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List of Abbreviations

ACIAR	Australian Center for International Agricultural Research					
AIPD-Rural	Australia-Indonesia Partnership for Decentralisation - Rural Economic Program					
AVRDC	The World Vegetable Center					
BPTP	Assessment Institute for Agricultural Technology					
DFAT	Australian Government's Department of Foreign Affairs and Trade					
EI-ADO	Analysing Agribusiness Development Opportunities in Eastern Indonesia					
NTB	West Nusa Tenggara Province					
NTT	East Nusa Tenggara Province					

Preface

This project is one of five lead commodity value chain studies undertaken as part of the larger \$1 million Australian Government's Department of Foreign Affairs and Trade (DFAT) funded project Eastern Indonesia Agribusiness Development Opportunities (EI-ADO). In this project, Australian Centre for International Agricultural Research (ACIAR) commissioned research to identify lead commodity value chains to be the focus of a new DFAT program Australia Indonesia Partnership for Decentralisation – Rural Economic Program (AIPD-Rural).

This report titled *Eastern Indonesia Agribusiness Development Opportunities (EI-ADO)* - *Analysis of Tomato Value Chains*,¹ was prepared by the Collins Higgins Consulting Group, as commissioned by ACIAR. The information and recommendations from this study will inform DFAT in the design of the AIPD-Rural program.

Field work was conducted for 30 days (shallots, tomatoes, chillies) in the months of November and December 2012. Additional follow up field work was performed by Krisnadi Ly and Teddy Kristedi in January and May 2013, and Tiago Wandschneider in May 2013. The report involved the analysis of background data, field trips and interviews with actors involved in all sectors of the value chain.

The author of this study is Tiago Wandschneider, with support from Kuntoro Boga Andri, Paul Gnifke, Teddy Kristedi, Krisnadi Ly and Ketut Puspadi. Environment and gender inputs were overseen by Emmanuel Santoyo Rio.

Thanks must go to all the value chain actors - input suppliers, farmers, collectors, processors, and traders - who provided time and valuable information to the team.

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

Stuart Higgins

Director

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Executive Summary

This study was conducted to inform pro-poor interventions in vegetable value chains under a new DFAT program: the Australia-Indonesia Partnership for Decentralisation -Rural Economic Program, or AIPD-Rural. It covers a wide range of issues deemed important for a general understanding of the tomato sub-sector in Indonesia, the tomato value chain in Malang district, its position in the wider market landscape, and its potential as a vehicle for improved rural livelihoods. Possible entry points for pro-poor chain innovations are proposed and discussed.

Indonesia's position in global production and trade

Southeast Asia and East Asia have a very marginal position in the global tomato industry. Indonesia is no exception. The country accounts for less than 1% of world production and an even smaller share of global export and import flows.

Spatial patterns and trends

Tomato is the fifth most important vegetable crop in Indonesia in terms of cultivated area. Between 50,000 and 60,000 hectares are harvested every year. West Java accounts for about one-third of domestic production. North Sumatra is the second largest producer, with about 10% of the national harvest. East Java ranks fourth, after Central Java, with about 6%.

Tomato production increased by 50% between 2007 and 2011. Productivity gains accounted for most of this growth. West Java and Bali have by far the most productive tomato farms. Average farm yields in East Java and East Nusa Tenggara (NTT) are considerably lower than the national average. While yields have been rising over time, there is still a large productivity gap between Indonesia and major tomato producing countries.

International trade

Indonesia is self-sufficient in tomatoes. There are some exports from northern Sumatra, but the volumes are very small. Singapore and Malaysia are the main markets. While there may be scope for increasing sales to these and other regional markets, the tomato sub-sector is not yet sufficiently organised to take advantage of such opportunities. Excess levels of pesticide residues and a lack of cold chains constitute major market access barriers.

Price patterns

Tomato prices fluctuate significantly within the year and within seasons. While there is always a peak harvest around August and September, supply and prices during other months of the year are much less predictable. Farmers appear to be over-reacting to prices, thereby exacerbating market volatility: when prices are low, they tend to reduce areas, leading to high prices at harvest time, and vice-versa.

Tomato production in Malang

In Malang, tomatoes are grown all year round as part of a highly diversified vegetable production system, with a peak-harvest period from May to October. The crop ranks third amongst all vegetables in terms of cultivated area, after chilli and cabbage. Between 1,200 and 1,300 hectares, (i.e. nearly one-third of the tomato area in the province), are harvested every year. Over half of the tomato area is located in Poncokosumo and Pujon. It is estimated that about 2,000 farm households in these two sub-districts and more than 3,000 in other parts of the district are involved in tomato cultivation.

Tomato farms in Poncokosumo and Pujon typically range from 0.1 and 0.3 hectares. They tend to be smaller in other sub-districts. Small farm size reflects a context where farm households have limited landholdings and grow three to five different vegetable crops, sometimes more, at any given point in time. Having a diversified vegetable crop portfolio reduces exposure to production and marketing risks.

Many different hybrid tomato varieties are grown in Malang. Altitude and season are two major determinants of varietal choices. In addition, some farmers prefer shorter harvesting seasons, whereas others opt to grow varieties that can be harvested over longer periods. When choosing varieties, farmers may also take fruit colour and size into consideration. The market has a clear preference for vegetable tomatoes that are neither too small nor too big and have a bright red colour.

Tomato farming is an expensive venture. Key informants reported average investment levels around US\$ 2,000-2,500 per hectare. One of the farmers surveyed spent nearly US\$ 6,000 on a hectare basis. Hired labour, fertiliser, and plant establishment materials are the main cost items, followed by fungicides and pesticides.

Tomato farms generate significant wage employment. Farm households in our small sample had an average wage outlay of more than US\$ 1,000 per hectare. Wage labour accounted for 80% of total farm employment and women for 60% of total wage employment. Female workers received lower wages than men.

The tomato input chain in Malang

Farmers purchase seed and agro-chemicals from local input shops. Prompt payment is the norm. In addition, many growers receive seed and agro-chemicals on credit from village traders. These also provide cash loans. Credit functions as an implicit verbal contract whereby the farmer agrees to sell the harvest to the trader.

In villages where tomato is a major crop, 40% - 70% of growers purchase seedlings from local nurseries. These nurseries also produce chilli and cabbage seedlings. They operate during the whole year. Most produce between 20,000 and 100,000 seedlings per month, but a few have a monthly output of 200,000 to 400,000 seedlings. These are large by Malang standards, but small in comparison to some nurseries in Pare, Kediri.

Spatial product flows and market channels

A significant share of the tomato harvest in Malang is consumed within the district, in Malang City, and in other parts of East Java. Bali, greater Jakarta, Lampung and Kalimantan are other market destinations. Nearly all the production is distributed and retailed through traditional channels.

Intra-district chains

Gadang market is the main wholesale distribution centre in Malang. Wholesalers in this market get their supplies from village traders. Collectors also channel produce to village assembly markets, a very important source of supplies for peri-urban and rural retailers. Prompt payment is the norm in intra-district chains.

Intra-provincial chains

Porong market in Sidoarjo is a major distribution centre for Malang tomatoes. Interdistrict traders go to this market every day to sell a variety of vegetables. Each has 10 or more regular buyers. Most are "large" market retailers from Sidoarjo, Surabaya, Gresik, Mojokerto, Pasuruan and Madura, or mobile traders supplying market and street vendors in these locations.

Some Gadang traders and some inter-district traders also supply wholesalers in Keputran market, in Surabaya, but this is a secondary channel. Inter-district traders prefer to send their supplies to Porong because this market is closer to Malang and handles larger volumes. Moreover, buyers in Porong purchase a range of vegetables and pay on the spot, whereas those in Keputran specialise on specific crops and pay a few days after delivery. In both cases, prices are determined when the parties meet at the market.

Supplies to neighbouring Blitar and Lumajang districts are channelled through village assembly markets in Malang. Many mobile traders from those districts source their daily supplies from these markets. Local collectors are their main suppliers.

Inter-provincial chains

A few traders in Malang channel tomatoes to wholesalers in and around Jakarta. This trade takes place throughout the year, peaking around Ramadan and in late December. Gadang market is the main assembly point for tomatoes sent to greater Jakarta. About ten wholesalers specialise in this trade.

Inter-provincial traders handle larger volumes of fewer vegetables than inter-district traders. They normally supply one or two markets where they have one or two buyers with whom they have been doing business for a long time. Transactions are coordinated over the phone. Prices are determined before a consignment is sent from Malang. The payment will be settled five or seven days after this has arrived at its destination. Inter-provincial traders receive no advances from buyers. They rely on their own funds and bank loans for working capital.

Inter-island chains

Kalimantan is the main market outside East Java. There is also a regular trade in tomatoes from Malang to Bali and Lampung, in southern Sumatra. Inter-island product flows usually peak around Ramadan and the New Year. Some inter-island traders reported higher trading volumes during the dry season.

Supplies to Kalimantan are coordinated by traders in Batu and Surabaya. There are at least 10 inter-island traders in Batu. Most supplies to Bali are managed by four or five traders in Gadang market. Gadang is also the main assembly point for tomatoes sent to Lampung. Transactions with Lampung buyers are conducted by some of the inter-provincial traders linked to markets in and around Jakarta.

Batu traders focus exclusively on the Kalimantan market, sell a range of fresh produce, and source most of their supplies from village traders. Some sell to just one or two clients in one or two markets, others have several regular buyers in three or four market locations. Their clients consist of traditional wholesalers from Banjarmasin, Samarinda, Sampit, Palangkaraya, Kumai, and other urban centres. One of the traders interviewed also supplies one catering company that services large mining concerns. While business relations with catering firms are governed by written contracts with fixed price arrangements, transactions with traditional wholesalers are based on verbal agreements and variable prices. Prices are agreed when an order is placed.

Transactions with buyers in Kalimantan are underpinned by high levels of trust. This is essential in a context where inter-island traders supply fairly large fruit and vegetable consignments, face variable post-harvest losses during transportation, and are paid several weeks after a consignment has been delivered. Inter-island traders are very reluctant to do business with new buyers in Kalimantan for fear that they may default on their payments.

Contract farming and collective action

No formal contract farming schemes were found in the Malang tomato chain. Such schemes are costly to develop and difficult to justify in a context where premium markets are so under-developed. Likewise, the current market landscape does not favour the emergence of farmer groups or cooperatives. At the moment, the demand for premium quality produce is too small to justify the costs and risks associated with collective action.

Information and knowledge flows

Malang offers a favourable context for the exchange of production and market information due to a large presence of commercial growers, traders, input retailers, and nurseries. In addition, all the main seed and agro-chemical companies have staff stationed in the district.

Despite this favourable context, there are some critical knowledge gaps. Knowledge on pest control is clearly inadequate. Location-specific research is needed to determine possible improvements over current practices. Furthermore, both farmers and traders

have difficulties forming reasonable expectations about future price scenarios, an essential consideration for any planting decisions.

Quality management systems

Tomatoes from Malang have a good reputation in East Java. The crop is harvested by farmers, often under the coordination and supervision of village traders. Tomatoes are sorted and graded on farm according to size. Farmers often receive higher prices for higher grades.

Tomatoes for the Java, Bali and Lampung markets are harvested at the mature green to breaker stage. The tomatoes will develop a full red ripe colour two or three days after harvest. Produce sent to Kalimantan is picked green so that it can better endure transportation and handling stresses.

Tomatoes are transported in large wooden boxes. These are then stacked on top of each other in small or large trucks. While such practices may be acceptable for tomatoes sold in nearby markets, they are clearly inadequate for produce that is shipped to Kalimantan. Current packaging practices are one important factor contributing to very high product losses along this chain. During the rainy season, Batu traders have to sell up to 60% of a consignment at discount prices because of quality losses during transportation to Kalimantan.

Margins

Net margins are known to fluctuate considerably between transactions because of short-term price volatility. Inter-district traders only know their selling price after they have purchased the crop from farmers and may incur some financial losses, or just break even, at times when the market is over-supplied and the price of tomatoes very low. In order to protect themselves against adverse price fluctuations, some inter-district traders have developed commission-based arrangements with farmers.

Inter-island traders in Batu operate with fairly high gross margins during the rainy season in order to protect themselves against post-harvest quality losses. These losses therefore have a clear negative impact on farm-gate prices.

Problems and constraints

Diseases, particularly bacterial wilt, fusarium, and anthracnose, and price volatility are the two issues farmers are most concerned with. Diseases can have a very negative impact on yields, especially during the rainy season, while the possibility that prices will be very low at harvest time is a major source of risk.

Short-term price volatility is the main problem faced by inter-district traders. They are particularly concerned with unpredictable fluctuations during periods of very low prices. During these periods, traders may incur losses on individual consignments.

Traders supplying Kalimantan highlighted two main problems: excessive quality losses during the rainy season and very late payment by clients. These traders are also

concerned with the risk of default by Kalimantan buyers, a situation that will result in financial losses and the breakdown in the business relationship.

Opportunities for pro-poor intervention

Impacts from interventions in the tomato chain could be increased significantly if Batu, Kediri, Banyuwangi and East Lombok districts were targeted alongside Malang. From an impact perspective, there is also a strong rationale for pursuing an upgrading of the whole vegetable sub-sector in target districts rather than a more narrow strategy focused exclusively on the tomato chain. Some of the proposed tomato chain interventions could be designed to include other vegetable crops.

Four possible areas for intervention were identified: grafted seedlings for control of bacterial wilt; improved packaging technologies for a reduction in post-harvest losses along the Kalimantan chain; development of market outlook assessment capacities for improved planting decisions; and protected cropping for increased farm profits.

While interventions aimed at supporting private sector investment in cold storage and improvements in fertilisation practices, water management, and pesticide use are also discussed, these are not included in the portfolio of recommended interventions because of limited scope for impacts at scale over the medium term.

1. Development of a local market for grafted tomato seedlings

Commercial grafted seedling production has been developed successfully in Vietnam, with significant positive impacts on tomato farm yields and incomes. There is an opportunity to replicate this process in East Java, with technical assistance from the World Vegetable Center. A series of participatory demo-trials will need to be implemented to test the technology, transfer critical technical know-how to local nurseries, and create the necessary demand from farmers. Larger nurseries will need to be actively involved as partners. Different models for production of eggplant rootstock, and opportunities for involving seed companies, will need to be assessed. While Malang is an obvious location for intervention, AIPD-Rural should also consider targeting Kediri district.

2. Improving packaging technologies and practices along the Kalimantan chain

Inter-island traders reported very high post-harvest losses during transportation to Kalimantan. These losses have a negative impact on farm-gate prices. Poor packaging practices are one contributing factor. AIPD-Rural should consider working with a selected number of inter-island traders in Batu and Surabaya and one or two packaging material firms to develop improved packaging solutions. The role of the project would be to link the two parties for joint development of appropriate solutions, fund product development costs, and subsidise the commercial piloting of new packaging prototypes. Opportunities for replicating the process for other vegetable crops should be pursued.

3. Anticipating future market scenarios for improved planting decisions

Tomato farmers appear to be at a loss when trying to make sense of market outlook scenarios. They tend to expand cultivation when prices are high, thereby creating a glut in the market three or four months later, and to reduce planted areas when prices are low, therefore failing to take advantage of product scarcities at harvest time. In order to support better planting decisions by farmers, AIPD-Rural could fund a training programme aimed at improving market outlook assessment capacities. Since Malang growers and traders have a diversified vegetable portfolio, it makes sense to focus on different crops, not just tomato. In order to increase outreach, the intervention could be extended to neighbouring Batu district. An appropriate provider of training services would need to be identified. Trainers would work with lead farmers and traders to identify improved planting strategies and develop links to sources of information that can help local chain actors anticipate future supply scenarios.

4. Development of protected vegetable cropping

Large seed companies such as East West could be targeted for the establishment of trial and demonstration structures in different sites and delivery of technical advisory services to village traders and farmers. This would offer opportunities for expanding seed sales. Strong input from researchers and economists throughout the whole intervention cycle will be needed for designing low-cost but effective structures, identifying the most profitable crop portfolios, and developing appropriate farm management protocols. It is recommended that Malang and perhaps Batu are initially targeted. If successful, the initiative could be scaled-out to other major vegetable production districts in East Java, as well as East Lombok.

Areas for future research

Several strategic areas for future research were identified during this study, including pests and diseases, post-harvest losses, cold storage, contract farming, processing, and export markets. Research in these areas should not be confined to tomato, but cover other vegetables as well.

1 Introduction

1.1 Project Background

This study was conducted in the context of EI-ADO (Analysing Agribusiness Development Opportunities in Eastern Indonesia). This is a project funded by the Australian Government's Department of Foreign Affairs and Trade (DFAT), overseen by the Australian Centre for International Agricultural Research (ACIAR), and implemented by the Collins Higgins Consulting Group. Its aim is to identify agricultural value chains and private sector agribusiness development opportunities with greatest potential to increase the incomes of poor men and women in East Java, West Nusa Tenggara (NTB), and East Nusa Tenggara (NTT).

EI-ADO comprises a number of research activities. A prioritisation of value chains was carried out during the first six months of 2012. Five commodity chains were selected for research, including vegetables, based on a range of socio-economic criteria and the perceived opportunity for pro-poor chain upgrading. Research on vegetable value chains was disaggregated into three separate studies: one on tomato, another on shallot, and a third on chilli. This report presents the findings for the tomato value chain. A strategic assessment of agricultural value chains in Eastern Indonesia was conducted in the final months of 2013. This final study will bring together the main findings from all EI-ADO studies, with a special emphasis on lessons and implications for government, the private sector, development projects, and donor agencies.

EI-ADO research outputs will inform value chain interventions under a new DFAT program: the Australia-Indonesia Partnership for Decentralisation - Rural Economic Program (AIPD-Rural). The goal of this programme is to increase the incomes of one million poor male and female farmers in four provinces of Eastern Indonesia by at least 30% by 2022. This is to be achieved through better farm practices, improved access to input and output markets, and a more enabling agribusiness environment, all of which are critical for increasing farm profitability and value chain competitiveness. AIPD-Rural is particularly interested in partnering with the private sector for the design and implementation of chain interventions that can contribute to those outcomes and impacts.

This area of research is also of interest to ACIAR. There is growing recognition of the need to embed agronomic research within market and value chain development frameworks and processes. This is regarded as critical for enhancing the relevance and impact of research-for-development efforts. The EI-ADO studies will provide useful insights about value chain development opportunities, the incentives for technical, product, and process upgrading along whole chains, and key research gaps. These findings will inform ACIAR's research agenda and projects in Indonesia.

1.2 Study Team

The study team included two value chain specialists, one vegetable expert, and two research assistants. Tiago Wandschneider, the International Value Chain Specialist, acted as Team Leader. Paul Gniffke, a plant breeder employed by the World Vegetable Center (AVRDC) prior to retirement, joined the team as the International Commodity

Specialist. Kuntoro Boga, an economist with the East Java Assessment Institute for Agricultural Technology (BPTP), was the National Value Chain Specialist. Teddy Kristedi, ACIAR's Project Coordinator, and Krisnady Yohannes, from BPTP East Java, assisted the team during the fieldwork and conducted several follow-up discussions and interviews with key informants.

1.3 Analytical Framework

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

The current study covers a wide range of issues deemed important for an understanding the structure, conduct and performance of the tomato value chain, its potential as a vehicle for poverty reduction, and the opportunities and incentives for chain upgrading. Some of the analysis is disaggregated by gender, one of the cross-cutting themes selected for analysis, alongside poverty and the environment. These study themes reflect the purpose of AIPD-Rural, which has been developed to promote pro-poor outcomes and impacts that benefit both men and women, without compromising the natural resource base available to future generations. The three themes are also present in ACIAR's work.

A presentation of the analytical framework would be incomplete without some consideration of cost and margin analysis. This is a critical component of value chain research, and one that was discussed at some length during the design and planning of the EI-ADO 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 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.

Farm gross margin data was collected during the fieldwork to gain insights into the structure of production costs and labour use patterns. Unfortunately, the data does not allow for firm conclusions regarding farm profitability because the sample is too small. Farm profits vary considerably within and between seasons, and within and across locations, due to high variations in yield and prices.

The study team also collected marketing cost and price data along the tomato chain. The data provides some understanding of marketing costs but cannot be used to assess net margins, as these are known to vary significantly in response to price volatility. Moreover, the data collected does not allow for a comparison between traditional and modern channels and between provincial and inter-island chains. Significantly more time and resources would have been required in order to collect robust net margin data along different chains and for different seasons.

1.4 Study Methodology

Existing studies, reports, and official statistics were reviewed early on during the research process to evaluate the information available and identify data gaps. Daily wholesale price data for 2009-11 was obtained from the Management Board of Pare market in Kediri, an important agricultural trading centre in East Java.

Collection of primary data was largely based on qualitative methods:

- Semi-structured interviews were carried out to collect information from input retailers, traders and knowledgeable observers. Checklists were used to guide these interviews (see Annex 2).
- Focus group discussions were the main method used to gather information from farmers. Nursery operators, village traders, and extension officers also joined some of the focus group discussions.
- *Direct observation* methods were employed during visits to farms, the facilities of village traders, wet markets, and retail outlets. Much was learned about the scale of farm and trading businesses, the functions performed by different chain actors, and quality standards through direct observation.
- *Triangulation* and *direct observation* methods were used to cross-check the quality of the data collected from key informants and evaluate their views and perspectives.

Qualitative methods are particularly suited to rapid appraisals of production and marketing systems, allowing researchers to explore a wide range of issues in some depth. Large structured questionnaires are the best method for collection of quantitative data, but take time to implement and cannot be used for flexible and indepth probing. *Structured questionnaires* were used to collect margin data from a small number of farmers and traders (see Annex 3).

1.5 Fieldwork

The fieldwork schedule is presented in Annex 1. A first round of field interviews were conducted in November and December 2012, over a two-week period:

- Five days were initially spent in Malang and Batu districts interviewing key informants in the tomato and chilli chains and some vegetable farm and trading enterprises, specifically targeting export and niche domestic markets. One team member spent another three days in late December collecting additional data from tomato and chilli chain actors in these two districts.
- A four-day visit to Kediri was organised to meet seed companies and gain a broader understanding of tomato and chilli production and marketing systems.
- Three days were spent in Surabaya interviewing traditional wholesalers and retailers and visiting modern retail outlets. Some of the interviews involved key informants in the tomato chain, but most targeted actors in the chilli and shallot chains.

Additional interviews were carried out between June and October 2013 to address some key data gaps. In June, two team members spent three days in Kediri talking to vegetable nursery operators and another three and a half days in Malang meeting tomato and chilli chain actors. The same researchers then spent two days in July following tomato and chilli consignments from Malang to Porong market in Sidoarjo and from Porong to traditional retail markets in and around Surabaya. In October, one of the researchers spent two days in Batu and Malang interviewing inter-island traders.

In total, the study team conducted six focus group discussions, carried out 11 structured and semi-structured interviews with smallholder farmers and commercial farms, and had discussions with two seed companies, one chemical company, two input retailers, nine nursery farmers, 23 intermediary traders, nine traditional retailers, three modern retailers, two vegetable export companies, three researchers, and eight government officers (see Table 1).

Districts	Input chain	Focus groups	Producers	Trade	Retail	Research	Govt.	Total
Malang	4	6	6	13		3	3	35
Batu	1		4	4			2	11
Kediri	9			1			2	12
Mojokerto			1					1
Sidoarjo				1	3		1	5
Surabaya				4	9			13
Total	14	6	11	23	12	3	8	77

Table 1 Key informants and respondents

1.6 Report Structure

This report comprises six sections. Following this introduction, Section 2 provides an overview of the Indonesian tomato sub-sector, including some analysis of its position in global production and trade and an assessment of price patterns. Section 3 focuses on the Malang tomato chain, including production systems, farm employment patterns, spatial product flows, vertical chain linkages, quality standards and management systems, problems and constraints, and opportunities for pro-poor chain upgrading. Key findings and some areas for future research are highlighted in Section 5. Section 6 lists the references used in the study.

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

2 The Tomato Sub-Sector in Indonesia

2.1 Indonesia's Position in Global Production and Trade

Indonesia has a very marginal position in the global tomato industry. Despite having achieved a record harvest of 954,000 tonnes in 2011, this represented just 0.6% of the world's production (see Figure 1). Indonesia has an even more marginal share of the global tomato trade (see Figure 2 and Figure 2). In 2011, in 2011, a year when about seven million tonnes² of fresh tomatoes were traded internationally, the country exported 675 tonnes and imported just 18 tonnes.

China is by far the leading tomato producer, with nearly one-third of global production. India ranks second, with around 10%, followed by the United States and Turkey. Egypt, Iran, Italy, Brazil, Spain, and Uzbekistan are other important tomato producers.



Source: Authors' calculations based on FAOSTAT data

Figure 1 Leading tomato producers (2011)

With two-thirds of global imports, the European Union and the United States are the main export markets for fresh tomatoes. The United States alone accounts for more than one-fifth of the world's imports (see Figure 2). Russia and Germany are the second and third largest export markets, with a combined 20% share of the global import trade. France and the United Kingdom rank fourth and fifth, respectively.

² These are approximate figures, as there are some discrepancies in the FAOSTAT global export and import data.



Source: Authors' calculations based on FAOSTAT data

Figure 2 Leading tomato importers (2011)

Southeast Asia and East Asia represent a very small export market. The two regions account for less than 1% of global fresh tomato imports (authors' calculations based on FAOSTAT data). In 2011 Singapore imported 31,987 tonnes of fresh tomatoes, mostly from Malaysia; Hong Kong imported 7,505 tonnes; Japan 2,963 tonnes; Malaysia 1,480 tonnes; and Thailand 1,161 tonnes (FAOSTAT, 2013). According to FAOSTAT trade data, in 20111 China (mainland) imported no fresh tomatoes. Regional imports were equivalent to less than 5% of Indonesia's production.

Southeast Asia and East Asia also have a marginal presence in the export trade. Their share of global exports in 2011 was just 2% (authors' calculations based on FAOSTAT data). Mainland China and Malaysia, the two largest regional exporters, sold 130,218 tonnes and 32,914 tonnes abroad, respectively. The leading fresh tomato export industries are located in Mexico, the Netherlands, and the Mediterranean region, close to major export markets, not in Asia (see Figure 3).



Source: Authors' calculations based on FAOSTAT data

Figure 3 Leading tomato exporters (2011)

Only 5% of the world's harvest is exported as fresh tomatoes (authors' calculations based on FAOSTAT data). Such a small share reflects the domestic orientation of the tomato industry in China, India and the United States, three countries that account for nearly half of global production. However, in several countries located in the vicinity of major markets, exports represent a significant share of domestic production. For example, in 2011 60% percent of the tomato harvest in Mexico, the world's largest exporter, was sold abroad, mainly in the United States. Morocco exported one-third of its production, mainly to Europe. In Spain, a country with a large domestic market, nearly one-fourth of domestic production was sold in other EU member countries.

Proximity to major markets is, indeed, an essential condition for export competitiveness. This is unsurprising given that tomatoes are a very perishable commodity. Being very far from all major tomato importing countries, Indonesia lacks the conditions for the development of a significant export trade. There may be opportunities for increasing exports to countries such as Singapore or Malaysia, but the sector is not yet sufficiently organised to take advantage of such opportunities. Exports are further discussed in section 2.3.

Location plays much less of a role in the growing international trade for processed tomato products. In 2011, 3.1 million tonnes of tomato paste and 1.5 million tonnes of peeled tomato were exported across the world (FAOSTAT, 2013). Italy is the leading tomato paste exporter, followed by China, and accounts for more than 75% of the world's exports of peeled tomatoes.

2.2 Production

2.2.1 Geographical distribution

Tomato is the fifth most important vegetable in Indonesia in terms of cultivated area, after chilli, cabbage, shallot and potato. Between 50,000 and 60,000 hectares are harvested every year (see Table 2). Tomato cultivation occurs across many islands. Java has about 35% of the total harvested area, Sumatra 27%, and Sulawesi 17%. West Java alone accounts for nearly 20% of the total area. Central Java, North Sumatra, Bengkulu and East Java form part of a second tier of provinces, each with a share of 7-8%. South Sulawesi, North Sulawesi, Lampung and South Sumatra have a 4-6% share each. Seven other provinces, including NTB, fall in the 2-3% category.

West Java stands out in terms of production. The province has by far the most productive tomato farms in Indonesia, alongside Bali, accounting for more than 35% of domestic production, nearly twice its share of the country's harvested area (see Table 2). North Sumatra, Indonesia's second largest tomato producing province, contributes another 10% of the national harvest. East Java ranks fourth, after Central Java, with about 6% of domestic production, and NTB tenth, with about 3%.

In each province, tomato cultivation is concentrated in one or two, often mid- to highelevation districts, where cooler climates are conducive to all-year round production. Bandung and Gajut are the main suppliers in West Java. In North Sumatra, production is concentrated in Karo. Wonosobo has the largest cultivated area in Central Java. Malang and Batu are important production centres in East Java, alongside Kediri and Banyuwangi. In NTB, most production comes from East Lombok, around Mount Rinjani.

Province	2007	2011	Share (%) 2007-11	Change (%) 2007-11
West Java	10,926	9,444	19.4	(14)
Central Java	3,412	5,064	7.7	48
North Sumatra	4,056	4,142	7.5	2
Bengkulu	3,793	2,387	7.5	(37)
East Java	3,300	4,349	7.2	32
South Sulawesi	3,427	3,591	6.3	5
North Sulawesi	2,259	2,601	4.9	15
Lampung	2,159	2,099	4.2	(3)
South Sumatra	2,125	2,008	3.7	(5)
West Sumatra	1,514	2,036	3.2	34
Central Sulawesi	1,169	1,774	2.8	52
East Kalimantan	1,500	1,153	2.6	(2)
Southeast Sulawesi	1,037	1,604	2.4	55
Aceh	1,420	1,110	2.4	(22)
Jambi	1,799	724	2.3	(60)
NTB	1,002	1,516	2.2	35
Papua	1,124	731	1.8	(35)
Bali	758	1,017	1.7	34
NTT	633	1,027	1.5	62
Indonesia	51,523	53,088	100	3

Table 2 Tomato harvested area (ha) in Indonesia (2007-11)

Source: Center for Data and agricultural information system (Pusdatin), Secretariat General, Ministry of Agriculture

Province	2007	2011	Share (%) 2007-2011	Change (%) 2007-11
West Java	267,220	354,832	37.1	33
North Sumatra	76,699	93,386	10.2	22
Central Java	40,794	73,009	7.6	79
East Java	33,237	67,646	6.4	104
West Sumatra	25,577	58,078	4.9	127
Bengkulu	23,210	39,748	4.4	71
South Sulawesi	12,999	44,807	3.7	245
North Sulawesi	26,319	27,221	3.7	3
Bali	9,369	33,542	3.3	258
NTB	10,040	33,864	2.9	237
Lampung	14,861	18,420	2.2	24
Aceh	10,642	17,358	1.9	63
South Sumatra	12,366	10,669	1.9	(14)
East Kalimantan	15,034	9,545	1.7	(37)
Jambi	10,467	9,970	1.5	(5)
Central Sulawesi	3,612	14,730	1	308
NTT	7,233	10,476	0.8	45
Southeast Sulawesi	5,258	6,231	0.8	19
Papua	5,854	5,883	0.8	1
Indonesia	635,474	954,046	100	50

 Table 3 Tomato production (tonnes) in Indonesia (2007-11)

Source: Pusdatin

The geographically scattered production areas, combined with the perishability of fresh tomatoes, a lack of cold chains, and high transportation costs, has major implications in terms of spatial flows. Most of the tomato harvest is consumed in urban centres near production areas. Still, inter-island flows are significant in the case of Malang, a district that has a continuous supply of tomatoes and benefits from relative proximity to Bali and Kalimantan. There is also a well-established tomato trade between Sulawesi and nearby Kalimantan. The study team did not visit West Java and therefore could not assess the extent of product flows between West Java and Sumatra.

2.2.2 Production trends

Tomato production in Indonesia has expanded by 50% between 2007 and 2011, i.e. at an annual average of more than 10% (see Figure 4). The majority of growth during this period came from farm productivity gains. The total harvested area did expand until 2010, but it contracted significantly in 2011. However, this was offset by improvements in farm productivity, which increased by 23% in 2011.





Figure 4 Annual variations in tomato production, harvested area and yield (2007-11)

While many provinces experienced an increase in production area, this declined in West Java and remained fairly stable in North Sumatra, two provinces that account for one-fourth of the total tomato area. As a result, between 2007 and 2011 the total harvested area increased by just 3%. During the same period, all the main tomato growing provinces experienced significant increases in farm productivity, with the average yield in Indonesia rising by nearly 50% (see Table 4).

2.2.3 Farm productivity

West Java and Bali stand out as the two provinces with the most productive tomato

farms (see Table 4). Annual yields in West Java averaged 28 tonnes per hectare between 2007 and 2011, nearly twice the national average of 14.8 tonnes. During that period, only four other provinces achieved higher yields than the national average: Bali, West Sumatra, North Sumatra, and NTB. Average yields for East Java and NTT were 12.6 and 10.6 tonnes per hectare, respectively. Compared to the national average, the two provinces had a yield gap of 15% and 28%. This rises to 55% and 62% when West Java is used as a benchmark.

Province	2007	2011	Average 2007-11	% change 2007-11
West Java	24.5	34.6	28	41
Bali	12.4	29.4	28	137
West Sumatra	16.9	25.9	21.5	53
North Sumatra	18.9	21.2	19.6	12
NTB	10	20.3	18.3	103
Indonesia	12.3	18	14.8	46
Central Java	12	13.5	14.2	13
East Java	10.1	13.9	12.6	38
North Sulawesi	11.7	10.3	11.1	(12)
NTT	11.4	9.7	10.6	(15)
South Sulawesi	3.8	11.6	10.4	205
Bengkulu	6.1	15.7	9.2	157

Table 4 Tomato yields (tonnes/ha) in Indonesia (2007-11)

Source: Authors' calculations based on Pusdatin data

Despite significant yield gains, there is still a large productivity gap between Indonesia and major tomato producing countries. Average yields of 50 tonnes per hectare or more are the norm in countries such as the United States, China, Spain, Portugal, Italy or Jordan (FAOSTAT, 2013). Producers in these countries benefit from suitable climates for tomato cultivation, have access to very productive varieties, and follow intensive cultivation protocols.

2.3 International Trade

As shown in Section 2.1, the quantity of tomatoes exported from Indonesia is too small to have any impact on domestic market conditions and farm-gate prices. Between 2007 and 2011, exports averaged 917 tonnes per annum, out of an average annual production of 812,000 tonnes (see Table 5). Exports peaked in 2007, when 1,851 tonnes, or 0.3% of domestic production, were shipped abroad. In a context of small and stagnant exports, significant increases in domestic production had to be absorbed by the domestic market.

	2007	2008	2009	2010	2011	Average 2007-11
Exports	1,851	874	565	618	675	917
Production	635,474	725,973	853,061	891,616	954,046	812,034
Exp/Prod (%)	0.3	0.1	0.1	0.1	0.1	0.1

Table 5 Fresh tomato exports	(tonnes) in Indonesia	(2007-11)
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Source: Pusdatin, FAOSTAT (2013) and authors' calculations

Singapore accounts for the bulk of Indonesia's tomato export trade. Malaysia is the second main market destination. Indonesian tomatoes sold in these two countries come from nearby northern Sumatra. Importer concerns over high pesticide residues have been reported by vegetable exporters in Medan as a major barrier to accessing regional markets (Menegay and Darmono, 2007). This concern was also expressed by one key informant in East Java. The lack of cold chains represents another important barrier to the development of a vegetable export sector in Indonesia. Changing whole supply chains to meet the quality requirements of importers in the region is not something that can happen overnight. Consequently, in the foreseeable future, the development of Indonesia's tomato sub-sector will be largely determined by domestic market conditions and the extent of technical innovation at farm level.

Indonesia is self-sufficient in tomatoes, a situation that is unlikely to change in the current context of rising production. Between 2007 and 2011 the country imported on average 94 tonnes per annum, which was equivalent to just 0.01% of the domestic supply (measured by production plus net exports) during that period (see Table 6). It is not surprising, therefore, that tomatoes were excluded from the list of vegetables subject to temporary import bans and quotas during the first six months of 2013, under new horticultural import regulations. While Indonesia enjoys a fair amount of natural protection for a very perishable crop such as tomatoes, that is not the case for processed tomato products. Every year, the Indonesian food industry uses around 10,000 tonnes of imported tomato paste (FAOSTAT, 2013).

	2007	2008	2009	2010	2011	Average 2007-11
Imports (a)	208	142	47	57	18	94
Prod + Imports – Exports (b)	633,831	725,241	852,543	891,055	953,389	811,212
[(a) / (b)] * 100] (%)	0.03	0.02	0.01	0.01	0.01	0.01

 Table 6 Fresh tomato imports (tonnes) in Indonesia (2007-11)

Source: Pusdatin, FAOSTAT (2013) and authors' calculations

2.4 Price Patterns

Prices vary significantly within the year and within seasons, often rising or falling by a factor of four or five, sometimes more, in just two or three months (see Figure 5). While there is always a peak harvest late in the dry season, around August and September,

during other months of the year the market situation is much less predictable. In 2009, for example, prices kept falling from January to late April, whereas in 2010 and 2011 the trend was the exact opposite. Similarly, in 2009 tomato prices remained at fairly low levels until November, compared to 2010 and 2011, when there was a sharp increase from mid-September to late October and from mid-November to mid-December, respectively. Given this price variability, it is very difficult for farmers to form reasonable expectations about future prices.



Source: Unpublished data, Dinas Pertanian, Kediri District

Figure 5 Weekly tomato prices, Pare market (2009-11)

From the field discussions, it is apparent that farmers are over-reacting to spot market prices, thereby exacerbating market volatility. Farmers and traders reported that planting decisions are heavily influenced by spot market conditions: when prices are low farmers tend to reduce areas, leading to high prices at harvest time, and vice-versa. This type of behaviour is reflected in two- to four-month price cycles, with a period of rising prices followed by a period of declining prices, and vice-versa. In their pursuit of high prices, farmers expand production to an extent that is self-defeating. Likewise, in their attempt to protect themselves against low prices, farmers appear reluctant to plant tomatoes when markets are depressed, thereby failing to take advantage of high prices at harvest time.

Storage under low-temperate conditions could help stabilise tomato markets, but the private sector is yet to invest in cold storage. As indicated by Suslow and Cantwell (undated), mature-green tomatoes can be stored for up to two weeks at 12.5°C without significant reduction of sensory quality and colour development. At lower temperatures, tomatoes may suffer chilling injury, including failure to ripen and develop full colour and flavor, irregular colour development, premature softening, and increased decay.

Tomato exports and imports could also play a price stabilisation role, but at the moment these are negligible. Tomatoes are not being imported into Indonesia during periods of high prices or exported to other countries when prices are very low.

3 The Tomato Value Chain in Malang, East Java

3.1 **Production System**

Tomato cultivation in Malang (and Batu) is part of a highly diversified vegetable production system. That was not the case 20 or so years ago, when rice, shallot, and garlic dominated local farming landscapes. Since then, Malang farmers have taken advantage of favourable conditions for diversification into high-value vegetable crops. Malang has many mid- and high-altitude villages where vegetables can be grown throughout the year because of their relatively cool climate and good access to water. These locations also benefit from good physical access to markets. They are located less than two hours away from greater Surabaya, the second largest conurbation in Indonesia, with over 5 million inhabitants. Malang City itself, the second largest in East Java, with a population of more than 800,000, and Malang district, with a population of nearly 2.5 million, are also important markets.

Favourable natural and market access conditions have enabled the development of a significant vegetable production cluster in Malang. The district is an important supplier of chilli, cabbage, tomato, potato and sweet corn. Broccoli, cucumber, carrot, celery, long-yard beans, other beans, and leafy vegetables are also produced all year round. Locally grown tomatoes and other vegetables are particularly visible in Surabaya markets and surrounding areas during the rainy season, when little or no competing supplies from other parts of East Java are available. Vegetable farm households still grow paddy during the wet season, but mainly to break the cycle of soil-borne diseases and pests, not so much as a food security strategy.

In Malang, tomato ranks third amongst all vegetables in terms of cultivated area, after chilli and cabbage. According to data provided by Dinas Pertanian, between 1,200 and 1,300 hectares of tomatoes are harvested per annum. This represents nearly 30% of the tomato area in the province (see Table 2). Kediri and Banyuwangi are two other important tomato producing districts in East Java, but they only supply the market during a short three-month harvesting season, between July and October.

In Malang tomatoes are grown all year round, with a peak-harvest period extending from May to October. The district produces medium-sized vegetable tomatoes. Cultivation of large and juicy fruit tomato and small cherry tomato is confined to higheraltitude areas in neighbouring Batu, but the production is fairly small as consumer demand for those two categories is very limited. Indonesians eat mainly vegetable tomatoes, often in cooked sauces. Fruit and cherry tomatoes can be found in modern retail outlets in large cities, but in very small volumes, as confirmed during the visits to supermarket stores in Surabaya, where just a few small boxes were in display.

Over half of the tomato area in Malang is located in just two sub-districts: Poncokosumo and Pujon (see Table 7). In some years Wajak may account for around 10% of the tomato area in Malang. The crop is also grown in several other sub-districts, but these have much smaller production areas than Poncokosumo or Pujon. Hence, any interventions in the Malang tomato sub-sector should initially target these two subdistricts.

Sub-districts	Harvested	area (ha)	Share (%)			
	2011	2012	2011	2012		
Poncokosumo	463	423	35	35		
Pujon	231	221	18	18		
Wajak	116	74	9	6		
Karangploso	44	69	3	6		
Other sub-districts	453	432	35	35		
Total Malang	1,307	1,219	100	100		

Table 7 Tomato harvested area in Malang (2011-12)

Source: Unpublished data, Dinas Pertanian Malang

In any given season, most tomato farmers in Poncokosumo and Pujon allocate between 0.1 and 0.3 hectares to the crop. Tomato farms in other sub-districts tend to be smaller. Therefore, one can conservatively assume that about 2,000 farm households in Poncokosumo and Pujon and more than 3,000 farm households in other parts of Malang are involved in tomato cultivation.

Small farm size reflects a context where rural households have limited landholdings and grow three to five different vegetable crops, sometimes more, at any given point in time. Vegetable farms typically range from 0.3 to 1 hectare, or 1.5 hectares in rare cases. Farms are divided into smaller parcels, and a block of tomato may be as small as a tenth of a hectare. The rest of the farm will be allocated to crops such as chilli, cabbage, broccoli, beans, celery, shallots, carrot, and sweet corn.

Many different hybrid tomato varieties are grown in Malang. Betavila (East West) and Savero (Syngenta) are popular in many mid-altitude areas. Betavila is grown in irrigated farms during the dry season and under rain-fed conditions during the wet season. Savero is a dry-season variety. Three other East West varieties (Tymoti, Permata and Marta) were mentioned by nursery operators and farmers in Malang. Menara, Lentana, and Tatiana were some of the other varieties cited during the discussions with local key informants.

Different villages tend to specialise in different varieties. Some are well adapted to lowland environments, some to mid-altitude settings, and some to high-altitude locations. Some are more tolerant of rain and resistant to certain pests and diseases, therefore being suited to wet-season conditions, while others deliver higher yields during the dry season. The duration of the harvest is another dimension weighing on farmers' choice of variety: some prefer a shorter harvesting season, whereas others opt to grow varieties that can be harvested over longer periods. Finally, when choosing varieties, farmers may take fruit colour and size into consideration. The market has a clear preference for vegetable tomatoes with a bright red colour and that are neither too small nor too big.

Vegetable cultivation in Malang is an expensive venture. Tomato farming is no exception. Farmers often rent hand-held tractors for land preparation and have to spend a fair amount of money establishing the crop, purchasing fertilisers and pesticides, and hiring labour to work on the farm. Raised beds with deep drainage

furrows need to be established before application of pre-plant cattle manure and/or chemical fertilisers. Tomato seedlings may be grown by the farm household itself, but production by specialised nursery businesses is becoming increasingly common, especially in the main production areas. Seedlings are transplanted after 15-20 days. Trellises made of bamboo or other wood supports are erected, and the growing tomato plant is trained to keep maturing fruit away from the soil. The crop is maintained with daily irrigation, frequent applications of protective pesticide sprays, and periodic supplemental side-dressing with fertilizer.

Despite the care put into their tomato farms, growers do not always produce a good crop. During the fieldwork, farmers reported very variable yields, ranging from six to 60 tonnes per hectare, confirming the view that they face high production risks. Such variability in yields cannot be fully explained by differences in soil quality, variety, seedling quality, or the type and quantity of other inputs applied. Timing of production is also an important factor, with farmers generally achieving higher yields during the dry season when pest and disease pressures are less acute. During the rainy season, between November and May, diseases such as bacterial wilt, anthracnose and fusarium can have a particularly devastating impact on the tomato crop.

Having a diversified vegetable crop portfolio enables Malang growers to reduce production and marketing risks, which are particularly high for high-value perishable produce. Malang farmers invest significant resources in their vegetable farms in the expectation of high returns, but they may make a loss on individual crops or merely break even. Vegetable cultivation is a high-investment, high-risk venture.

3.2 Production Costs

Tomato production is no exception to the high investment required for vegetable cropping. During one focus group discussion in Poncokosumo, tomato growers reported average investment levels of IDR 20-25 million, i.e. around US\$ 2,000-2,500, per hectare. They used these figures to claim that tomato farming is beyond the financial (and risk-bearing) capacity of poor households. Data collected from four tomato growers reveals higher production costs than those cited during the focus group discussions for three of the four farms surveyed. However, the sample is too small for any meaningful extrapolation.

On average, the four sampled farmers invested IDR 39 million (over US\$ 4,000) per hectare (see Table 8). Seed and seedlings represented 7% of farm production costs, plant establishment materials 21%, fertiliser 22%, fungicides and insecticides 17% and hired labour 26%. It should be noted, however, that production costs varied significantly across the sample. Two of the farmers used plastic mulch, applied much larger amounts of fertiliser and pesticides, and hired more labour than the other two farmers.

	Farmer 1	Farmer 2	Farmer 3	Farmer 4	Average	Share (%)
Seed	2,333	1,250	2,400	1,800	1,946	5
Seedlings	1,200	560	720	960	860	2
Plant establishment materials	12,000	2,056	9,660	8,528	8,061	21
Fertilizer	5,783	3,750	14,530	10,630	8,673	22
Other chemicals	5,273	2,876	9,700	9,550	6,850	17
Hired labour	7,107	3,220	15,048	15,757	10,283	26
Other costs	653	3,580	3,950	2,783	2,742	7
Total	34,349	17,292	56,008	50,008	39,415	100

|--|

Source: Fieldwork data (November 2012)

The farm households surveyed in our small sample had an average wage outlay of about IDR 10 million per hectare, i.e. over US\$ 1,000. If this figure is extrapolated to the whole district, an estimated US\$ 1.3 million in farm wage income is generated per year.

3.3 On-Farm Labour Use

Tomato is a labour-intensive crop. The labour input for the four sampled farms ranged from 158 and 632 person-days per hectare; the average was 396 person-days per hectare (see Table 9). Only 20% of the labour input came from farm households. The other 80% was provided by wage labour. Women accounted for 43% of total farm employment but 60% of total wage employment. Tomato farms are generally managed by the male head of the farm household, who are also responsible for input purchases and product sales, but women often represent more than half of the casual labour force employed to work on the farm. They play a particularly important role during the transplanting of tomato seedlings, weeding and harvesting stages. Women may also fertilise the crop but are very rarely involved in spraying activities.

As in other parts of Java, there is a clear gender wage gap. One of the growers surveyed paid IDR 37,000 per day to female workers and IDR 47,000 per day to male workers. On two other farms, women earned IDR 25,000 per day, compared to the male wage rate of IDR 30,000. On the fourth farm, women and men were paid IDR 35,000 and IDR 30,000, respectively. Based on these examples, one can conclude that women working in tomato farms earn 15-20% less than men. Another important difference is that women are generally employed for half-day shifts so that they can have time to take care of household chores while men typically work full-day shifts.

	F1	F2	F3	F4	Avg. (N=4)
Farm employment (person-days / ha)	357	158	632	438	396
Hired farm labour / total farm labour (%)	66	75	90	100	83
Hired female labour / total hired labour (%)	88	54	71	25	60
Female employment / total employment (%)	42	41	64	25	43

Table 9 On-farm labour use

Source: Fieldwork data (November 2012)

3.4 Chain Actors and Linkages

3.4.1 Input distribution

Input chains are represented in

Figure 6. During the land preparation stage, tomato growers may hire hand tractors from other local farmers. F1 hybrid seed, fertilisers, fungicides, pesticides, and herbicides are purchased from local input shops. These are generally well stocked, selling varieties that are suited to different seasons and a wide range of agrochemicals. Prompt payment in cash is the norm, although some input retailers may at times provide credit to select farmers they have established and trusted relationships with.

A significant number of tomato growers have access to seed and agro-chemicals on credit from village traders. Three-month and pre-harvest cash loans from traders are also common. While no interest is charged, farmers may accept slightly lower prices from traders who have advanced inputs, cash loans, or both. Credit functions as an implicit verbal contract whereby the farmer agrees to sell his or her harvest to the trader. Such arrangements minimise search and other transactions costs. They ensure that traders have access to minimum supplies of different vegetables all year-round. The number of farmers a trader typically deals with ranges from 20 to 60, depending on the scale of the trading business and the financial capacity of the trader. Criteria for selection of borrowers include the scale and productivity of the farmer, the personal relationship between the trader and the farmer, the farmer's reputation within the community and past history in selling to the trader. Clearly, high levels of trust between the trader and farmers are a necessary condition for delivery of credit services.

Many tomato farm households grow their own seedlings. They do so in order to reduce costs, for logistical convenience and/or because they are unsure about the quality of the seedlings supplied by local nurseries. However, in villages where tomato is a major crop, 40-70% of growers purchase seedlings from specialised nurseries. This option saves time and labour. Access to quality seedlings is another important motivation. In some cases, farmers may buy from nurseries because they have poor access to water, a critical input for successful seedling production, or because it may be necessary to replant following poor establishment of their own seedlings. Some farmers access seedlings on credit from village traders, an important client for the larger nursery businesses.

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Figure 6 Input chain in Malang

Traders and farmers often order seedlings in advance. In most cases, the seed to be grown into seedlings will be provided by the farmer or trader. When purchased by the nursery operator, clients are often asked to pay part of the value of the transaction in advance and part upon delivery of the seedlings. The study team met with nursery businesses that primarily service farmers who bring their own seed and nurseries that also produce seedlings for opportunistic, spot market sales. The latter strategy has a higher level of risk. In order to develop a good understanding of local demand for different varieties, the nursery operator will be in close contact with staff from seed companies, local input stores and farmers themselves.

The portfolio of local nurseries is not confined to tomato seedlings. Chilli accounts for a significant share of their business. Many also grow cabbage seedlings. Broccoli, cucumber, and other vegetables are less important. Product diversification allows nurseries to operate all year round, although sales are usually higher during the early dry-season months.

Most local nurseries produce between 20,000 and 100,000 seedlings per month, but a few have a monthly output of 200,000 to 400,000 seedlings. There are four such nurseries in Poncokosumo. They are large by Malang standards, but in the Pare subdistrict of Kediri, which has a more developed nursery cluster, there are a couple of businesses producing up to 600,000 or 700,000 seedlings per month. These nurseries grow seedlings in greenhouses, whereas in Malang only plastic roof protection is used. Only a few larger nurseries have adopted the more expensive UV plastic. Unlike their smaller competitors, these nurseries use polybags, a standard technology in Kediri. Female labour is employed to fill the bags by hand, a very labour-intensive activity. In the larger Kediri nurseries, equipment is used to perform this task.

As expected, larger nurseries employ much more labour than their smaller counterparts. The larger nursery farmer interviewed in Malang has nine permanent workers. Another has a permanent workforce of four. Smaller nursery operators rely more on their own labour and some casual labour. Smaller nurseries supply farmers in their vicinity. Larger nurseries have a broader market area and a more diversified client portfolio. Larger growers and traders, including some from outside the sub-district, are important customers.

3.4.2 Spatial flows and market channels

A significant share of the tomato harvest in Malang is consumed near production areas, i.e. within the district, in Malang City, and in other parts of East Java, particularly in and around Surabaya. Bali, greater Jakarta, Lampung and Kalimantan are other important market destinations.

Malang tomatoes are distributed and retailed through traditional channels. Only a very small share of local production is channelled to modern retail outlets. These outlets have a very marginal presence in the domestic tomato trade. According to unpublished data collected from a representative sample of consumers in Surabaya, Solo and Bogor, only 2% of households in these three cities rely on hypermarkets and supermarkets as the main outlets for their tomato purchases (Wendy Umberger, pers. comm.). The actual market share of the modern retail segment is much smaller because a significant share of the Indonesian population lives in villages and small and medium-sized towns with no access to supermarket stores.

When buying their daily vegetables, Indonesian consumers show a strong preference for traditional markets, despite the fact that these are often over-crowded and unhygienic. Street vendors are another important source of vegetables. As observed during the fieldwork, vegetable tomatoes retailed in traditional markets often have a similar or better appearance than those displayed in supermarkets or hypermarkets. More importantly from a consumer perspective, tomatoes sold through traditional channels are considerably cheaper. Many consumers also seem to enjoy the experience and the convenience of buying tomatoes and other vegetables from traditional retailers.

None of the traders interviewed in East Java were selling to the food industry. Food processing companies in Indonesia rely on imported tomato paste or puree. A vegetable cooperative in Batu reported that ATK, a Japanese firm with offices in Papua, Makassar and Maluku, is assessing the feasibility of developing local production of organic tomato puree for the Japanese market. Surabaya was chosen as the potential location for a new factory. At the time of the interview (November 2012), the company was conducting product trials to determine the nutritional value and other quality parameters of locally grown organic tomatoes.

Traditional tomato chains (intra-district, intra-provincial, inter-provincial and inter-island) are discussed in the next four sub-sections. The supermarket chain is not discussed as it has little relevance for a project such as AIPD-Rural, which aims to deliver pro-poor impacts at scale within a five-year timeframe. Despite strong growth in the modern retail sector, supermarkets still have a very residual share of the retail market and this is unlikely to change in the foreseeable future. Currently, modern stores procure tomatoes and other vegetables from wholesale markets and dedicated suppliers. The latter buy their supplies from a small number of farmers or market wholesalers, in a system that is not so different from the traditional trade. Supermarket suppliers have been able to infiltrate the modern retail segment due to their ability to meet the contractual conditions imposed by supermarkets (i.e. late payments and high penalties for failing to deliver agreed volumes), not necessarily because they have developed a supply of high quality vegetables. Some key informants also reported that, in many cases, personal relationships with supermarket procurement managers and the payment of informal fees are necessary conditions for entry into the modern retail channel.

3.4.3 Intra-district chains

The intra-district chain is depicted in Figure 7. Malang City represents an important market for local tomato growers. Gadang market is the main wholesale distribution centre, supplying large numbers of urban retailers. There are some 30 wholesalers in Gadang that sell tomatoes (and other vegetables). About half specialise in sales to retailers, handling between 1 and 3 tonnes of tomato per day. The other half specialise in long-distance trade, supplying wholesalers in Bali, greater Jakarta and Lampung. Gadang traders get their supplies from collectors and inter-district traders.

Village assembly markets, of which Karangploso is perhaps the largest, supply periurban and rural retailers. Many collectors bring their supplies to these markets. Interdistrict traders may occasionally sell at these markets, but they primarily target markets outside the district.

Prompt payment is the norm in intra-district chains. Village traders pay farmers upon collection of the crop or within a day. These traders often employ their own "workers" to collect (and grade) the crop on farm. Likewise, wholesalers pay their suppliers upon delivery of a consignment or within days. Wholesalers only accept delayed payment from select regular customers. Wholesalers in Malang City do not provide cash advances to their suppliers. The only significant credit flows along intra-district chains are between village traders and farmers. These were discussed in section 3.4.1.

Inter-district traders are a much more important source of credit than collectors because they handle larger volumes and deal with a larger number of growers. Both collectors and inter-district traders sell a variety of vegetables, but for many of them tomato is a key crop in their portfolio, especially in Poncokosumo and Pujon. In these two sub-districts, inter-district traders normally sell between 1 and 3 tonnes of tomato per day and have 40 to 80 regular suppliers. Collectors tend to handle less than 1.5 tonnes per day. They will normally purchase vegetables from 20 to 40 growers.


Figure 7 Intra-district chain

3.4.4 Intra-provincial chains

The intra-provincial chain is depicted in

Figure 8. Porong market in Sidoarjo is a major distribution centre for Malang tomatoes. Many inter-district traders go to Porong every day to sell a variety of vegetables. They have been participating in this trade for many years. The produce is transported in pick-up trucks owned by the traders themselves. Each has several regular buyers in Porong. These are "large" market retailers from Sidoarjo, Surabaya, Gresik, Mojokerto, Pasuruan and Madura, or mobile traders who supply market and street vendors in these locations. Some of the retailers buying directly from Porong also supply market and street vendors. Interestingly, some market retailers in and around Surabaya buy their supplies collectively from Porong market. The fact that inter-district traders have been doing business with buyers in Porong for many years is important for efficient coordination and negotiation of transactions. Prices are determined when the parties meet at the market.

Some Gadang wholesalers and some inter-district traders also supply Keputran, the main wholesale market for fresh produce in Surabaya, but this is a secondary channel. Inter-district traders prefer to send most of their supplies to Porong because this market is closer to Malang and handles larger volumes than Keputran. Moreover, buyers in Porong purchase a range of vegetables and pay on the spot, whereas those in Keputran specialise in specific vegetable crops and pay within a few days of delivery.

Supplies to neighbouring Blitar and Lumajang districts are channelled through village

assembly markets. Many mobile traders from these districts source their daily supplies from village markets in Malang. Local collectors are their main suppliers.



Figure 8 Intra-provincial chain

3.4.5 Inter-provincial chains

The pathway and participants in inter-provincial chains are depicted in Figure 9. A few traders in Malang supply wholesalers in and around Jakarta. This trade takes place throughout the year, peakin3g around Ramadan and in late December, before the New Year. Despite the distance, some wholesalers in Jakarta and surrounding cities source tomatoes from Malang because the district can provide a continuous supply.

Gadang market is the main assembly point for tomatoes sent to greater Jakarta. Approximately ten wholesalers in Gadang specialise in the Jakarta trade. Some also supply buyers in Lampung, in southern Sumatra. The study team interviewed one such trader. He sells approximately 3 tonnes of tomato per day to one wholesaler in Tanah Tinggi market in Tanggerang and a similar quantity to one customer in Lampung. He buys tomatoes from seven village traders in the Wajak sub-district.

At least one village trader, Ibu Lulu, supplies greater Jakarta directly. She is the largest vegetable trader in Poncokosumo. Ibu Lulu has been doing business with one wholesaler in Tangerang since 1996. Chilli is the main vegetable in her portfolio, but she does send 30 to 40 boxes of tomato (1.8 to 2.5 tonnes) daily to her client in Tanah Tinggi market. Ibu Lulu works closely with 150 local growers, but she also buys from other districts in East Java. Sometimes she even procures tomatoes from Keputran market in Surabaya.



Figure 9 Inter-provincial chain

Inter-provincial traders handle larger volumes of fewer vegetables than inter-district traders. They normally supply one or two buyers in one or two markets. Inter-provincial traders face difficulties in dealing with many wholesale customers because each needs a continuous supply of relatively large consignments and because high levels of trust are required for long-distance transactions. Transactions are coordinated over the phone, so the parties do not meet face to face. Prices are determined before a consignment is sent from Malang, but the payment will normally be settled five to seven days after the produce arrives at its destination. Inter-provincial traders do not receive advances from buyers, having to rely on their own funds and bank loans for working capital.

3.4.6 Inter-island chains

Kalimantan is the main market outside East Java (see Figure 10). Product flows

fluctuate significantly throughout the year, depending on the price differences between Malang and Kalimantan. There is also a regular trade in tomatoes from Malang to Bali and Lampung, in southern Sumatra. Inter-island flows from Malang usually peak around Ramadan and the New Year. Some traders reported higher trading volumes during the dry season.



Figure 10 Kalimantan chain

Supplies to Kalimantan are coordinated by inter-island traders in Batu and Surabaya. The study team interviewed three of these traders in Batu, but unfortunately there was no opportunity to meet inter-island traders in Surabaya.

More than 10 traders in Batu focus on the Kalimantan market. Some are large operations servicing the East Java-Kalimantan trade in fruits and vegetables, construction materials, and other goods. Individual tomato consignments will typically range from 1 to 8 tonnes, depending on the trader and the time of supply. The larger traders source their tomatoes from different districts, but most of their supplies come from village traders in Malang and Batu. Some Batu traders supply just one or two clients in one or two markets, others are linked to several markets and may have five or more regular buyers in each location. Their clients consist of traditional wholesalers in Banjarmasin, Balikpapan, Samarinda, Sampit, Palangkaraya, Kumai, and other urban centres. One of the traders interviewed also supplies one catering company that services large mining concerns.

While business relations with catering firms are governed by written contracts with fixed price arrangements, transactions with large primary wholesalers are based on verbal agreements and variable prices, determined on the basis of spot market conditions in Kalimantan. The price for each consignment is agreed upon when an order is placed. Any product losses and discounts for poor quality have to be borne by the inter-island trader. During the rainy season, Batu traders work with high gross margins in order to protect themselves against high post-harvest losses.

Transactions with Kalimantan buyers are underpinned by high levels of trust. This is essential in a context where inter-island traders supply fairly large consignments of perishable produce, face variable product losses during transportation, and are only paid several weeks after a consignment has been delivered. There were cases of Kalimantan buyers defaulting on their debts reported during the fieldwork. This was highlighted as the main reason why some inter-island traders no longer supply Kalimantan. Understandably, marketing networks are very stable. Most Batu traders have been supplying their clients for a long time and are reluctant to do business with "new faces".

Most supplies to Bali are managed by four or five traders in Gadang market. The study team met one of these traders. He sends daily consignments to ten regular clients in Baturiti wholesale market. Sometimes the consignment will comprise a six-tonne truck fully loaded with tomatoes. Other times it will consist of three or four tonnes of tomatoes, with the balance of the load comprising other vegetables, particularly broccoli. Occasionally, when prices in Malang are very high, he will procure tomatoes from his customers in Bali.

Gadang is also the main assembly point for tomatoes sent to Lampung. These transactions are conducted by some of the inter-provincial traders that have links to buyers in and around Jakarta. The Jakarta and Lampung chains are very similar in their structure and governance (see section 3.4.5).

3.4.7 Contract farming and collective action

No formal contract farming arrangements were found in the Malang tomato chain. Contract farming schemes are costly to develop and can only be justified where firms are targeting premium markets in Indonesia or abroad. Currently, such chains are very under-developed. The study team only identified one formal contract farming scheme in Malang. The scheme is managed by Horti Bima, a Taiwanese export company that has forward contracts with 150 vegetable growers, but these are for the production of snow peas, sown pea shoots, and sugar snap peas, not tomatoes. The company also produces jam from a range of fruits and vegetables. All production is exported to Taiwan. The company's contracting system is currently functioning well. While some participating farmers may face exclusion due to side-selling, during the past five years their number has remained fairly stable.

Likewise, the current market landscape does not favour the emergence of collective, farmer-owned enterprises. A clear demand for premium quality produce, purchased for a significant price premium, provides the strongest justification and incentive for the development of informal and formal farmer cooperative enterprises with linkages to

modern trading firms. Such demand is currently too small to justify the costs of collective action in the production and marketing spheres.

The team met the management of NOFAR, one vegetable trading enterprise in Batu that is working with certified farmers for the production of a wide range of organic vegetables, including vegetable, fruit and cherry tomatoes. After more than five years in operation, the enterprise is still facing many challenges: less than 30 growers supply organic tomatoes and the volumes are small; a significant share has to be sold in conventional markets due to a lack of premium buyers; there is limited demand for expensive organic vegetables; only selected, relatively wealthy farmers, located far from each other, participate in the NOFAR chain, making monitoring and coordination challenging and costly. Pricing arrangements are also problematic, as farmers are not being explicitly penalised for delivering sub-standard produce that is rejected after inspection at the NOFAR premises. The enterprise is at a difficult juncture. NOFAR is hoping that investment by ATK in an organic tomato puree factory in Surabaya will address current marketing problems. At the time of writing there were no assurances that the investment would go ahead.

The team also interviewed the management of Herbal Estates, an organic venture in Batu, and PT. Bahtera Agrikultura Indonesia, a safe vegetable operation in Mojokerto. Both companies had more professional management than NOFAR. Additionally, they were supplied with produce grown on their own farms, each extending over an area of just 3 hectares. Small additional supplies were procured from a few scattered contract growers. Both Herbal Estates and PT Bahtera Agrikultura were very cautious about expanding their supply base due to the technical challenges of producing organic and safe vegetables and the small size of premium market channels. Herbal Estates sells to high-end hotels and specialised retail chains, such as Ranch and Papaya, while PT Bahtera supplies consumers in affluent neighbourhoods of Surabaya through its own network of door-to-door retailers. Another vertically integrated organic farming business in Batu was mentioned during the interviews, but the enterprise relies solely on its own small farm as a source of supplies. It does not buy organic vegetables from smallholder farmers.

These different enterprises have some key features in common. They are very small ventures; they have low scalability potential; and they have very limited or no upstream links to smallholder farmers. NOFAR is the only enterprise that relies on smallholder farmers for the bulk of its supplies and this may contribute to the challenges it is facing in the production, management and marketing spheres.

3.4.8 Information and knowledge flows

In sub-districts such as Poncokosumo, Pujon, Wajak and Karangploso there is a large presence of commercial vegetable growers, traders who also have their own vegetable farms, input retailers, and nurseries. These areas also have a clear commercial interest for seed and agro-chemical companies, who have some marketing and field staff stationed in Malang. Such a concentration of chain actors creates a favourable context for exchange of production- and market-related information (see Figure 11).

Farmers, nursery operators, and traders are constantly trialling new varieties, rotation crops, inter-crops, and agro-chemicals. These experiences are shared through family,

social, and market networks. For example, nursery farmers that trial new varieties as part of their business development will share their experience with relatives, neighbours, and clients.



Figure 11 Knowledge and information flows in the Malang tomato chain

Seed and agro-chemical companies have played an important role in local technology adoption processes, even though their services are driven by their own commercial interests, i.e. promotion of their products, not necessarily the best options available to farmers. Marketing and field staff working for the main seed companies interact with many input retailers, nursery farmers, and vegetable growers when promoting recently released varieties. Demo-trials are sometimes implemented in order to expose potential users of these varieties. Likewise, all major agro-chemical companies have staff based in Malang who organise local demo-trials as part of their product promotion responsibilities. These companies also distribute information materials e.g. brochures about specific agro-chemicals, through local input retail outlets.

Government extension services are a more impartial source of technical advice. However, they face acute resource and institutional constraints, resulting in only a marginal role in local innovation processes. Extension officers lack key knowledge and skills, as well as the performance-related incentives that are so critical for the delivery of an effective service.

Good understanding of local demand for seedlings is critical for the success of nursery businesses, especially those selling in spot markets. Information about farmer planting intentions is obtained from farmers' themselves and local traders. Nursery operators also consult seed company staff and input retailers on a regular basis in order to access information on local seed sales.

Information about spot market prices has obvious relevance for farmers as without it they cannot assess the fairness of the terms offered by village traders. With numerous daily transactions and the existence of local assembly markets, it is not difficult for farmers to access spot price information. However, both farmers and traders seem to have difficulties making sense of intra-annual price patterns and forming reasonable expectations about price outlook scenarios. These abilities are critical for making informed planting decisions. As discussed in section 4.5, this weakness could be addressed through the transfer of strategic market assessment capacities and facilitation of linkages to selected sources of information within and outside Malang.

Knowledge of pest and disease management strategies was identified as another important gap. Farmers often improvise or follow local practice in their attempt to deal with pest and disease problems. Understanding of pests and diseases, their causal factors, optimal timing for intervention and the relative cost-effectiveness of different control technologies is often weak. Control options will often differ between villages due to the influence of local agro-climatic conditions and production systems. Location-specific research is therefore needed to determine possible improvements over current practices but such services are costly and rare.

3.5 Quality Management Systems

Tomato from Malang has a good reputation in East Java. According to the traders interviewed in Porong market, Malang tomatoes have better colour, size and taste than competing produce from Bandung, in West Java, but a shorter shelf life.

The tomato harvest is carried out by farmers but coordinated and supervised by village traders. The crop is usually collected, sorted and packed on the farm. Traders are therefore able to ensure that product standards, particularly fruit maturity and size, meet the requirements of their buyers.

Product perishability has a visible influence on the timing of the harvest. Tomatoes for the Java, Bali and Lampung markets are harvested at the mature green to breaker stage in order to ensure a shelf-life of at least four days. The tomatoes will normally develop a full red ripe colour two or three days after harvest. Produce sent to Kalimantan is picked green so that it can better endure transportation and handling stresses. It will take at least two days, often more, to assemble and deliver a tomato consignment to wholesale buyers in Kalimantan.

Tomatoes are graded on the farm according to size. Grade A tomatoes weigh around 80 grams (12 fruit per kilogram), grade B about 70 grams (14 fruit per kilogram), and graded C between 60 and 65 grams (16 fruit per kilogram). Farmers are often paid

higher prices for higher grades. Clean tomatoes with no defects will also fetch a higher price than fruit of inferior appearance. Some examples of price differentiation across grades were provided by traders based on recent prices. These examples are presented in Table 10 for illustrative purposes.

	Grade A	Grade B	Grade C
Inter-district trader, Poncokosumo	1,000	700	500
Inter-district trader, Wajak	1,000 – 2,000	700 – 1,500	500 – 1,000
Inter-provincial trader (Gadang)	800	4-500	350
Inter-island trader (Gadang)	1,200 – 1,500	500 - 700	350

Table 10 Purchasing prices (IDR/kg) for different tomato grades

Source: Fieldwork data

Tomatoes are transported in wooden boxes of 60 to 65 kilogram capacity, irrespective of their destination. These boxes are then stacked on top of each other in small or large trucks. While such practises may be acceptable for tomatoes transported in small vehicles to nearby markets, they are clearly inadequate for produce that is shipped to Kalimantan in large trucks and under high temperatures and humidity. Current packaging practices are certainly one important factor contributing to very high product losses along this chain. This is an issue that merits further research.

Inter-district traders reported negligible physical and quality losses, as they supply markets that are less than two or three hours from the production areas. The tomatoes are normally sold within a few hours after arriving in Porong. Wholesalers in Keputran market experience losses of 5% or less during the dry season, but these may rise to 10% or more during the rainy season. Such losses include produce that needs to be discounted due to bruising and other defects. Retailers reported similar level of losses.

According to traders in Gadang, physical losses during transportation to Bali and markets in or around Jakarta are negligible. It takes up to 12 hours for the tomatoes to reach Bali and 18 hours for the produce to arrive in Jakarta. However, it is common for 5-10% of a consignment to be sold at a discounted price because of quality losses between the farm and the destination markets in Bali or greater Jakarta.

Contrary to Malang traders, inter-island traders in Batu face very high quality losses during the rainy season, despite the fact that they buy immature fruit and varieties with lower water content. One trader reported that between 40% and 60% of the tomatoes traded during the wet season have to be discounted by up to 25%. A second trader estimated that half of his supplies during that period are sold at a reduced price, which can be as low as 50% of the normal price. A third reported price deductions for 40% to 50% of his rainy-season consignments. These losses could be reduced if traders were to adopt improved packaging practices.

3.6 Margins

Price and marketing cost data along the Poncokosumo-Porong chain was collected on 16-17 July 2013, just before Ramadan, at a time when tomato prices were particularly high (see Table 11). Tomato growers received approximately 70% of the retail price.

Inter-district traders, distributors, and retailers "appropriated" 12% of the crop's retail value as net margin. Marketing costs accounted for 19% of the retail price. Retailers earned a relatively low margin due to product losses and high transportation costs per kilogram, representing 40% and 20%, respectively, of total marketing costs from the farm through to retailing. The net margin for inter-district traders was also small when measured as a percentage of the price received in Porong, but less so in absolute terms because of high market prices. As highlighted by many key informants, inter-district traders earn very small profits on average, and may even incur financial losses when the market is over-supplied and the price of tomatoes very low.

	Farmer	Inter-district trader Malang	Large retailer Sidoarjo	Small retailer Sidoarjo
Selling price (IDR/kg)	9,000	9,750	10,500	13,000
Share of retail price (%)	69	75	81	100
Gross margin (IDR/kg)*		750	750	2,500
Gross margin (%)		7.8	7.1	19.2
Variable costs (IDR/kg)		410	273	1,811
Labour		32	16	0
Packaging		108	110	37
Transportation		164	38	500
Product losses		0	98	1,050
Other		106	11	224
Net margin (IDR/kg)*		340	477	689
Net margin (%)		3.5	4.5	5.3

 Table 11 Gross and net marketing margins along the Malang-Porong chain

Source: Fieldwork data, 16-17 July 2013

* Gross margin per kg = selling price – purchasing price

** Net margin per kg = selling price – purchasing price – other variable costs per kg

Some caution is needed when interpreting margin data. Net margins are known to fluctuate considerably between transactions, especially those earned by inter-district traders, who face the highest marketing risks. Inter-district traders only know the price they will receive in Porong after they bring the tomatoes to the market, i.e. after the produce has been purchased from farmers. This is very risky because prices may vary significantly from one day to another, or even within the same day. In order to protect themselves against adverse price fluctuations, some inter-district traders have developed commission-based marketing arrangements with farmers they provide credit services. In such cases, the trader will keep a share of the farmer's supply, say five kilograms for every 60-65 kilograms, or charge a fixed amount, say IDR 600 or 700 per kilogram sold.

All actors in the Malang-Porong chain are price takers. In other words, traders have limited scope to determine purchasing and selling prices. Village traders and retailers operate in highly atomistic or competitive spot markets where prices are constantly changing in response to changing supply conditions. It is true that village traders may have some flexibility in determining the price paid to farmers they have provided credit. However, this comes at a cost. Scarce working capital has to be allocated to these farmers as credit. More importantly, there is a mutual understanding that traders must purchase all vegetables produced by those farmers, even when that is not in their interest, i.e. at times when market prices are very low. Access to credit services and guaranteed sales are the two main reasons why many farmers prefer to sell repeatedly to the same trader. However, it should be noted that they face no shortage of potential buyers in their village and can easily shift from one to another if they feel that they are not getting a fair deal.

It is unfortunate that the study team had no time to collect price and marketing cost data along the Malang-Kalimantan chain. Discussions with inter-island traders in Batu indicate that these operate with fairly high gross margins during the rainy season in order to protect themselves against discount sales. Inter-island traders pay farmers on the basis of the price offered by their buyers in Kalimantan, with farm-gate prices reflecting collection, packaging and transportation costs, as well as expected price penalties for poor-quality produce.

3.7 Problems and Constraints

Tomato growers repeatedly mentioned diseases, particularly bacterial wilt, fusarium, and anthracnose, as a major risk, especially during the rainy season, when the impact on yields can be very high. None of the tomato varieties grown in Indonesia is resistant to bacterial wilt. Moreover, the disease cannot be controlled through chemical applications. While certain varieties have some resistance to fusarium and anthracnose, these still pose a serious risk to the tomato crop. Fungicides used to control anthracnose are not always effective. All these diseases could be eliminated or significantly reduced if farmers were to abstain from growing tomatoes, chillies, and other plants from the *solanaceae* family for several years, but this is impractical due to the importance of such crops in local production systems.

Farmers also expressed serious concerns about price volatility. The unpredictability of intra- and inter-seasonal price patterns, and the likelihood that prices will be very low at harvest time, is a major source of risk. This issue was also highlighted by village traders. These traders are particularly concerned with unpredictable inter- and intra-daily price fluctuations during periods of very low prices, which can result in short-term losses.

Finally, traders supplying Kalimantan highlighted two main problems: excessive quality losses during the rainy season and very late payment by clients. These traders are also concerned with the risk of payment default by Kalimantan buyers, a situation that will result in financial losses and lead to a breakdown in the business relationship.

4 Opportunities for Pro-Poor Chain Innovation

4.1 Targeting Strategies

This study focused on Malang. This is the only AIPD-Rural district where tomato is an important crop and therefore a possible vehicle for pro-poor impacts. It is estimated that more than 5,000 farm households in Malang earn an income from tomato farming. In addition, tomato farms generate US\$ 1 million or more per annum as wage income.

Income impacts from interventions in the tomato chain could be increased if other districts were targeted alongside Malang. Batu is an obvious choice due to its importance as an inter-island trading centre and upstream market linkages to production areas in Malang. Kediri and Banyuwangi should also be considered. During the peak dry season, these two districts are the main suppliers of tomatoes in eastern Indonesia. Kediri also has the most advanced tomato nurseries in the region.

From an impact perspective, there is also a strong rationale for pursuing an upgrading of the whole vegetable sub-sector in Malang and Batu, rather than a more narrow strategy focused exclusively on the tomato chain. Such approach is equally justified in East Lombok, where farmers and traders have also developed highly diversified vegetable crop portfolios. As discussed below, some of the proposed tomato chain interventions could be designed to include other vegetable crops. While possible interventions in the potato and chilli chains have been covered in two separate EI-ADO studies, further research could be conducted to identify opportunities for pro-poor innovation in other vegetable chains.

4.2 **Proposed Interventions**

Four value chain interventions with the potential to increase farm household income have been identified:

- Promotion of grafted tomato seedlings. Grafted tomatoes are the only effective solution available for addressing high pre-harvest losses due to bacterial wilt. Grafted tomato seedlings have been adopted on a large scale in southern Vietnam, with very positive impacts on farmer incomes.
- Improved packaging for long-distance trade. The development of improved packaging for tomatoes shipped to Kalimantan provides an opportunity for reducing high post-harvest losses in the inter-island trade during the rainy season. These losses are a barrier to trade and depress farm-gate prices. If successful, packaging innovations could perhaps be adapted to other perishable vegetables sent from East Java to Kalimantan or Sumatra.
- Development of market outlook assessment capacities for tomatoes and other major vegetable crops. This can result in more informed planting decisions by farmers, reducing their exposure to low prices and enabling them to take greater advantage of high prices.

• Development of protected cropping. Low-cost greenhouses are a promising technology, having the potential to increases the returns from vegetable farming during the rainy season.

Improvements in fertilisation practices, water management, and pesticide use are also likely to have significant positive impacts on the productivity and profitability of tomato farms. It is very challenging, however, for a chain development project such as AIPD-Rural to facilitate this type of innovations at scale over the medium term, the reason why this is not included in the portfolio of recommended interventions. Significant farm research is needed to better understand current crop management systems in different locations and to identify specific technical upgrading options that can deliver improved profits to a large number of tomato farm households by saving costs, improving yields, or both. Furthermore, transferring relevant know-how, in a context where technical upgrading opportunities are likely to differ across farms, even within the same site, and public extension is performing very poorly, is very challenging. A significant number of participatory farm demonstrations would need to be implemented across many sites. It is unclear whether large seed and agro-chemical companies would be willing to participate in this process due to the costs involved and uncertainties regarding the impacts on the sale of their products. Some leverage could be achieved by targeting local traders, but the dissemination of technical knowledge would always be a slow process.

Likewise, facilitation of private investment in cold storage for tomatoes and other perishable vegetables is not recommended at this stage, even though it provides a pathway for reducing short-term price volatility, a major source of concern for farmers and traders. The private sector in Indonesia seems to lack the technical know-how and business expertise required for successful development of cold storage for a range of perishable produce. High investment costs are another deterrent. While AIPD-Rural would be well positioned to address these constraints, it is unclear whether investments in cold storage can be profitable in a context characterised by traditional and highly fragmented production and marketing systems. Even assuming that financial feasibility criteria can be met, cold storage would need to be developed at significant scale in order to have meaningful impacts on farmers' incomes through a reduction in the supply of perishable produce when there is over-production or when crops are harvested one or two weeks before a period of peak demand, such as Ramadan.

Clearly, research is needed to assess the financial feasibility as well as the potential for and likely impacts of cold storage development in a province such as East Java. AIPD-Rural could consider funding such type of research. Potential demand for cold storage services from farmers and traders, storage protocols for different horticultural produce and varieties, the most feasible production and/or market locations for establishment of storage facilities, optimal facility design and scale from an investment perspective, and potential investors are some of the key areas for investigation.

4.3 Development of a Local Market for Grafted Tomato Seedlings

4.3.1 Rationale for intervention and impact logic

Nurseries and tomato growers in Malang have identified bacterial wilt as a serious disease, especially during the wet season. None of the tomato varieties available show strong resistance against the disease. Furthermore, bacterial wilt cannot be controlled through chemical sprays and crop rotations have limited success at best.

Grafting tomato scions on bacterial wilt-resistant rootstock provides the most effective control strategy. Grafting would also address *Fusarium* wilt, increase water and nutrient uptake, help the plants cope with abiotic stresses such as excessive moisture and soil temperature, and improve fruit colour and appearance (Genova *et al*, 2013). Tomato grafting is a mainstream technology in Japan, South Korea and Taiwan. It has also been successfully adopted in Lam Dong province, the largest producer of tomatoes in Vietnam (Genova *et al*, 2013). In 2007, four years after local farmers were first exposed to the technology, the area planted to grafted seedlings extended over 4,000 hectares. By 2011 it had increased to 6,400 hectares. Adoption of this technology increased average farm yields by an estimated 30% increase and average net farm incomes by an estimated US\$ 6,528. It also increased profits and employment in the nursery sector.³ These impacts are represented in see Figure 12.

The opportunity to replicate this process in East Java and the challenges involved justify the intervention of a project such as AIPD-Rural. The success (and impact) of such an intervention will depend on the level of crop losses due to bacterial wilt. Grafted seedlings cost at least twice as much to produce as conventional seedlings (Joe Mariyono, pers. comm.), and therefore farmers will only be willing to invest in the technology if they can see significant improvements in yields.

The development of eggplant seed production systems is another essential condition for the success of the intervention. Some local eggplant varieties are resistant to bacterial wilt, and can therefore be used as rootstock, but limited availability of seed is a problem. Local eggplant varieties are self-pollinated, which explains why seed companies have not invested in multiplication activities.

³ Some 70 nurseries in Lam Dong supply grafted tomato seedlings.



Figure 12 Developing a local market for grafted tomato seedlings: impact logic

4.3.2 Intervention strategy and service delivery model

It is recommended that Malang and Kediri are initially targeted for the development of grafted tomato production. Batu and Banyuwangi could be considered at a later stage, depending on the results achieved and the lessons learned in the pilot districts. Kediri offers perhaps the most favourable context for intervention due to its comparatively developed nursery cluster, particularly in Pare, where the larger seedling production farms are located. The World Vegetable Center (AVRDC) has been promoting grafted tomatoes in Kediri for two years, in partnership with BPTP East Java, through the USAID-funded project "Mobilizing Vegetable Genetic Resources and Technologies to Enhance Household Nutrition, Income and Livelihoods in Indonesia". This project has focused its intervention on the transfer of grafting skills to farmers and nurseries and the implementation of on-farm trials, but the technology has not yet been adopted commercially. AIPD-Rural is well positioned to build on this initial work. The project can provide a strong value chain and business perspective. There is scope for greater participation of large nurseries and a need for greater emphasis on viable business models for eggplant seed production.

On-farm testing of grafted tomato seedlings constitutes a first necessary step in the development of a local market for the technology. A series of participatory demonstration trials will need to be implemented in order to compare the productivity of grafted and conventional seedlings. These demonstration trials would provide an opportunity for transfer of essential technical knowledge to nurseries and for generating demand for the technology by local farmers.

Local nurseries need to be active partners in the intervention. They can contribute to the establishment of trial plots and the mobilisation of farmers for participation in field days. Larger nurseries should be targeted as they are the most capable and innovative and have the broadest market reach.

Different models for sustainable production of eggplant rootstock will need to be assessed. Options include multiplication by the nurseries themselves, by seed growers or seed groups contracted by the nurseries, by seed growers or seed groups operating independently, and by seed companies. There is a need to assess the potential interest of companies such as East West, Syngenta or BISI in developing commercial production of eggplant seed and becoming involved in demonstration trials and the provision of training and advice to local nurseries. Although eggplant is self-pollinated, a strong demand for grafted seedlings from farmers and nurseries may provide an opportunity for joint sales of eggplant and tomato seed by the relevant seed companies.

Study visits to Lam Dong province in Vietnam are strongly recommended. During these visits, participating nursery operators could gain useful technical insights, gain an understanding of possible rootstock production models and be encouraged by the success of Vietnamese nurseries. Some traders could also be invited to participate to generate interest in grafted seedlings. These traders could then influence adoption by the farmers they work with.

Possible service delivery models are represented in

Figure 13. AVRDC has strong technical expertise and could therefore be contracted to provide training and advisory services to partner nurseries and eggplant seed producers and to facilitate business linkages between the two. Seed companies are another potential partner: they could play a role in the development of eggplant seed production and work with nurseries to test and develop local demand for grafted seedling technologies.

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Figure 13 Developing a local market for grafted tomato seedlings: service delivery model

4.4 Improved Packaging in the Inter-Island Trade

4.4.1 Rationale for intervention and impact logic

Tomatoes for the Kalimantan market are harvested early, while they are still green, as this reduces post-harvest losses. Despite this, inter-island traders still experience very high losses during the rainy season. Up to 60% of a consignment may be discounted due to poor quality on arrival in Kalimantan. Inadequate packaging practices are a contributing factor in such high losses.

AIPD-Rural should consider working with traders in Batu and Surabaya and packaging manufacturers in Surabaya to develop improved packaging for the Kalimantan trade. This is a relatively simple and low-cost intervention. Improved packaging is likely to be adopted if the cost savings from reduced product losses offset the additional packaging costs, something that would need to be determined throughout the intervention, with the involvement of inter-island traders.

The potential increase in the farm-gate price of unripe tomatoes in Malang, Batu and other parts of East Java currently supplying Kalimantan provides a strong rationale for intervention (see Figure 14). Currently, inter-island traders operate with high margins to protect themselves against product losses. If these were to be significantly reduced, inter-island traders would be able to pay suppliers higher prices, leading to an increase in farm-gate prices. Competition between inter-island traders and between their upstream suppliers provides the mechanism to ensure that the benefits of marketing cost savings would flow to farmers.

It is also conceivable that an extended shelf-life for tomatoes purchased by Kalimantan wholesalers would reduce product losses at the retail end, resulting in lower prices for consumers. This would expand the size of the Kalimantan market, increasing imports from areas such as Malang and Batu. As increased supplies are channelled off East Java during the rainy season, prices within the province would rise.





4.4.2 Intervention strategy and service delivery model

Consultation with inter-island traders in Batu and Surabaya, and wholesalers in Kalimantan, should inform the design of this intervention. The purpose of these consultations would be to gain a better understanding of product losses along the Kalimantan chain, generate interest in the proposed innovation, and identify appropriate private sector partners.

Some post-harvest research should also be conducted in the early stages of the intervention to understand the causes of fruit breakdown during transportation to Kalimantan. It may be that post-harvest losses could be reduced through changes in

variety, crop management, and/or harvesting practices. Research findings may therefore provide important insights into innovations that could complement improvements in packaging practices.

AIPD-Rural will need to work closely with a selected number of inter-island traders and one or two packaging material manufacturers. The project would facilitate linkages for the joint development of appropriate packaging solutions, fund product development costs, and subsidise the commercial piloting of new packaging prototypes by interisland traders (see Figure 15). When testing these prototypes in commercial transactions with Kalimantan buyers, the risk to pilot traders is that additional packaging costs may exceed savings from lower product losses. In order to compensate them for this risk, AIPD-Rural could pay for the cost of the packaging materials during a short trial phase. Experiences during these market trials could inform further refinement of packaging solutions.

The intervention will only succeed if participating traders change their packaging practices and others follow their example, an outcome known as crowding-in. This could be encouraged through a series of promotional workshops involving inter-island traders and packaging manufacturers. During these workshops, AIPD-Rural could facilitate discussion of the opportunities for replicating the experience for other fresh produce. Given that inter-island traders handle a diversified portfolio of fruits and vegetables, there may be scope for improving packaging practices for a range of products.



Figure 15 Improving packaging of tomatoes for the inter-island trade: service delivery model

4.5 Anticipating Market Scenarios for Better Planting Decisions

4.5.1 Rationale for intervention and impact logic

The study team was surprised by the extent to which tomato growers in Malang are influenced by recent market prices in their planting decisions. Farmers appear to be using prices at planting as an indicator of market conditions at harvest time. However, as discussed in section 2.4, this type of collective behaviour in a district that is an important supplier is self-defeating. By expanding planted area when prices are high, farmers end up creating a glut in tomato markets at harvest. Likewise, by reducing planted areas at times of low prices, farmers fail to take advantage of product scarcities and higher prices at harvest time.

Traders also appear to be at a loss when trying to make sense of short- and mediumterm market scenarios. Village traders purchase and sell tomatoes every day, and therefore have good access to spot price information. However, they seem unaware of intra-annual price patterns, i.e. the fact that tomato markets in East Java tend to follow two to four-month cycles, whereby a period of low prices is normally followed by a period of high prices. If they were more conscious of these patterns, they could advise the farmers they service to expand production when spot markets are depressed and to be more cautious in their planting decisions when prices are high. Village traders would have an incentive to do so based on an unwritten agreement to purchase all produce from regular suppliers even when it is not in their immediate interest i.e. when market prices are very low. These are the periods when vegetable traders earn very little (if any) money from a particular crop.

There is a case, therefore, for intervention by AIPD-Rural. The project could fund the transfer of market outlook assessment capacities to village traders and farmer extension groups. The purpose would be to enhance their ability to anticipate future market dynamics, an outcome that should result in better planting decisions and higher profits for both farmers and traders (see Figure 16).



Figure 16 Improved planting decisions: impact logic

Since tomato growers in Malang have a diversified vegetable portfolio, it makes sense to focus on different vegetable crops, not just tomato. Additionally, in order to increase the impact of the intervention, traders and producer groups in the neighbouring Batu district could also be targeted. Malang and Batu have similar production systems, with vegetable farmers growing tomato and various other vegetables throughout the year.

4.5.2 Intervention strategy and service delivery model

A provider of training services will need to be identified in the early stages of the intervention. Possible candidates include one of the universities in Malang or BPTP East Java. Because current staff lack in-depth knowledge about the marketing system for target crops, there would be a need to train the trainers and support the development of an appropriate curriculum.

The format of the training program will not be based on theoretical lectures. What is envisaged is practical sessions in each selected commune where facilitators would work with participants to review planting decisions for tomato and other vegetables, assess these in the context of intra-annual price patterns for the past three or four years, and identify better planting strategies for key vegetable crops. In the case of tomato, the evidence suggests that farmers would be better-off planting larger areas when prices are low and adopting the opposite strategy at times of high prices.

During the proposed training, participants should also have access to sources of information that can help them anticipate future supply scenarios. This could include the introduction of local chain actors in Malang and Batu to traders and extension staff in strategic locations for future information exchange. These sources could be

contacted by phone at planting times so that growers can form reasonable expectations of future supply scenarios and prices.

As shown in Figure 17, the role of AIPD-Rural would be to transfer critical knowledge and skills to trainers and fund the training programme. This could be implemented in four or five sub-districts of Malang and in Batu over a two-year period. The organisations and staff responsible for delivering the training would be well equipped to replicate the initiative in other parts of East Java after the intervention is phased out, but this would require new funding from government or development projects. It is unlikely that traders and farmers in East Java will be able or willing to cover service delivery costs.



Figure 17 Transferring market outlook development capacities: service delivery model

4.6 Development of Protected Vegetable Cropping

4.6.1 Rationale for intervention and impact logic

Tomato farmers in Malang and other districts of East Java are constrained in their choices of farm technologies and management practices by finance and technical knowledge. Addressing the financial constraints that vegetable growers face is a challenging proposition. However, AIPD-Rural could play an important role in exposing a large numbers of tomato farmers to crop management practices that can have significant positive impacts on farm productivity and profitability.

Protected cropping during the hot rainy season, using low-cost, locally available materials, is a particularly promising innovation. Recent ACIAR-funded research in Leyte, the Philippines, has shown that investment in low-cost structures is financially viable, although the returns on the investment are influenced by the choice of crops (Armenia *et al*, 2013). A simple roof cover can significantly increase the productivity of a wide range of vegetables, including tomatoes, by offering protection against extreme rain, wind, and associated diseases, including bacterial wilt. Netting shields the crop

against insects. By reducing the need for fungicides and pesticides, greenhouse technology has significant positive impacts on the environment and the health of farm workers and consumers.

4.6.2 Intervention strategy and service delivery model

Large seed companies could be targeted for the establishment of trial and demonstration structures in different sites and delivery of technical advisory services to village traders and farmers (see Figure 18). This would offer opportunities for promoting their varieties. Successful development of protected vegetable farming at scale would also increase overall demand for vegetable seed by enabling an expansion of cultivated areas, especially during the rainy season. East West is the largest supplier of hybrid vegetable seed in Indonesia and may therefore be particularly interested in partnering with AIPD-Rural for the piloting and promotion of protected vegetable cropping. In 2012 and 2013, the company cooperated with the Private Sector Investment Programme, an initiative funded by the Dutch Government, to distribute net houses to 400 tomato and pepper farm households in two district of East Java: Jember and Banyuwangi (East West Seed, 2012). It appears that a highly subsidised, supply-driven approach was followed.



Figure 18 Development of protected vegetable farming: service delivery model

A different intervention strategy, focused on the design of affordable structures, wide crop portfolios, and the transfer of technical know-how for effective management of protected crops, is recommended. While such approach requires considerable technical expertise and an extended piloting period, it is necessary for sustainable and scalable impacts. An emphasis on affordability, diversified crop options, and appropriate crop management practices is critical for the profitability of protected farming, the single most important determinant of future uptake of the technology.

The involvement of village traders and farmers from the early intervention stages is important to generate interest in the innovation and ensure that affordability is explicitly accounted for in the design of protective structures. The choice of structure will also have implications regarding crop selection, plant protection and irrigation management, which need to be considered (see, for example, Gonzaga *et al*, 2013). Strong input from researchers and economists throughout the whole intervention cycle will be needed for designing low-cost but effective structures, identifying the most profitable crop portfolios, and developing appropriate farm management protocols. Data from control farms in open fields will need to be collected for proper technical and economic evaluation of pilot technologies.

Recent experience in the Philippines suggests that individual growers outperform farmer groups. Some of the groups that invested in protected structures, perhaps with subsidies from government, failed because of difficulties in equitable sharing of responsibilities and rewards (Armenia *et al*, 2013). Hence, while farmer groups can be targeted in the context of technology transfer interventions, it appears that individual adopters are more likely to succeed.

It is recommended that Malang and perhaps Batu are initially targeted. If successful, the initiative could be scaled-out to other major vegetable production districts in East Java, as well as East Lombok.

5 Some Conclusions and Areas for Future Research

5.1 Poverty

Tomato is an important source of income for many vegetable farm households in Malang. These households can generally be classified as resource-poor. Most have one hectare or less under a rotation of different vegetables. These farms are a major source (often the most important source) of household income. Vegetable farm households are not income-poor, however. Tomato and other vegetables are high-value crops. The levels of investment and risk associated with the production of these crops are beyond the capacity of very poor households. On the other hand, it should be noted that many vegetable growers in Malang were once poor. For them, gradual diversification into vegetable cultivation enabled them to move up the income ladder.

Tomato farms are also an important source of wage income. Tomato is a very labourintensive crop, and most of the labour input is provided by casual farm workers, not members of the farm household. These workers are amongst the poorest actors in the tomato chain. Most have marginal or no landholdings. Casual farm work is critical for their livelihood.

Farm households in Malang operate in a land-scarce context. The opportunities for increasing agricultural income through expansion of cultivated areas are very limited. In order to improve income, farm households will need to develop more productive (profitable) farm businesses. This can be achieved through a reduction in production costs per unit of output, higher prices for current crops, or diversification to more profitable crops.

The chain interventions identified in this study target the first and second outcomes. Opportunities for spreading the impacts of proposed innovations beyond Malang district and the tomato chain should be actively pursued. For example, village traders and farmer groups in Batu could be targeted as part of the proposed market outlook assessment training, which could also cover several vegetable crops, not just tomatoes. Kediri could (and should) be targeted in the context of interventions supporting the development of local markets for grafted seedlings. Packaging innovation processes in inter-island tomato chains could be adapted to other fresh produce chains, not only in Malang and Batu, but also in other AIPD-Rural project areas.

Finally, it should be noted that all proposed interventions are relatively neutral in their employment effects, with the exception of protected cropping, which could lead to an expansion of cultivated areas for labour-intensive vegetables during the rainy season. In addition, the development of grafted seedling production would increase employment in the commercial nursery sector, although the overall impact should be relatively small.

5.2 Gender

Both men and women participate actively in the tomato chain. Nursery and tomato farms are usually managed by men, whereas women are more involved as wage labour. Men control most local trading enterprises, but women have a stronger presence in the traditional retail trade. The chain interventions proposed in this study are largely neutral in their gender effects. Still, women are likely to be employed in the production of grafted tomato seedlings, while an expansion in vegetable farming during the rainy season due to adoption of protected cropping technologies would have greater impacts on the employment of women than men.

5.3 Environment and Human Health

As in the case of other vegetable crops, the spraying of chemicals for control of pests and diseases constitutes the main environmental (and human health) issue in the tomato sub-sector. Large amounts of fungicides and insecticides are applied on tomato farms. Impacts on the health of farmers and farm workers are a particularly serious issue, as very little personal protective equipment is utilised. Men are responsible for spraying the crop and so they are the most affected.

It is also possible that consumers may be affected by high levels of chemical residues in the tomato fruit. This is a major barrier to export development. Effective marketbased solutions for chemical residue problems in vegetable crops require strong leadership in businesses working closely with farmers to meet food safety standards for premium export and domestic market segments. Some examples were identified and described in this report, but the number of farmers involved is very small. In Indonesia, the regulatory and market incentives for development of safe food chains are currently weak.

The need for pesticides can be drastically reduced through adoption of greenhouse technology, one of the possible areas for intervention identified in this study. Another strategy is to develop locally appropriate, integrated pest and disease management solutions that are affordable and more cost-effective than current practices. This is a long and arduous task, and one that would require a strong input from researchers. Localised action-research would be essential for assessments of pests and diseases in the context of the whole production system, not just for individual crops, and for testing and refining different control practices. Success in one area would not necessarily be replicable in other areas due to differences in local agro-climatic conditions and production systems. Such an approach is not recommended for AIPD-Rural because it does not fit with its private-sector focus. However, it is appropriate for the mandate and work of ACIAR.

5.4 Areas for Future Research

Pests and diseases are a strategic area for research and intervention. The potential impact of improved pest and disease management systems on the income of vegetable farmers, the environment, and human health cannot be overemphasised. This study identified grafted tomato seedlings as a possible, environmentally-benign solution for controlling tomato wilt disease, and one where there is a clear role for the private

sector, but the technical, financial, and market feasibility of the technology in East Java still needs to be validated through pilot interventions. Likewise, greenhouse technology can significantly reduce agro-chemical use, but action-research is needed to test the technical and financial performance of different structure design and management options across a variety of local production systems.

Post-harvest losses along tomato and other vegetable chains are another critical area for research due to their potential negative impacts on farm-gate and consumer prices. Such research should focus on the inter-island trade, as physical and quality losses along these chains are often very high. Reducing these losses would establish new opportunities for inter-island trade, benefiting both producers and consumers. This is the focus of one of the interventions proposed. This study identified post-harvest losses during transportation from East Java to Kalimantan as a major issue and improved packaging technology as one possible solution. However, further research is needed to quantify losses along the whole chain, determine the causes of fruit breakdown, and assess the technical and financial feasibility of different innovations with chain actors.

Knowledge of regional export markets for tomato and other vegetables is very limited. Yet, export development has a clear strategic relevance in view of its potential impacts on technology adoption, quality upgrading processes, farmer incomes, and employment. Countries with a competitive tomato processing sector could be the subject of case study research to better understand potential technologies and business models for a country such as Indonesia.

The development of a local tomato processing industry would reduce short-term price instability and create some employment opportunities, especially for women, but research is needed to support private sector investments. The development of cold storage would also have a stabilising effect on prices and create favourable conditions for the development of long-distance trade and exports. Storing tomato and other vegetables under cool conditions is technically complex. Effects on the quality and market acceptability for different crops and varieties need to be determined before the financial feasibility of different storage models can be assessed.

One interesting contract farming experience involving a Taiwanese firm exporting peas to Taiwan was identified during the study. Some companies have developed forward contracts with farmers in Eastern Indonesia and other regions for the production of chilli and potato. These and other contract farming experiences in the Indonesian vegetable sector should be the subject of future research. There are certainly lessons to be learned by government, the private sector, and projects targeting agribusiness firms as agents of pro-poor innovation, such as AIPD-Rural.

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7 Annexes

Annex 1: Fieldwork schedule

Dates	Location	Purpose
26-30 November 2012	Batu and Malang	Visit to one assembly market and interviews with staff from Dinas Pertanian in Batu, input shop owners, staff from one pesticide company, farmers, managers from vegetable production and trading enterprises, village traders, wholesalers, and retailers
3-4 December	Kediri	Interviews with two seed companies, one nursery operator, and two wholesalers
7-9 December	Surabaya	Interviews with wholesalers in Keputran market, retailers in Wonokromo market, supermarket managers and the Director of one safe vegetables' commercial farm
19-22 December	Malang	Interviews with farmers and village traders
4-6 June 2013	Kediri	Interviews with nursery farm operators
17-20 June 2013	Malang	Interviews with staff from BTPT Malang, extension officers, one researcher, nursery operators, farmers and village traders
15 July	Malang	Interviews with village traders
16 July	Sidoarjo and Surabaya	Interviews with traders in one assembly market and three retail markets
11-12 October	Batu and Malang	Interviews with inter-island traders

Annex 2: Checklists

Input Sup	opliers: seed and chemical companies, input retailers, nurseries
1. Background information	 Location/address/contact No. and location of field staff (if seed or agro-chemical company) Product portfolio Other background information
2. Seedling production (nurseries)	 Product portfolio Scale of production Seasonality in seedling production Technologies employed Varieties grown (w/ indication of their advantages and disadvantages) Employment of male and female labour
3. Technical know- how	 Knowledge of tomato cultivation and post-harvest technologies Sources of technical information and knowledge about tomato Knowledge gaps
4. Environment and human health	 Environmental and human safety issues associated with agro-chemical use Are farmers aware of these issues? Are these issues discussed with farmers?
5. Input sales	 Location of buyers Inputs sold to tomato growers Gaps in product portfolio and reasons Importance of tomato growers as clients Main barriers to an increase in sales to tomato growers Strategies to increase sales
6. Linkages with suppliers	 From whom does the input supplier buy inputs from? 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 (w/ranking) Opportunities for increasing sales to tomato growers Does the key informant see any opportunities for collaboration with a development project intervening in the tomato sub-sector? If yes, what are the opportunities for collaboration?

Farmers (Focus Group Discussions)		
1. Background	Village / district	
information	 Number of households living in the village 	
2. Socio-economic	 Ranking of crops in terms of area and income 	
importance of	 Importance of livestock 	
tomatoes	 Ranking of household income sources (farm and non-farm) 	
	 Contribution of tomato to household income 	
	 How typical or atypical is the village as far as the socio-economic importance of tomato is concerned? 	
3. Tomato development processes	 Timeline of tomato production and marketing development in the village; comparison w/ other villages 	
4. Typology of	 Approximate % of households in the village that grow tomato 	
tomato growers	Typical farm size and range	
5. Tomato production	 Tomato varieties grown in the village, ranking of varieties, and differences with other villages in the area 	
systems	 Reasons behind varietal choices 	
	 Planting and harvesting times 	
	 Irrigation, fertilization, disease and pest control, other cultivation practices 	
	 Harvest and post-harvest practices 	
	 Hiring of labour 	
	 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	 Gender division of labour within the household 	
(production)	 Gender composition of hired labour 	
	 Gender roles in input purchases and product sales 	
7. Environment	 Key environmental issues in tomato cultivation 	
and human safety	 On-farm use of chemicals; storage and handling of agro-chemicals 	
8. Input purchases	Input suppliers (profile and location)	
	 No. of input dealers and nurseries in the area 	
	 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 and their relative importance	

	 Number of tomato collectors/buyers in the area
	 Stability in farmer-buyer relationship
	 Forms of payment (advance payment, on the spot, delayed payments)
	 Services provided by collectors and other buyers (inputs, credit,)
	 Information flows between farmers and buyers (technical/market)
	 Strengths and weaknesses in the relationship with buyers
10.Product quality	 Quality standards of buyers
	 Who sorts and grades the tomato crop?
	 Farmers' awareness and assessment of the quality of their tomato
11.Prices	 Price trends (farm-gate) and expectations about future prices
	 Price seasonality (farm-gate)
	 Price differences between different varieties, grades, and qualities
	 Price determination processes (negotiation, competition between buyers)
12.Sources of	 Main sources of technical information (ranking and gender differences)
technical information	 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	 Main sources of market information (ranking and gender differences)
market information	 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	 Key problems and constraints (production and marketing)
opportunities	 Key opportunities (production and marketing)
	 Barriers to access to these opportunities
	 Recommendations for intervention: what type of interventions would enable farmers to improve tomato production and marketing? Please prioritize

Village Traders		
1. Background information	Location/address/contact	
	 Number of years trading tomatoes 	
2. Tomato sales	 Tons of tomato traded per day/month/annum (last 3 years) 	
	 Distribution of sales within the year and changes over the past 3 years 	
	 Challenges and strategies to increase tomato sales 	
3. Linkages with	 Villages from where the trader procures tomato 	
suppliers	 Number of tomato farmers supplying the trader 	
	 Does the trader buy from the same farmers in different years? 	
	 Services provided 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 	
4. Linkages with	 Main buyers, their profile (location, legal status, scale) 	
buyers	 Changes in the last 3 years and reasons 	
	 Stability in the relationship with buyers 	
	 Services provided by buyers (e.g. advances) 	
	 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 	
5. Quality	 Quality grades and standards applied by the trader and buyers 	
management systems	 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 	
6. Sources of	 Main sources of information about tomato markets (ranking) 	
market information	 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 	
7. Gender	 Gender of suppliers Gender of collectors and accombly traders 	
	Genuer or collectors and assembly traders	

	Gender of buyers
8. Prices	 Current purchasing and selling prices
	 Price trends, expectations about future prices, and reasons
	 Differences in the prices paid by different buyers
	 Price seasonality
	 Current tomato purchasing and selling prices for different varieties and grades
9. Costs	 Main marketing costs (variable and fixed)
	 Costs per ton sold
10.Constraints,	 Opportunities for the development of the tomato collection business
opportunities	 Strategies and barriers to develop or access these opportunities
and interventions	 Key challenges and constraints (w/prioritization)
(wrap-up)	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 tomato 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	
	 Number of years trading tomatoes 	
2. Tomato sales	I ons of tomato traded 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 tomato sales	
3. Varieties	 Varieties traded 	
	 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 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	 Type and profile of suppliers, and relative importance 	
suppliers	 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	 Main buyers: location, legal status, and scale 	
buyers	 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	 Quality grades and standards of the trader and buyers 	
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management systems	 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	 Trader's assessment of his/her access to information about tomato markets 	
market	 Main sources of information about tomato markets 	
information	 Assessment of different sources of market information (regularity, type of information, and reliability of the information) 	
	 Gaps in market know-how 	
9. Prices	 Current purchasing and selling prices (different varieties, different grades) 	
	 Tomato price trends for different varieties, and reasons 	
	 Are there any clear differences in the prices paid by different buyers? 	
	 Price seasonality 	
10.Costs	 Main costs to the wholesaler (variable and fixed) 	
	 Costs per ton sold 	
11.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 	
12.Constraints,	 Key opportunities for the development of the tomato trading business 	
opportunities	 Barriers to develop or access these opportunities 	
interventions	 Strategies to develop or access these opportunities 	
(wrap-up)	 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 tomato 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? 	

Traditional Retailers											
1. Background information	Location/address/contact										
2. Tomato sales	Quantity of tomato sold per week/month/yearSeasonality in tomato sales										
3. 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 										
4. Quality management systems	 Quality grades and standards at the retail end Typical quantitative and qualitative product losses at the retail end 										
5. Gender	Gender of traditional retailers										
6. Prices	 Price differences between varieties and grades, and reasons Price seasonality, and reasons Current tomato purchasing and selling prices (different varieties, different grades) 										
7. 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 vegetables 									
2. Tomato sales	 Weekly / monthly / annual tomato sales Tends in tomato sales (last 3 years) Seasonality in tomato sales 									
3. Linkages with domestic suppliers	 Origin of tomatoes sold, and reasons Who supplies tomatoes to the retailer? Requirements to become a registered supplier Number and profile of suppliers (location, scale, legal status, etc.) Stability/changes in the supplier portfolio Terms of the contract with tomato 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 tomato chain 									
5. Prices	 Price differences across varieties and grades Seasonality of tomato prices 									
6. 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 tomato Does the supermarket see any opportunities for collaboration with a development project intervening in the tomato sub-sector? If yes, what should be the focus of the collaboration? 									

Annex 3: Structured format for collection of farm gross margin data

Crop :	Farmer:
Variety :	Villlage:
Season :	Subdistrict
Hectares:	District

Primary Crop

Secondary Crop

									Price/U		
No	Component	Unit	Measurement	Price/ Unit		Value (Rp)	Unit	Measurement	nit	Value (Rp)	
А	Production Cost										
	1.Material Costs										
	a. Seed : var:		kg			-				-	
	- var:					-				-	
	- var:					-				-	
	b. Fertilizer					-				-	
	Phonska (NPK 15-15-15 slow)					-				-	
	Mutiara (NPK 16:16:16 fast release)					-				-	
	SP-36					-				-	
	Urea					-				-	
	ZA (Amm. Sulphate)					-				-	
	Dolomite					-				-	
	КСІ					-				-	
	Manure (Compost)					-				-	
	c. Pesticide :					-				-	
	Agromex					-				-	
	Pegasus					-				-	
	Endure					-				-	
	Arjuna					-				-	
	Lanete					-				-	

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Prefaton			-			-	
Supermex			-			-	
Taldin			-			-	
Abacyper			-			-	
Decis - 0,5 ltr.			-			-	
Fastax			-			-	
Kanon 40 EC			-				
d Europicide :			-			-	
			-			-	
Tyson			-			-	
Pion M			-			-	
Dithana			-			-	
			-			_	
Unisep			-			_	
Score							
Mancozeb			-			-	
Marshall			-			-	
			-			-	
e. Catalisator (Spreader/sticker) :			-			-	
-			-			-	
f. Herbicide :			-			-	
- Round Up/Gramaxone			-			-	
- Goal			-			-	
- Prowl			-			-	
			-			-	
g. Plant support :			-			-	
- Bamboo stake			-			-	
-String			-			-	

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- Plastic Mulch						-					-	
-Basket/Pail						-					-	
-Nails for hanging						-					-	
		Labour (D	ays						Labour (Days	abour (Days		
		Family			Price	Value	Fa	mily	Hire		Price	Value
	М	F	М	F	per day	(Rp)	М	F	М	F	per day	(Rp)
3. Labour Costs												
a. Land preparation						0						0
b. Nursery : -						0						0
c. Planting : -						0						0
d. Fertilizing						0						0
e. Weeding						0						0
f. Stick (plant holder)						0						0
g. Spraying						0						0
h. Irrigation						0						0
i. Harvesting						0						0
j. Cleaning						0						0
k. Handling (grading)						0						0
I. Drying						0						0
m. Transporting						0						0
n. Packaging						0						0
n. Other :						0						0
4. Other costs :												
- Land rents						0						0

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					-		 _	
	- Loans			0			0	
	- Taxes			0			0	
	- Water Contribution			0			0	
	Total 1 Production Costs 1 + 2 + 3 + 4 + 5							
В	Return and Profit							
	1. Yield							
	- Main product							
	- Secondary product							
	2. Production Cost							
	3. Net Income							