standards of the trader and buyers ▪ Quality management systems by the trader, upstream suppliers, and downstream buyers ▪ Coordination systems for ensuring that quality grades and standards are met ▪ Sanctions to suppliers and the trader for non-compliance? ▪ Strengths and weaknesses in quality management systems ▪ Typical quantitative and qualitative product losses experienced
8. Sources of market information	▪ Trader's assessment of his/her access to information about mango markets ▪ Main sources of information about mango markets ▪ Assessment of different sources of market information (regularity, type of information, and reliability of the information) ▪ Gaps in market know-how
9. Gender	▪ Typical gender of wholesalers / inter-island traders ▪ Gender of suppliers ▪ Gender of buyers
10. Prices	▪ Mango price trends for different varieties (past 3 or 5 years), and reasons ▪ Are there any clear differences in the prices paid by different buyers? ▪ Price seasonality within Indonesia ▪ Current mango purchasing and selling prices (different varieties, different grades)
11. Costs	▪ Main costs to the wholesaler (variable and fixed) ▪ Costs per ton sold
12. Business environment	▪ Assessment of the policy and regulatory environment in Indonesia ▪ Trader's assessment of support infrastructure ▪ Trader's assessment of other important business environment dimensions
13. Constraints, opportunities and interventions (wrap-up)	▪ Key opportunities for the development of the mango trading business ▪ Barriers to develop or access these opportunities ▪ Strategies to develop or access these opportunities ▪ Key challenges and constraints (w/prioritization) ▪ What should be done to address challenges and constraints? ▪ What are the key changes or developments that can enable the development of mango trading? What needs to change? What are the key innovations required? ▪ Recommendations for public and project interventions aimed at enabling these developments ▪ Does the trader see any opportunities for collaboration with a development project intervening in the mango sub-sector?

Supermarket Suppliers	
1. Background information	▪ Location/address/contact ▪ Range of fresh produce traded ▪ Number of years supplying fruits to supermarkets
2. Fresh mango sales	▪ Quantity of fresh mango traded per annum ▪ Distribution of sales within the year ▪ Market channels (supermarkets, modern stores, wholesalers, exporters, other) and their relative importance ▪ Growth trends in different market channels/segments
3. Varieties	▪ Varieties sold and their relative importance in terms of sales ▪ Varietal preferences of different market channels / clients ▪ Key changes in the variety portfolio (last 3 years) and reasons ▪ Assessment of different varieties (agronomic performance, seasonality, appearance, eating quality, consumer demand, export potential, prices)
4. Mango production (enterprise may or may not be directly involved in production)	▪ Involvement in mango production (area, number of trees) ▪ Production in own land versus rented farms/trees ▪ Mango varieties grown, relative importance, and reasons ▪ Production seasonality (including comparison across varieties) ▪ Production technology used (irrigation, fertilization, disease control, pest control, use of growth hormones for inducing flowering, harvesting) ▪ Harvest and post-harvest practices ▪ Factors driving or hindering technology adoption (e.g. price incentives, technical know-how, physical access to inputs, cost of inputs, other)
5. Sources of technical information	▪ Enterprise own assessment of its access to technical information ▪ Main sources of technical information ▪ Assessment of different sources of technical information (regularity of interaction, type of information, and reliability of the information)
6. Linkages with suppliers	▪ Number, location, and profile of suppliers (e.g. individual farmers, groups, farmer-collector, collector, wholesaler / sale / legal status) ▪ Changes in supply base during the last 5 years, and reasons ▪ Services provided to suppliers (e.g. technical, inputs, credit, other) ▪ Information flows to suppliers (e.g. variety, cultivation, quality, other) ▪ Conditions set by the enterprise (variety, quality, volumes, delivery times, prices, payment procedures, other)? ▪ Does the enterprise have a contractual relationship with suppliers? If yes, what are the terms of the contract? If not, how does it coordinate with suppliers? How is the negotiation process conducted? ▪ Strengths and weaknesses in the relationship with suppliers
7. Linkages with buyers	▪ Main buyers ▪ Stability in the portfolio of buyers ▪ Services received from buyers (e.g. advances, product promotion, …) ▪ Information flows to buyers, and vice-versa ▪ Conditions set by buyers (quality, volumes, delivery times, pricing, payment procedures, other) ▪ Does the enterprise have a contractual relationship with buyers? If yes,

	what are the terms of the contract? If not, how does are transactions coordinated and negotiated? ▪ Strengths and weaknesses in the relationship with buyers
8. Quality management systems	▪ Quality grades and standards of the enterprise and buyers ▪ Quality management systems by the enterprise, upstream suppliers and downstream buyers (e.g. sorting, grading, treatments, packaging) ▪ Sanctions for non-compliance ▪ Strengths and weaknesses in quality management systems ▪ Typical quantitative and qualitative product losses
9. Sources of market information	▪ Assessment of access to information about mango markets ▪ Main sources of information about mango markets (ranking) ▪ Assessment of different sources (regularity of interaction, type of information provided, and reliability of the information provided)
10. Services	▪ Key external services for a successful mango trading business (e.g. credit) ▪ Who provides these services? ▪ Main weaknesses and gaps in service provision
11. Prices	▪ Price trends for different varieties (last 3 or 5 years) ▪ Are there any clear differences in the prices paid by different buyers? ▪ Price seasonality
12. Costs	▪ Main costs to the trader (variable and fixed) ▪ Costs per ton sold
13. Business environment	▪ Assessment of the policy and regulatory environment in Indonesia ▪ Assessment of support infrastructure
14. Constraints, opportunities and interventions (wrap-up)	▪ Key opportunities for development of mango trading business ▪ Key challenges and constraints ▪ Innovations that can enable the development of mango trading ▪ Recommendations for public and project interventions ▪ Does the enterprise see any opportunities for collaboration with a development project intervening in the mango sub-sector?

Traditional Retailers	
1. Background information	• Location/address/contact
2. Fresh mango sales	• Tons of fresh mango sold per week/month/year • Seasonality in mango sales • Share of Indonesian and imported mangoes in total sales • Timing and trends in the sale of imported mangoes, and reasons • Origin of imported mangoes, and reasons
3. Varieties	• Varieties sold • Share of different varieties in mango sales and reasons • Key changes in the variety portfolio (last three years) and reasons • Assessment of different varieties in terms of seasonality, appearance, eating quality, consumer demand, export potential, and market price
4. Linkages with suppliers	• Type and profile of suppliers • Information flows from the retailer to suppliers, and vice-versa • Strengths and weaknesses in the relationship with suppliers
5. Quality management systems	• Quality grades and standards at the retail end • Typical quantitative and qualitative product losses at the retail end
6. Gender	• Gender of traditional retailers • Gender of suppliers
7. Prices	• Price differences between varieties, and reasons • Price seasonality, and reasons • Current mango purchasing and selling prices (different varieties, different grades)
8. Costs	▪ Main costs to the retailer (variable and fixed) ▪ Costs per kg

Modern Retailers	
1. Background information	▪ Location/address/contact ▪ Number of outlets and geographical distribution ▪ Offices responsible for procurement of fruits
2. Fresh mango sales	▪ Annual mango sales ▪ Tends in mango sales (last 3 years) ▪ Seasonality in mango sales ▪ Ranking of varieties according to sales volume ▪ Trends in the sale of different varieties, and reasons ▪ Share of Indonesian and imported mangoes in total sales ▪ Timing and trends in the sale of imported mangoes, and reasons ▪ Origin of imported mangoes, and reasons
3. Linkages with domestic suppliers	▪ Origin of mangoes within Indonesia, and reasons ▪ Who supplies mango fruit to the retailer? ▪ Requirements to become a supplier to the retailer ▪ Number and profile of suppliers (location, scale, legal status, etc.) ▪ Stability/changes in the supplier portfolio ▪ Terms of the contract with mango suppliers (e.g. quality, volumes, delivery times, pricing, payment procedures, other) ▪ Strengths and weaknesses in the relationship with suppliers
4. Quality management systems	▪ Quality specifications of the retailer ▪ How have these changed over the past 3 or 5 years? ▪ Sanctions for non-compliance with quality standards (and other contractual requirements) ▪ Strengths and weaknesses in quality management systems along the retailer's mango chain
5. Product promotion	▪ Does the supermarket develop promotion campaigns for fruits? What type of campaigns? What has been the experience? Any examples for mango?
6. Prices	▪ Price differences across varieties and grades ▪ Differences between the price of local and imported mangoes ▪ Seasonality of mango prices
7. Opportunities and interventions (wrap-up)	▪ Opportunities for development of contractual relationships with new suppliers ▪ Recommendations for public and project interventions aimed at supporting the development of high-quality modern retail chains for mango ▪ Does the supermarket see any opportunities for collaboration with a development project intervening in the mango sub-sector? If yes, what should be the focus of the collaboration?

Exporters	
1. Background information	▪ Location/address/contact ▪ Number of employees ▪ Number of years exporting fruits; range of fruits exported ▪ Number of years exporting fresh mangoes
2. Fresh mango exports	▪ Quantity of fresh mango exported in the last 3 years, and reasons behind inter-annual variations ▪ Relative importance of exports (% of total mango sales, with indication of other market channels) ▪ Timing of mango exports and reasons (domestic supply and prices, demand in importing countries) ▪ Varieties exported and reasons (e.g. availability, price, quality, seasonality, consumer preferences in destination markets) ▪ Export market potential for different varieties and reasons ▪ Strengths and weaknesses of Indonesia as a mango exporter ▪ Potential for development of mango exports
3. Destination markets, regulations and requirements in these markets	▪ Destination markets, relative importance, and reasons ▪ Main competitors in these markets ▪ Export regulations in Indonesia ▪ Import regulations in destination markets ▪ Quality and other requirements in different export markets
4. Quality management systems	▪ Export quality standards ▪ Who sets these standards? ▪ Quality management systems by the company and upstream suppliers (e.g. sorting, grading, post-harvest treatments, packaging) ▪ Coordination systems for ensuring compliance with export standards ▪ Strengths and weaknesses of quality management systems along the exporter's chain ▪ Sanctions for non-compliance (rejection of fruit, price deductions, etc.) ▪ Typical quantitative and qualitative losses in the mango export trade ▪ Quality of mango exported by the company and competitors in Indonesia
5. Linkages with buyers	▪ Who buys from the exporter in destination markets? ▪ Since when does the exporter have a business relationship with different buyers in these markets? ▪ Services provided by importers (e.g. advisory, market information, product promotion, …) ▪ Information flows from the exporter to importers, and vice-versa ▪ Conditions set by buyers (quality, volumes, delivery times, pricing, payment procedures, other)? ▪ Does the exporter have a contractual relationship with importers? If yes, what are the terms of the contract? If not, how does the exporter find buyers and how are transactions negotiated? ▪ Strengths and weaknesses in the relationship with buyers

6. Linkages with suppliers	▪ Who supplies the exporter? ▪ Profile of suppliers (location, scale, legal status, etc.) ▪ For how long has the exporter had a business relationship with different suppliers? ▪ Functions performed by suppliers (e.g. cultivation, sorting, grading, packaging, other) ▪ Services provided to suppliers (e.g. technical, inputs, credit, other) ▪ Information flows from the exporter to suppliers (e.g. variety, cultivation, quality, delivery times, other) ▪ Information flows from suppliers to the exporter ▪ Conditions set by the exporter (variety, quality, volumes, delivery times, pricing, payment procedures, other) ▪ Does the exporter have a contractual relationship with suppliers? If yes, what are the terms of the contract? If not, how does the exporter access supplies for export? How is the negotiation with suppliers conducted? ▪ Strengths and weaknesses in the relationship with suppliers
7. Services	▪ What are the key services for a successful mango export business? ▪ Who provides these services? ▪ What are the main weaknesses and gaps in service provision?
8. Prices	▪ Price seasonality within Indonesia and in export markets ▪ How do export prices generally compare with domestic prices? ▪ Are there any clear differences in the prices paid in different export markets? ▪ How are purchasing prices determined? What are the price differences across varieties and grades? ▪ How are export prices determined? What are the determining factors? What are the price differences across varieties and grades?
9. Costs	▪ Main costs to the exporter (variable and fixed) ▪ Costs per ton exported
10. Business environment	▪ Assessment of the policy and regulatory environment in Indonesia ▪ Assessment of support infrastructure
11. Constraints, opportunities and interventions (wrap-up)	▪ Key opportunities for the development of mango exports from Indonesia ▪ Key challenges and constraints: what is preventing Indonesia from becoming a significant exporter of mangoes? Why isn't Indonesia more competitive in the regional markets? ▪ Necessary innovations and developments ▪ Recommendations for public and project interventions aimed at enabling these innovations and developments ▪ Does the exporter see any opportunities for collaboration with a development project intervening in the mango sub-sector?

Annex 3: Structured Questionnaire for Collection of Farm Gross Margin Data

Village/District/Province _____

Name of farmer _____

Telephone contact _____

1. Background information

1.1 Number of mango trees (2011)

Owned _____

Rented _____

1.2 Age of trees (2011)

Total No. trees of productive age	
No. trees < 5 years	
No. trees of 5-9 years	
No. trees of 10-19	
No. trees > 20 years	

1.3 Varieties grown (2011)

	No. trees	No. trees productive age
Arumanis		
Gedong Ginku		
Other		
Other		

2. Production

2.1 How many kilograms of fruit do you harvest on average per tree?

	Kgs	Does not know
Arumanis		
Gedong Ginku		
Other		
Other		

3.1 How many kilograms of fruit were harvested in the 2011/12 harvest?

	Kgs	Does not know
Arumanis		
Gedong Ginku		
Other		
Other		

3.2 In which months was the fruit harvested?

	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb
Arumanis										
G. Ginku										
Other										
Other										

3. Sales and revenues (2011)

3.1 In 2011, did you sell your fruit on the tree or after harvest?

		Kgs
One the tree		
After harvest		

3.2 If you sold fruit on the tree, how many trees did you sell and for how much?

	No. trees	Av. Price IDR
Arumanis		
Gedong Ginku		
Other		
Other		

3.3 If you sold mango fruit after harvest, how many kgs did you sell and for how much?

	Kgs	Av. Price IDR	Value IDR
Arumanis			
Gedong Ginku			
Other			
Other			

3.4 If you sold fruit after harvest, where did you sell it?

Farm		Collection point	
Home		Market	
Trader's house		Other_____	

4. Variable cultivation costs (2011)

4.1 In 2011, did you fertilize your mango trees?

No _____

	No. trees fertilized
Yes _____	_____

4.2 If you did fertilize your mango trees, which organic and chemical fertilizers did you use?

	Kgs	Unit costs (2011, IDR)	Total Cost IDR
1.			
2.			
3.			
4.			

4.3 How much labour did you spend fertilizing your mango trees?

	Person days			
Family labour				
	Men Person days	Daily wage IDR	Women Person days	Daily wage IDR
Hired labour				

4.4 Did you use any chemicals for managing diseases and pests?

Yes _____ No _____

4.5 If yes, what chemicals did you use and how much did they cost?

	No. packs	Unit costs (2011, IDR)	Total Cost IDR
1.			
2.			
3.			
4.			
5.			
6.			

4.6 Did you rent any spraying services? If yes, how much did you pay for these services?

	IDR
Rental of spraying services	

4.7 How much labour did you use and hired to manage pests and diseases?

	Person days			
Family labour				
	Men Person days	Daily wage IDR	Women Person days	Daily wage IDR
Hired labour				

4.8 In 2011, did you apply Paclobutrazol?

	No. packs	Unit costs (2011, IDR)	Total Cost IDR
_____			

4.9 If yes, how much labour did you use or hire to apply Paclobutrazol?

	Person days			
Family labour				
	Men Person days	Daily wage IDR	Women Person days	Daily wage IDR
Hired labour				

4.10 In 2011 did you prune your mango trees?

		No trees pruned
Yes		
No		

4.11 If yes, how much labour did you spend or use pruning mango trees?

	Person days			
Family labour				
	Men Person days	Daily wage IDR	Women Person days	Daily wage IDR
Hired labour				

4.12 In 2011 did you irrigate your mango trees?

		No trees irrigated
Yes		
No		

4.13 How much labour did you use and how much you spend irrigating your mango trees?

	Person days			
Family labour				
	Men Person days	Daily wage IDR	Women Person days	Daily wage IDR
Hired labour				

4.14 What other irrigation did you incur?

	No. packs	Unit costs (2011, IDR)	Total Cost IDR
Water			
Energy			
_____			
_____			

5. Harvesting costs (2011)

5.1 In 2011, if you harvested mango fruit, how much labour did you use and hire, and for how much?

	Person days			
Family labour				
	Men Person days	Daily wage IDR	Women Person days	Daily wage IDR
Hired labour				

5.2 How much labour did you use and hire to bring the fruit from the farm to your home and/or the location where you sold the fruit?

	Person days			
Family labour				
	Men Person days	Daily wage IDR	Women Person days	Daily wage IDR
Hired labour				

5.3 How much did you spend in transportation?

	IDR
Vehicle rent	
Fuel	
Bus fee	
Other_____	

6. Post-harvest costs, excluding transportation (2011)

6.1 In 2011, did you sort and grade your mango fruit?

Yes _____

No _____

6.2 If yes, how much labour did you spend or use?

	Person days			
Family labour				
	Men Person days	Daily wage IDR	Women Person days	Daily wage IDR
Hired labour				

6.3 Did you spend any money in boxes or baskets for packaging the fruit?

			IDR
Yes		How much?	
No			