DETERMINANTS OF MANGO FARMER CHOICES OF MODERN VS TRADITIONAL MARKET CHANNEL AND FARM TECHNOLOGY INTENSIFICATION IN JAVA INDONESIA

By

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

Agricultural Food, and Resource Economics-Master of Science

2014

ABSTRACT

DETERMINANTS OF MANGO FARMER CHOICES OF MODERN VS TRADITIONAL MARKET CHANNEL AND FARM TECHNOLOGY INTENSIFICATION IN JAVA INDONESIA

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This paper discusses the determinants of mango farmer participations in modern market channel and the determinants of sprayer trader use by mango farmer in Indonesia. The paper also analyzes the impact of modern market participation and sprayer trader use to the outputs, inputs use and adoption of technology done by mango farmers. The paper uses bi-probit regression for the first stage model and Zellner's Seemingly Unrelated Regression (SUR) for the second stage model. Primary data were collected in 2011 from direct interview with 416 mango farmers spread in 36 villages in Java Island (East and West Java), Indonesia. Important results suggest that: (1) participation in modern market channel and the use of sprayer trader are not determined by farm size, thus support "inclusion" of small farmers in modern channel; (2) non-land assets are important determinants of modern market channel participation and sprayer trader use by mango farmers; (3) the use of sprayer trader has insignificant effect on the probability of mango farmers to participate in modern market channel. However these two equations are endogenous; (4) household participation in the modern market channel only affects, and positively, to adoption of growth hormones.

This work is dedicated to Neya, Mas Ari, Ibu dan Bapak, Papah dan Mamah

ACKNOWLEDGEMENTS

I thank Dr. Thomas Reardon, my major professor, for his continued support and encouragement. I also thank to the members of my committee, Dr. Songqing Jin and Dr. John Kerr. I would like to thank Rie. Ben, Debbie Conway, and Linda Beck for their assistant on technical support.

This thesis is an outcome from an MSU research project funded by Assets and Market Access Collaborative Research Support Program (AMA CRSP) from USAID.

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Chapter 1: Introduction

1.1 Overview

Nationally, mango is an important fruit in Indonesia. More than 99% of its production goes to the domestic market and less than 1% is exported (Table 1). The Indonesia National Survey and Census (Susenas) shows that domestic mango consumption has been increasing by 18% annually. It was only 0.37 kg/capita/year in 2007 but 0.63 kg/capita/year in 2011. This is faster than for other fruits (which increased by 15% annually) and for rice (as main staple food) which increased by less than 1% annually. Our key informants managing fresh produce sections of modern retail stores, noted to us that demand for mangoes increased 10%-20% annually in the past 5 years.

This rapid increased of mango consumption demand has been it appears a key driver in structural change in market systems for mango, in mango production technologies (with a shift from traditional low input "extensive" production to labor- and chemical- intensive production), and even in the agricultural services market supplying farmers with "sprayer-trader" (ST) services. The traditional mango supply chain ("many hands", small scale, little variety diversification beyond the "commodity" variety Harumanis (and a handful of home-consumed local niche varieties), local coverage of the market, and sales only to traditional retail) appears, from the evidence in this study, to have gradually changed into a semi-transformed supply chain – with "intermediationally shortened" supply chains (with the elimination of certain marketing segments up to direct purchase from suppliers by midstream or downstream players), an increase in scale of actors and transactions, a diversification of varieties into commercial niche varieties, and a spatially wider market coverage (interisland and to cities), serving more varied market channels (specialized wholesaler, processor, hotel and restaurant, exporter, modern retail).

The need to respond to growing urban demand appears to be a reason for the changes in production practices, commercialization, and variety diversification. The traditional production practices with no or little chemical use has gradually changed to the use of chemical inputs, such as fertilizer and pesticides, to boost yields. To extend production over the year and thus sell at higher prices, farmers have adopted growth hormone to induce flowering so that fruit can be borne beyond the normal season.

The increasing demand for mangoes appears also as the reason for the emergence on Java (as it has in the Philippines) of the agricultural service of "sprayer-traders". A sprayer-trader (ST) runs an enterprise (with one or more persons) that prunes and sprays trees for orchard owners, and usually also markets the fruit. The ST usually has some kind of contract agreement with each owner to prepare land and care for trees (sprays, prunes, fertilizes), may also harvest, and markets mangoes. Lack of technical expertise, equipment, time, and/or finances to manage the production and marketing aspects of their mango farms, are hypothesized to be the reasons why some farmers collaborate with or outsource from STs for their mango farming and marketing. This has been studied (but not published on) in the Philippines, but this thesis is the first study of this in Indonesia.

In Indonesia, there have been some studies on mango production and post-harvest issues related to (the tiny market niche of) mango export (Soemarno et al., 2009; Anugrah 2009; Almuhaesimi, 2012 and others). There has been some analysis on the impact of government programs in the mango sector, such as seedling giveaways (Hartanti, 2010), which we show is a very minor phenomenon "on the ground," despite figuring large in the policy discussions. There have also been a few studies on mango distribution and market integration in Indonesia (Munthe, 1998; Sulistyowati, 1998; Herlambang 2005). However, there has been relatively little recent

study, and is thus a major gap in research, concerning whether and how there has been a transformation in mango marketing by farmers (with the differentiation of market channels), mango production (with a shift from extensification to intensification), and changes in the agricultural services sector attending mango production. There has also been no work assessing the determinants of farmer participation in these changes (such as a function of assets).

1.2 Research Questions

This thesis focuses on four research questions: (1) What determines mango farmer participation in modern market channels? (2) What determines mango farmer use of STs? (3) Are mango farmers' participation in modern markets and mango farmers' use of sprayer-traders related? (4) What are the technological (especially "intensification") implications of modern markets and ST choices: does the use of ST and market modernization spur technological change in mango farming, in particular with respect to the input use levels of labor, fertilizer, pesticides, and adoption of growth hormones?

The first, the second, and the third research questions cover the determinants of participation (hence inclusion or exclusion) of small farmers in the restructured market channels that relate to micro assets needed to meet the requirements of the restructured markets, and "meso assets" and conditions (such as infrastructure) that affect that participation.

1.3 Hypotheses

This thesis tests whether household assets and zone characteristics are key determinants of inclusion in modern market channels and in the process of technological intensification, as well as use of ST services. It is expected that farm size, physical assets, and non-physical assets

like education determine modern market participation. Total mango trees owned are a proxy for wealth and farm size (given tree densities differ a lot over farms). I expect that as total mango trees owned increases: (1) farm households have higher wealth; (2) with higher wealth there is a reduction of the degree of risk aversion of the farmer, (3) with less risk aversion, farmers are more willing to adopt new market channel opportunities; (4) moreover, more wealth means greater direct or indirect access to cash, which could, if credit markets are even partially idiosyncratically failing, determine investments in the technologies and commercial practices needed for modern markets.

It is also expected that zone characteristics will affect modern market participation. Farmers located in zones with better infrastructure and more concentrated mango areas are more likely to participate in modern channels.

It is expected that farm size, and physical and non-physical assets determine ST use by farmers. The effect of these variables is hypothesized to have a mixed impact. For farmers with few mango trees, an ST can link to them to the market without the farmers needing to take the time, access a vehicle, or learn about the market. But also a very small orchard can mean that the farmer has time to tend his own trees. For farmers with many trees, the farmer may feel less need of an ST's help to access technology and markets. But that large farmer might also feel labor-constrained and want help that is also skilled; that need might be magnified if he has off-farm employment squeezing his time.

Zones characteristics are expected to have mixed effects on ST use. Farmers located in zones with better infrastructure (near to market) are more likely to use STs as "farming managers or assistants" because quality or quantity demands of markets exceed the farmers' own time or skills. But having good access to markets due to better roads may reduce the farmers' need of an

ST with a vehicle and perhaps handling a number of farmers at once and thus having his own economies of scale.

It is expected that use of an ST will be positively related to modern market participation as the ST may fill gaps in the farmers' technical expertise, equipment, time, and/or finances to manage the production and marketing aspects of mango farming and trading.

The adoption of the modern market channel is expected to spur intensification of input use – irrigation and pesticides and fertilizer for fruit quality and quantity; hormones for stretched seasonality; labor for quality control and extra pruning for fruit quality. It is possible that modern markets could cause a reduction in pesticide use on the fruit if buyers require that.

The paper proceeds as follow. Section 2 discusses the sampling, zones, survey, and data. Section 3 presents descriptive statistics. Section 4 presents general model, implementation model, econometric model, and econometric results. Section 5 concludes.

Chapter 2: Data, Sampling Framework, and Survey Instrument

2.1 Data

Primary and secondary data were collected to get detailed information on activities, behavior, and performance of mango farmers in two provinces. The survey was done in July-August 2011, just before the mango season in 2011. Primary data were collected from direct interviews with 416 mango farmers spread over 36 villages on Java (East and West Java). After data cleaning, 404 observations remained for analysis.

Relevant documents published by formal institutions (from Dept. of Agriculture, Central Statistics Bureau, and Local Government Agricultural Offices) provided secondary data. Data on populations of mango farmers and mango trees in each village in East Java and West Java were drawn from the Agricultural Census held in 2003. These data were used as the main source to develop the sampling frame for this study.

2.2 Sampling Framework

In this study, the sample was chosen using a multistage stratified random sampling procedure. This method was used to ensure that all parts of the population are represented in the sample. There were 5 stages in the selection of the sample.

2.2.1 Province Level Selection:

The study focuses on Java, which has three-quarters of the mango production (volume) of Indonesia. East Java and West Java were chosen as representative provinces because mango production from these two provinces was 62% of total national mango production (BPS, 2008). Those two provinces are generally thought to be the areas with the most dynamic development of

mango farming. We also thought that these provinces would have a lot of variation over farms n terms of size and market access, and over zones, so that there would be enough variation of situations and farms to test the hypotheses presented above.

2.2.2 District Level Selection

Two districts in each province were purposively chosen to generate sample variation. The "commercialization level" was used to determine the districts. This is defined here as how important and developed the mango sector is in an area. This is proxied by mango volume. Based on a review of secondary data and interviews with key informants (extension officers, government staff, farmers, traders), the selected districts were Probolinggo and Pasuruan, in East Java; and Cirebon and Majalengka, in West Java.

2.2.2.1 Probolinggo, East Java

Probolinggo is the foremost (in volume) production area in East Java (Dept. of Agriculture, 2004-2008) and has been so since the 1970s. The most common varieties planted and traded in Probolinggo are: Harumanis, as the bulk commodity variety; Golek and Manalagi as commercial niche varieties; and Podang, and Lalijiwo as local niche varieties. Probolinggo is located in the northern part of East Java, near the Madura strait. Mango grows well in this area since Probolinggo is a lowland area (0 to 600 m altitude), with a warm temperature range from 24-30 C, and high humidity. These traits are considered ideal for growing mango.

Probolinggo is located on the main inter-island route that connects not only the west and east parts of East Java, but also connects Java and Bali. Being in a busy route makes Probolinggo the center of mango trading in East Java. This access is believed (by the key informants) to cause Probolinggo to be recognized as the main mango market destination for the surrounding areas, mainly from Pasuruan. Apart from being distributed locally (to Surabaya, Malang, and Kediri),

mangoes from Probolinggo are also distributed to other major cities in other provinces such as Jakarta and Bandung (West Java) and Semarang (Central Java). Interisland trading to Bali (across the sea to the west of East Java) and to Kalimantan (across the sea north of East Java) started in the early 2000s. A very small amount of mango exporting also started at that time.

The combination of a good agroclimatic setting and access to big cities and other islands makes Probolinggo an area of concentration for big mango traders and the lead mango marketing area in East Java.

2.2.2.2 Pasuruan, East Java

Pasuruan is also well known as one of the main mango production areas in East Java, rivalling Probolinggo. It produces a high volume of mango sent daily during harvest season to Probolinggo to be marketed into the domestic trade routes. Pasuruan is in a lowland area with average temperatures ranging around 24-32 C, with high humidity. It also is considered as an ideal place for growing mangoes. The main mango varieties there were Harumanis and Gadung.

Pasuruan is located on the main road that connects major cities in East Java. It is 65 kilometers southeast of Surabaya (the capital city of East Java). Although Pasuruan is nearer to Surabaya (as a main consumption area), key informants said that most producers send their mangoes to traders in Probolinggo. This may be because the traders in Probolinggo have close access to buyers in Surabaya (modern retail, hotel/restaurant, etc.).

2.2.2.3 Cirebon, West Java

Cirebon is listed as among the top six production areas in West Java in 2004-2008 (Dept. of Agriculture, 2004-2008). It is mainly flat land, 24-30 C temperature range, and high humidity, all ideal for mangoes. Although currently Cirebon is not the first ranked production area in West Java according to the Dept. of Agriculture statistics, 10 years ago Cirebon it was indeed the

volume leader. But what traders told us leads to a different view than these official statistics suggest. Key informants (traders from Cirebon and Majalengka) said that 5 tons of mangoes are traded per day in Cirebon (reaching 30 tons per day in the peak season); they said they believe that this is the highest traded volume among production areas in West Java. Mango varieties that are commonly found in Cirebon are Harumanis (as the commodity), the commercial niches Gedong and Cengkir/Dermayu and Manalagi, and the local niche variety Kidang.

Cirebon is located in the east part of West Java, adjacent to Central Java to the East and Java Ocean in the North. It is located on the main road that connects West Java and East Java. This access enables mangoes to be marketed to Semarang and Surabaya, two big cities in Central and East Java. A highway that directly connects Cirebon to Jakarta (the capital of Indonesia) also enables mangoes from Cirebon to be sold easily to Jakarta. Cirebon has an important (and longstanding) harbor that enables mangoes to be traded to other islands such as Kalimantan and Sulawesi.

2.2.2.4 Majalengka, West Java

Majalengka is listed as the leading mango production area in West Java (Dept. of Agriculture, 2004-2008). The lowland areas have 24-30 C temperature ranges and high humidity like the other main mango areas. Mango varieties that are commonly found in this area are the commodity Harumanis, then the commercial niche varieties (Gedong, Cengkir/Dermayu, Manalagi) and some local varieties, Bapang, and Kidang. Majalengka covers mountains, hills, and lowland areas. The Northern part of Majalengka is the main mango production area because most of it is lowland (as mango does not grow well in cold areas, that is, in hills and mountains). Sometimes mango is planted in paddy fields (as mixed cropping).

Majalengka is located on the main inter-cities route that connects several important cities in West Java. This enables mango from Majalengka to be widely traded to other cities, for example Bandung (the capital city of West Java) and Jakarta. Mango also moves from this area to other islands: for example, a key informant (a mango collector in Majalengka) said that he supplies mango to a big trader in Cirebon to be sent to Kalimantan. Moreover, mango is retailed along the inter-cities road.

2.2.3 Sub-district Level Selection

The total number of mango trees and the distance from the sub-district to the main road were used as bases of stratification for the sub-district selection. The total number of trees and distance were used as proxies for market and infrastructure. To maximize variation over sample households, we selected three sub-districts in each district using following steps.

First, the total numbers of trees in each sub-district were calculated based on the data that we got from the agricultural census in 2003 done by the Indonesia Statistical Bureau (BPS). The agricultural census is held once every 10 years; thus the data in 2003 are the most recent that are accessible.

Second, each sub-district was ranked from the least to the most trees (in the sub-district) and divided into three categories (small, medium, high) in ascending number of mango trees. The distance to the main road (province road) for each sub-district was also ranked and divided into 3 categories (far, moderate, near). Distance to province road is used because it has a similar quality of road to that of the municipal roads, and thus we control for road quality. Then a composite method was used by adding the indexes (in number of trees and distance to province road) to count the composite effect from both variables. A higher value means more trees and closer to the main road.

Third, then the values in second step were ranked and divided into 3 categories: sub-districts with total score 2 (means few trees and poor infrastructure), sub-districts with score ranges from 3 to 5 (means combination of many trees and poor infrastructure or few trees and good infrastructure), and sub-districts with perfect score 6 (means many trees and good infrastructure). From the second category (sub-districts with score ranges from 3 to 5), I chose the "many trees but poor roads" because there were too few mango farmers to sample in the "few trees good roads" areas. Then from each category, a sub-district was randomly chosen.

2.2.4 Village Level Selection

Four villages from each sub-district were randomly chosen assuming that the stratification in sub-district level was already accommodating our need for variation.

For household level selection, stratification on farm size was made based on the number of trees owned per household. Marginal farmers (in Indonesian parlance often called "backyard farmers") have 4-10 trees; small farmers have 11-100; and medium farmers have more than 100 trees.

I constructed the shares of each size class by the size stratum's share in the total number of trees in the areas of the provinces (not the share of that size class in the total mango farmer population). Our sampling is thus: (1) 40% "marginal" farmers who represent 40% of the trees population based on the census (BPS census in 2003), even though they constitute around 80% of the mango farmer population; 40% from the "small" stratum; a stratum that has 40% of the trees in the overall mango tree population, and 20% of the actual farmer population); and 20% from the medium stratum, which has only less than 1% of the farmer population but 20% of the tree population in the census. Note that roughly 60% of the trees are grown by 21% of the mango farmer population; this manifest concentration runs counter to the prevailing conventional

wisdom in national policy circles that holds that nearly all mangoes come from tiny farms. This composition was similar in West Java and East Java.

2.3 Survey Instrument

The survey instrument consisted of a structured questionnaire by which we collected information about household and farm characteristics, behavior, and assets. 2009, 2005, and 2004 were the reference years that were used to count the current and the lagged condition. 2009 was used as the "current" year instead of 2010 because in 2010 most mango trees (in the survey area) produced very low volumes due to too much rain causing flowering failure. 2005 was used as the lag year because mango trees need at least 5 years to start producing; thus actions in 2005 are most likely to affect conditions in 2009.

The content of the household questionnaire (sent under separate cover, due to its large size, to the committee) is as follows: Brief history on the start-up of mango farming; Land inventory (mango and non-mango) in 2004-2009; Adoption and dis-adoption of variety from the initial planting to 2009; Arrangement between household and Sprayer Trader (ST) for plot/s maintained by ST in 2009 and 2005; Mango production in the three largest plots in 2009 and 2005; Technology adoption and quasi-fixed mango related equipment in 2009 and 2005; Market channel (choices and characteristics) and transaction costs in 2009 and 2005; Participation in organizations, training, and extension in 2009, 2005, and 2004; Household characteristics in 2009, 2005, and 2004; Migration in 2009, 2005, and 2004; Household income and other assets in 2009, 2005, and 2004.

Chapter 3: Descriptive Statistics Derived From the Survey Data

3.1 Stratifications Used in the Descriptive Analysis

The tables annex contains two types of descriptive tables; each of the latter comes in two variants, based on stratification of the sample. “Tables X.b” are based on farm size stratification, classified by the number of mango trees per household. Marginal farmers (in Indonesian parlance often called “backyard farmers”) have 4-10 trees; small farmers have 11-100; and medium farmers have more than 100 trees. I use number of trees rather than land area because tree densities can differ a lot over farms.

“Tables X.a” are based on market channel stratification, between traditional and modern market channels, as follows. The traditional market channel is defined as a farm household who sells mangoes locally (within the area where the mangoes are produced), to: **Final consumers** (in the local production area); **Local commissioners** (a broker who gets a commission from a transaction but he/she does not take possession of the product and the transaction is usually of a small volume); **Local collector** (local wholesaler who buys and sells mango locally and takes possession of the product); **Small wholesaler** (person who buys mango from production areas and sells the products directly to traditional retailers or small fruit stores (in small volumes) in consumption areas); **Large commissioner at the wholesale level** (broker who gets commissions from transactions but he/she does not take possession of the product and he/she handles large volume transactions typically, and usually supplies various markets in production areas); **Large wholesaler in production area**; **Large commissioner in wholesale market in production area**; **Large commissioner in wholesale market in big cities in production provinces** (e.g., commissioner in Caringin-Bandung); **Traditional retailer**.

The “modern channel” is defined as farm households who sell to modern market channel (and can also sell to the traditional channel) as a first buyer (the buyer to whom the farmer sold directly) or indicated by the farmer as the second buyer (the agent that bought the mangos from the indicated first buyer, thus indicating the type of channel). Farm households that are considered as modern are households who sell to: **Large wholesaler in a wholesale market in production area**; **Large wholesaler in a wholesale market in production province level** (apart from Jakarta and Surabaya); **Large wholesaler in wholesale market in Jakarta** (e.g., wholesaler in Kramat Jati); **Large wholesaler in wholesale market in Surabaya** (e.g., wholesaler in Gedongdoro-Surabaya); **Large wholesaler in wholesale market in East Jav**a; **Specialized/dedicated wholesaler** who supply supermarket (eg: Bimandiri); **Processor**; **Hotel and restaurant**; **Exporter**; and **Modern retailer**.

There were 157 respondents (39% overall sample) who were in the modern market category and 247 respondents (61% overall sample) who were in the traditional channel.

3.2 Descriptive Results

Table 3.1.A. shows human and social/organizational assets of the households by market channel and stratification**.** The salient points are as follows.

First, the membership rate of mango farmers in cooperatives or farmer groups, in general or specialized in mango, is minor. In 2009, only 18% of all households were in any cooperative or other farmers’ organization, similar for those in both strata. But the shares of households in mango cooperatives/associations was very tiny: the shares in row 3.1.2 are of the total of farmers in any association that are in mango associations per se; hence overall, 13% * 18% of the farmers

are in mango associations, only 2% (with a slight difference between modern market households with 4% and traditional channel households with 1%).

Second, households in the modern market channel are significantly distinguishable in terms of access to networks related to inputs, knowledge/information on mango farming, and product markets. Compared with traditional channel farmers, they had more friends/relatives which were input sellers, extension agents, wholesalers in the traditional market, wholesalers in the modern market, and processors.

Table 3.1.B. shows human and social/organizational assets of the households by farm size stratification. The salient points are as follows.

First, medium farmers are significantly different in terms of organizational membership, and networks that may facilitate access to inputs, to knowledge/information on mango farming, and to product markets. A stunning 43% of medium farmers are members of cooperatives or farmer organizations while only 15% of small farmers and 6% of marginal farmers are members of cooperatives or farmer organization. Medium farmers are much more (and marginal farmers the least) apt to have relatives or friends who sell inputs, work as extension agents, or work as mango wholesalers in the traditional and modern market channels.

Second, government programs on free seedlings, subsidized fertilizers, mango farming related equipment, and training (e.g. field school) are very biased towards medium farmers. This is an important finding. In our key informant discussions with the government, over and over the government emphasized how important government aid in seedlings has been to start the mango farming and upgrade technology (like giving away hormones). But set 5 of the lines in the table show a very different reality. Only 3% of the farmers got seedlings from the government, and that varied from 3 to 2 to 8% from smallest to largest farm stratum; for hormones, only 1% of the

farmers got this from the government, ever. For fertilizer, that was 2%, pesticides, 0.5%, yellow trap (integrated pest management), 0%, pheromones, 1%, a sprayer, 1%, loan, 1%, irrigation equipment, 3%. The numbers were even lower in 2005. The table does show that a quarter of households (with very strong correlation with orchard size) received field mango school training from the government, and only on production techniques (nothing on post-harvest techniques); that share was a fifth in 2005. **The government played only a very limited direct role in mango system change.**

Table 3.2.A. shows non-mango physical assets of mango farmers by market channel stratum. It shows several interesting points as follows. Households in both channels in their great majority (70% and 78%) have other types of farm income, like rice production. This shows that they are not "specialized" in mango; but interestingly, both for traditional and for modern, 20-30% are specialized. That is intriguing especially in the unexpected case of the traditional channel farmers.

Looking down at Table 3.2.B for this same variable, we find that even among very small orchard owners (the marginal), a striking 35% of them do not have other non-mango farm income (while for large farmers, only 15% do not). This means that even large mango farmers are not specialized in mango. But it is also fascinating that the specialization rate actually climbs from 15 to 28 to 35% as one descends in farm size strata – unexpectedly. One asks, how can a very small mango farm support a family? The answer, it does not, can be seen from the other income sources; 62% of marginal and small growers have off-farm employment, 15% of marginal have pensions. Lines 1.9 and 1.10 show that the nonfarm income is substantial over all the strata. Table 3.3A reconfirms that only about half the farms own only mango plots; specialization is not strong.

Table 3.3.A. shows mango farm characteristics in 2009 by market channel. The results here are important for the literature. Line 7 shows that modern market households own nearly 3 times more mango land than the traditional channel households – 1.3 vs 0.5 ha. Interestingly, the same ratio holds for overall land (mango plus non-mango land), as the modern channel farmers have about 2.7 ha and the traditional farmers, only 0.7. This adds a point to the literature regarding whether farm size affects modern channel participation.

Table 3.3.B, using farm size stratification as the perspective, shows that there is really a striking difference in mango orchard size over farm strata – a 20-fold difference from the tiny marginal farmers' orchards (a tenth of a ha, literally "backyard") to only 0.7 ha for small, to nearly 2 ha of mangoes for the medium farmers. This is why we find that while the majority of mango farmers in terms of numbers are "marginal", the lion's share of total mango land is farmed by the medium farmers, a finding very surprising to the Indonesian context.

As an aside, the results also show that the modern channel farmers are less specialized, at least in land use. Table 3.3.A shows that as much as 52% of their land is under non-mangoes, while for the traditional farmer, only 34% of their land is under non-mango. While the overall land size point reconfirmed our hypothesis, the fact that modern farmers are less specialized at least on their farms, is surprising. But these small farms are clearly both commercialized (sell mango, buy food) as well as diversified in overall incomes, with off-farm income. Table 3.3.B shows that even tiny marginal farmers have very small overall farms, still only 0.3 ha; the medium farmers have 2.4 ha overall, still not "large" farmers; but also they are much more specialized: the medium have only 20% of their overall farmland under non-mango, while the small farmers have half under non-mango and the marginal, 65% under non-mango.

Second, locations of mango farms are mostly in the same village as where the households live. However, households in the modern channel are more apt to live in a different village from their plots but in the same sub-district. For those who have mango farms in a different village, they most likely face higher transaction costs, in terms of transportation costs, supervision costs, or harvest collecting costs.

Third, very importantly as a contribution here, households in the modern channel have more trees compared to small and marginal farms. The table also shows that households in the modern channel (as measured in 2009) have more trees on average compared to households in the traditional channel both in 2003 (when the census was conducted) and in the initial planting years (on average, households plant mango trees initially 21 years ago**). This is an indicator that farm size (proxied by number of trees) is more likely to correlate with the probability of modern channel participation**.

Fourth, there is significant variety[1] diversification among the strata, but with some differences over strata. Households in the modern channel are significantly distinguishable in

[1] Harumanis is a variety with green skin, weighs 300 grams each (on average), and has a sweet taste. Gedong gincu has the most appealing outer appearance with yellow reddish skin, weighing 200-250 grams each, and having a mix of sweet and sour taste, most likely more favored by consumers in West Java. Gadung is a modification of Harumanis. It has almost the same outer characteristics as Harumanis, but it tastes sweeter. It is more favored by consumers in East Java. Cengkir/Dermayu has a green skin outer look, 300-350 grams each, with sweet starchy taste, and is mostly planted in Cirebon. Manalagi has green skin, 200 grams each, and a sweet taste. It has a unique characteristic because it already tastes sweet even when the fruit is

terms of share of plots under commercial niche varieties planted on their mango farms. Households in the modern channel have a higher share of Gedong gincu and a lower share of (local) "other" varieties (which are traditional and less commercialized varieties). Apart from the statistical significances, the table shows that overall, for the whole sample, the most prevalent (in terms of plots) is the (bulk commodity variety) Harumanis, followed by "commercial niche" diversification varieties (Gedong gincu, Gadung, Cengkir/Dermayu, Manalagi, Madu), then the smallest share is "other" varieties, which are the local mainly home-consumed varieties. Households in the modern channel also have that same composition in terms of the plot-numbers ranking of the three categories. By contrast, households in the traditional channel have the share of "other, local" varieties ranked in the second after Harumanis; this is a major finding because it shows that diversification of varieties commercially, and market channel, are linked.

Table 3.3.B. shows mango farm characteristics in 2009 by farm size**.** The result shows some interesting points.

First, there is a rapid change in terms of farm size between 2003 and 2009. In 2009, the number of trees owned by small mango was 35% more than in 2003 (when the census was done). For medium farmers, the number of trees owned in 2009 was more than twice the number those households had in 2003. But marginal farmers had almost 50% fewer trees than in 2003. One possible reason for the latter is that many marginal farmers transformed into small mango farmers in 2009 (Table 3.3.C. confirms this). The mean number of trees owned by the average marginal farm in 2003 is six, and there were 187 households within this category. Meanwhile,

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unripe. Madu has green skin, weighs 150-200 grams each, and has the sweetest taste, and is the newest variety compared with those above.

the mean of trees owned by marginal farmers in 2009 was 4 trees per household (just enough to categorize them as mango farmers) and there were only 34 households in this category by 2009.

Second, medium farmers have a higher share of plots under commercial-niche varieties compared to the small and marginal farmers (indicated by the higher share of plots under Gedong Gincu, Madu, and Cengkir). Interestingly, marginal farmers also diversify their mango holdings, just somewhat less than the medium farmers. Apart from Harumanis, they also had Manalagi, Cengkir, and even Gadung and Gedong on their farms.

Table 3.3.C. shows the comparison of number of households in 2003 and 2009 by farm size stratum, and thus investment and disinvestment in trees. Interesting results are as follows.

The number of medium farmer in 2009 is 60% higher than the number of medium farmer in 2003. The number of small farmers in 2009 is 72% higher than the number of small farmer in 2003. Strikingly, the number of marginal farmer in 2009 is 82% lower than the number of marginal farmers in 2003. There appears to have been a large shift of marginal farmers into small farmers. Comparing the farm size stratification in 2003 and 2009, only 7% of marginal farmers in 2003 continued as marginal farmers in 2009; 37% of marginal farmers in 2003 shifted to be small farmers in 2009. Few small or medium farmers changed categories over the period. An interesting question then arises on what causing the major shift of marginal farmers in 2003 to 2009. Further discussion on this issue will be addressed below.

Table 3.4.A. shows investment in mango trees by market channel stratum. Interesting results are as follows.

First, households in the modern channel plant a lot more after the start year: 38% of households in the modern channel added trees between the initial planting year to 2009, compared with only 26% of traditional channel farmers.

Second, most households added Harumanis (36% in the modern and 27% in the traditional channel) and also the commercial niche varieties; modern channel farmers tended to add Gedong Gincu, Manalagi, then Cengkir/Dermayu, while households in the traditional channel added Gadung, Gedong Gincu, and Cengkir/dermayu. Surprisingly, not just modern but also traditional farmers diversified into the commercial niche varieties.

Third, households in the modern channel are statistically different in terms of the source of mango seedlings that they use. Most of them (61%) get seedlings from private nurseries (versus only 24% for households in the traditional channel), 15% by grafting from own trees (13% for households in the traditional channel), and 10% from government (26% for households in the traditional channel).

Fourth, in terms of time of adoption, most households add more trees mainly in the past five years (46%) and there is no significant difference in the mean of two groups (47% for households in the modern channel and 45% for households in the traditional channel). This means that major dynamic changes occurred in 2005 to 2009 regardless of what the market channels are.

Table 3.4.B. shows tree investment by farm size strata. Several important findings are as follows.

First, medium farm households are significantly different in terms of adopting or adding more mango trees onto their farms. 52% of medium farms add trees during the initial planting year to 2009. This number is higher than for small farms (29%) and marginal farms (12%).

Second, in terms of the mango variety of the trees added, there were almost no statistical differences among the farm strata. Medium and small most added Harumanis, and then both second ranked added the commercial niche varieties. The smaller farmers were in fact a bit

more likely to add the niche varieties than were the medium farmers, showing again that diversification is shared over farm size strata, a surprising finding.

Third, contrary to the conventional wisdom (in policy circles) claiming that government programs are important for giving out free mango seedlings, the great majority of farmers get seedlings from private nurseries. Our findings also show that the government seedling giveaway program is biased toward medium farmers (37% of medium farmers and 10% small farmers get seedlings for free from the government, excluding the marginal farmers).

Overall, findings in Table 3.3 and Table 3.4 suggest that major changes have occurred in the past five years before the survey recall year (2005-2009) in terms of farm size (shift of marginal farmers into small farmers) and the diversification of varieties. Beside the demand side "pull," what factors might have driven these changes. One reason might be the effect of government programs; in policy discussions, those are usually looked to as the possible reasons for changes. We find here that it is possible that such programs have effects, but are unlikely to be the major drivers.

A case in point is the government program called the "Program for Integrated Horticulture Development in Upland Areas" (IHDUA) launched in 1998-2002. It was funded by OECF 477 LOAN and Japan Bank International. West Java was part of the mango development zone which is focused in Indramayu, Cirebon, and Majalengka for the development of the new variety Gedong Gincu. That program may have played some role in diversification at least into Gedong Gincu for several reasons. (1) Table 3.4.C. on investment in mango trees by province shows that most tree investment in the past five years (before the survey) happened in West Java, while that investment in East Java occurred mosty more than 10 years ago. (2) Table 3.4.C. also shows that apart from Harumanis, another variety that increased rapidly is Gedong gincu.

These two findings seem related to the IHDUA project, but there are several things that attenuate the importance of this link. (1) Gedong gincu is not a government-bred variety nor available only through projects. (2) The IHDUA projects promoted variety diffusion by handing out seedlings, but the total number of these seedlings was only 0.6% of the total of mango trees in those three districts, thus a tiny effect especially in a perennials context. (3) The IHDUA project was in 1998-2002, hence 7-11 years before the survey; that would have showed up in the data as Gedong adoption prior to the "5 years before the survey" when in fact we find the intensive Gedong adoption. (4) Table 3.4.A., 3.4.B., and 3.4.C. show that the person who suggested the households to add mango trees on their farms were friends and relatives. Most of the households who added mango trees in the past five years bought the seedlings from private breeder.

From these facts, I conclude that the major shift is in fact not directly caused by IHDUA project, although this, and a few other smaller scale projects, might have spurred diversification, at the margin. Rather, it appears that private nurseries might have been a major vector of diffusion of this variety. That has been little explored in research or the literature and deserves more attention.

Table 3.5.A. shows technology use and adoption by mango farmers by market channel**.** Several important findings are as follows.

First, at odds with the conventional wisdom from key informants that "mango is grown with traditional technology, with little use of external inputs" it is found that external input use is widespread. 43% of households in the modern channel farmers and amazingly, even 19% of households in the traditional market use growth hormones for their trees. Other farmers, STs, and

private extension agents are statistically significant in introducing the use of growth hormones to the households.

When we started this work, in government and research circles we were told “mango farmers are traditional, they use no fertilizer.” But we found 73% of households in the modern market channel and even 67% of households in the traditional channel apply fertilizer (compost/manure/foliar) to their trees. Again, government extension has a very minor role: farmers noted that in fact it was “other farmers” who introduced the idea of fertilizers for mango trees to them. As interesting, it is statistically significant that households in the modern market channel were introduced to fertilizer application by STs.

Pesticides are also widely used in mango farming. 52% of households in the modern channel and 30% of households in the traditional channel apply pesticides to their mango trees. Other farmers and STs are claimed to be the ones who introduce fertilizer application to households.

Second, households in the modern market channel are statistically distinguishable in terms of non-land assets owned. Very important to the literature is that households in the modern channel have a higher share of owning sprayer (manual sprayer or power sprayer) and truck or other vehicles.

Table 3.5.B. shows technology use and adoption by mango farmers by farm size. Several important findings are as follows.

First, it is found that external input use was widespread among all farm size strata. For growth hormones (to extend the season): 28% of mango farmers used it, with some farm size bias, but less than I expected: 63% of medium farmers, 25% of small farmers, and 3% of marginal farmers. For chemical fertilizer: 69% of mango farmers used it in 2009; 92% of

medium farmers, 67% of small farmers, and 56% of marginal farmers. For pesticides: 39% used pesticides, with some farm size bias, but less than expected: 79% of medium, 36% of small farmers, and 6% of medium farmers.

Second, the government extension agent's role is minor in introducing the technology and affecting farmer's decision on inputs use adoption. Most farmers claim that they were introduced to the new technology (in input use) mostly by other fellow farmers, or by STs.

Table 3.6.A. shows output produced and inputs used aggregated over all seasons in 2009 by market channel. Several important findings are as follows.

First, households in the modern market channel statistically significantly have higher total production and higher yield in 2009 compared to the households in the traditional channel.

Second, overall input expenditures per tree in 2009 in households in the modern channel are not statistically different from the households in the traditional channel; however, the input composition (and thus technology) differed between them. Households in the modern channel spent more on fertilizer, pesticides, and family labor, but spent less for hired labor compared to the households in the traditional market. From field observation, high shares of households in the modern channel sell their mangoes graded. Since they sell their mango after harvest, they need to watch their trees for thievery (often happen in a mango orchard located in remote area, away from housing). Instead of hiring someone else, they do it by themselves; thus the family labor is relatively high for the households in the modern channel.

Table 3.6.B shows output produced and inputs used by mango farmers stratified by market channel. Some important findings are as follows.

First, total production in 2009 for medium farmers is statistically higher than for the small and marginal farmers; this makes sense since medium farmers have more trees. Small

farmers have the highest yield compared to medium and marginal farmers but it is not statistically significant.

Second, the input-output ratio (total variable cost per tree divided by the yield) in marginal farms on average is much lower than in small and medium farms. For marginal farmers, $0.04 of variable costs is needed to produce one kilogram of mango. This is almost ten times smaller than the small and medium farmers who need almost $0.5 variable cost to produce one kilogram of mango. It shows that marginal farmers are more efficient in terms of production cost compared to the small and medium.

Table 3.7.A. shows contract arrangements between STs and mango farmers in 2009 by market channel. The salient points are as follows.

In 2009, the use of ST is small (just emerging). However, a greater share of modern market farms engage with STs compared to the households in the traditional market. Households use ST because they think the ST has more financial capital, better knowledge in mango farming, and also because the household has other demands on its labor (off farm employment).

Table 3.7.B. shows contract arrangements between ST and mango farmers in 2009 by farm size. The salient points are as follows.

First, medium farmers are more likely to have arrangement with ST compared to small and marginal farmers. Surprisingly, none of the marginal farmer engages with STs. This is not as seen in the field when I did questionnaire testing. This fact is also contradicted with findings in ST survey which was also conducted in the same time and location as this household survey. The most possible explanation is that this ST-mango farmer arrangement is relatively new and just emerging (very small) thus it cannot be captured by random sample.

Second, better capital, better access to information and market, and better knowledge in mango farming are some reasons for farmers to have arrangement with STs. Interestingly, 29% of respondents say that they have too many mango trees to handle, thus they use STs to tend their mango trees.

Third, since ST and household contracts are relatively new and just emerging, it is important to know how this arrangement works. STs are usually the ones who come to the household and offer a contract to household. The arrangement is made before the tree flowers. The duration of the contract is 3 years on average. Most households (85% over all respondents who made arrangement with ST in 2009) receive a fixed amount from STs. A few households (15%) receive a share on percentage basis and mostly paid by cash in the same day of the agreement. The value of the contract is mainly based on the total number of trees that a household has. On average, the value of the contract is $12 per tree (for 3 years, since the average duration of contract is 3 years). Most of the time the ST is fully responsible for paying the production cost after the contract is agreed. In a few cases, households and STs share the production cost (the latter happens only when household and ST have a percentage basis arrangement).

Apart from the emerging ST, there is also a mere trader who contracts mango trees from mango farmers (the local terms for this man usually called "*Penebas*"). *Penebas* works almost the same as ST but the main difference lies on the agricultural practices on the mango trees done by ST (*Penebas* usually do not do agricultural practices on trees they contracted).

Table 3.8.A. shows types of selling and prices received by mango farmers in 2009. Some salient results are as follows.

First, the most common type of selling is "*tebasan*" (48% of all farmers). *Tebasan* is a type of selling in which farmers sell their mangoes before harvest and the price of selling is for all mango trees that the household has. Households in the traditional channel statistically significantly have a higher rate of using this type of selling (51%) compared to households in the modern channel (44%). Some respondents (marginal and medium farmers) said that they prefer this type of selling in order to avoid the burden of harvest expenditures (and also tree/field watching). During the peak season, mangoes can be harvested once in two days or at least twice in a week (for approximately a month). They said that they do not have time to do it often but they also do not want to lose the opportunity to get income from the tree. The medium farmers (who have old-tall mango trees) said that harvesting mango is not easy. They need an expert who can climb and pick the mangoes that are often hard to reach. Knowing the risk (of falling and dying), their wages are expensive ($4 to $5/hour, while the average wages for agricultural labor is around $2/hour). By *tebasan*, the buyer will be responsible for all harvest related expenses (labor, transport, and boxes).

Second, for farmers who use per tree selling, the average price that is received by farmers for each tree in 2009 is $26. Households in the modern market receive a higher price ($31/tree/season) than households in the traditional channel ($21/tree/season). For *tebasan*, the price per tree received by farmers is ten dollars higher compared to per tree selling. Households in the modern channel still receive higher price per tree ($42) compared to the households in the traditional channel ($32). For farmers who use "per Kg" selling type, the share of households in the modern channel who sorted their mangoes is higher than the households in the traditional channel and they receive higher price mango per kg. If I assume that the yield of a mango tree is

100 kg/year, using the average price per tree in *tebasan*, it can be calculated that price per kg for *tebasan* is around $0.36 ($36/100kg), the same as the price for sorted mango grade 3.

Table 3.8.B shows type of selling and prices received by mango farmers in 2009 by farm size. Some salient results are as follows. First, most of medium farmers sell their mango per kg (72%), then by *tebasan* (25%), and per tree (3%). On the contrary, small and marginal farmers sell their mango mostly using "*tebasan*". Second, the share of medium farmers who sorted their mango is higher than the share of small farmers. The price for unsorted mango (Harumanis) per kg for medium farmers is higher than the price received by small farmers ($0.6/kg and $0.4/kg respectively). For the sorted mango, the price for grade A mango is higher for the medium farmers compared to the small farmers.

Chapter 4: Theoretical Model, Econometric Specification, Estimation Methods, and Regression Results

4.1 Theoretical and General Implementation Models

The key features of the model are that market access is not uniform because households may face different transactions costs to market participation (Omamo, 1998a, b; Key et al., 2000; Renkow et al., 2004). De Janvry et al. (1991) and Fafchamps (1992) show how transaction costs can drive the upper and lower bound of the given factor (such as labor) price band creating market failures. Sadoulet et al. (1995) suggests if there were market failures, then a non-separable household approach should be followed.

I use a household utility maximization framework to present the integrated model of household's decisions (production and consumption). The subsequent model follows a simple non-separable household model that classifies goods and factors in three categories; tradable which are not subject to a credit constraint (TNC), tradable subject to a credit constraint (TC) and non-tradable. Also the two tradable categories (TC and TNC) compose the tradable (T) category. The household's problem model is written as follows:

$$\max_{c,q} u(c, z^h) \tag{4.1}$$

Subject to:

(i) $\sum_{i \in T} p_i(q_i - E_i - c_i) + S \geq 0$, cash constraint,

(ii) $\sum_{i \in TC} p_i(q_i - E_i - c_i) + K \geq 0$, credit constraint,

(iii) $g(q, z^q) = 0$, production technology,

(iv) $p_i = \bar{p}_i, \ \ i \in T,$ exogenous effective market price for tradable,

(v) $q_i + \ E_i = \ c_i, \quad i \in NT$ equilibrium conditions for nontradables,

Where:

q>0 represents goods produced, including food and cash crops,

q<0 represents factors used including labor and purchased factors,

c represents goods consumed, including food and purchased goods,

E is the household initial endowment,

S is net transfers received, including remittances,

K is access to credit,

$\bar{p}_i$ is the vector of exogenous effective market prices,

z^h is the vector of household characteristic and

z^q is the vector of fixed production factors and farm characteristics (fixed capital, farm size).

From the maximization problem and constraints stated above I can then write the following Lagrangian equation:

$$L = \ u(c, z^h) + \ \lambda \left[\sum_{i \in T} p_i (\, q_i - E_i - c_i) + S\right] + \eta \left[\sum_{i \in TC} p_i (\, q_i - E_i - c_i) + K \right] + \ \emptyset \ g(q, z^q) + \ \sum_{i \in NT} \mu_i (\, q_i - E_i - c_i) \qquad (4.2)$$

The three types of goods then are treated symmetrically in the solution of the model by defining endogenous decision prices p^*as follows:

$$p_i{}^* = \ \bar{p}_i, \quad i \ \in TNC \qquad `(4.3)$$

$$p_i{}^* = \ \bar{p}_i (1 + \ \lambda_c), \quad \lambda_c = \eta / \lambda \,, \ i \ \in TC \qquad `(4.4)$$

$$p_i^* = \mu_i / \lambda, \quad i \in NT \tag{4.5}$$

Then, after the manipulation of the first order conditions, the production decisions regarding all tradable and non-tradable are represented by a system of supply and factor demand functions in the decision prices (p^*) and quasi-fixed production assets (z^q):

$$q = q(p^*, z^q) \tag{4.6}$$

4.2 Implementation Model

A two-stage econometric model is specified. The first stage, the decision model, examines the market channel participation and the use of ST adoption decisions. The second stage is used to estimate the impact of adoption on output, inputs use, and technology adoption.

4.2.1 Market Channel Adoption

The result of the factor demand functions in equation 4.6 is used as the base of the market channel adoption model. According to Hernandez (2012), "Markets represent post-harvest technologies, then the decision to participate in markets is analogous to adoption of a technology" (p. 114).

For estimation I consider a fully reduced form of the model (Lopez, 1986). Since the decision prices p^* are functions of the exogenous farm gate prices ($\bar{p}$), the household characteristics z^q and z^h associated with production and consumption decisions, exogenous transfers (S) and credit (K), then the equation 4.5 can be rewritten as follows:

$$q = q(\bar{p}, z^q, z^h, S, K) \tag{4.6}$$

Sadoulet and de Janvry (1995) show that:

> One can estimate the demand for a subset of inputs or the supply function without having to deal with a full system. The distinguishing feature of these equations is that the production decisions depend on characteristics (z^h) of the consumption decisions, as opposed to what would be found in a pure producer model. (p. 179)

This model assumes that the adoption/selection process is made on a static portfolio of observable producer characteristic and does not consider imperfect and asymmetric information.

Thus, the general implementation model that is used in this study is as follows:

$$Modern\ market\ channel\ participation =$$

$$f\ (input\ and\ output\ prices, farm\ assets, human\ assets, non\ farm\ assets, community\ assets, exogenous\ transfer,\ access\ to\ credit) \quad (4.7)$$

Input and output prices map out directly from the vector of exogenous prices ($\bar{p}$) in our conceptual model. Exogenous output prices map directly from the conceptual model and are implemented as the output price (p_q). Household assets that affect production (z^q) and consumption (z^h) decisions are divided into the following asset categories: (1) human assets; (2) farm assets; (3) nonfarm assets; and (4) community assets. Exogenous transfers (S) and access to credit (K) map directly from the conceptual framework.

Based on the conceptual and empirical models above, I construct the specific implementation model as follows:

Modern market channel participation =

f (*Number of adults in the HH, Dependency ratio in the HH, Education of the head of HH, lagged Number of mango trees owned, Irrigated mango orchard, Share of niche variety owned, Lag of value of nonfarm income, Has more than 100 trees and had lagged off farm income,*

Lagged own rice field, Lagged own truck/other vehicle, travel time from farm to province road, located in west java, located in concentration area, number of input supplier in village, existence of micro finance in village, lagged value of whether has relatives who work in the modern channel, HH use ST) (4.8)

I construct the regression specification which shows variables to be used in the estimation of each empirical model. For the dependent variable, **Modern market channel adoption**, I have a binary dependent variable that shows farmers' choice of market channel (modern markets =1, traditional markets= 0). The independent variables for market channel equation is chosen by the above conceptual and general implementation models and are as follows.

First**, vector of exogenous prices,** are proxied by**:** (1) travel time from the farm to the province road; the exogenous input prices should vary by the transaction costs that involve transporting the inputs from the manufacturer/distributor to the farm: therefore distance measures are appropriate. It is hypothesized that travel time has a negative sign; the longer time needed means higher input prices faced by household, and the household would be less likely to participate in the modern market channel. Alene et al. (2008) shows that farmers far from the fertilizer markets supply less output than farmers living closer to these markets; (2) input supplier population: this variable is defined as the total number of input stores located in the same village as the household. It is expected to have a positive impact on modern market participation.

Second, **human capital assets**, are proxied by: (1) umber of adults (15 to 64 years old) in the household: I expect that more available household labor will increase the probability of participating in presumably more labor demanding market channels, the modern market; (2) dependency ratio in the household in 2009: I expect that the higher dependency will reduce the

probability of participation in the modern market because it would increase the burden on the productive labor; (3) education level of the head of household: The educational level of the household head is expected to be related to the analytical thinking capacity of the farmer. It is expected that those farmers with higher education levels will be able to collect and have a better understanding of production and marketing information so that they can customize their production and marketing systems according to the supply specifications set by modern marketing channels (Chicazunga et.al, 2008).

Third, **farm physical assets**, are proxied by: (1) Lagged total mango trees owned as proxy to wealth and farmers size. I expect that as total mango trees owned increases: farm households have higher wealth; with higher wealth there is a reduction of the degree of risk aversion of the farmer, with less risk aversion, farmers are more willing to adopt new market channel opportunities; (2) Lagged irrigation: This variable is defined as a binary variable that captures whether the household has (or does not have) irrigation in 2005. I hypothesize that irrigation should favor participation in the modern market channel, since it can allow farmers to have consistent supply and quality of mangoes; (3) Access to transportation means: This variable is defined as a binary variable and captures whether the farm household is equipped with transportation means. I would expect a positive effect on modern market channel participation, since it allows farmers to deliver their mangoes to the modern distribution centers, and they do not have to rely on alternative transportation; (4) Lagged rice farm: This variable is defined as a binary variable and captures whether the farm household owned rice farming land in 2005. This variable serves as proxy to wealth considering that in Indonesia, mainly in Java Island, 80% of farmers in Java do not have land anymore; they still depend on farm sector but they rent or just being farm labor on the land (Susenas, 2008). Moreover, for those who own a rice farm, the

average land holding is relatively small (0.3 ha/farmer). Thus someone who owns rice farm is considered as a rich person compared to others (and thus appropriate as proxy to wealth); (5) Share of commercial niche variety trees owned by household: It is expected that household who has high share of niche variety (Gedong gincu, Gadung, Cengkir/dermayu, Manalagi, and Madu) will participate more in the modern channel.

Fourth, **rural off-farm income** generating activities are used as a proxy for wealth and the availability of labor. This variable has an ambiguous expectation since on the one hand rural non-farm employment can help relax the household's credit constraint and allow for self-financing of farm assets and crop inputs (Reardon *et al.,* 2000) that will also allow for participation in a more demanding modern market channel. On the other hand, empirical evidence (Barrett, 2007) shows that as the share of rural non-farm employment on total household income increases, farm households shift away from agriculture and therefore from new market participation opportunities.

Fifth, **interaction between farm physical assets and nonfarm asset** is defined as the household having more than 100 mango trees (thus being medium farmers) and having nonfarm income in 2005. This variable is hypothesized to have mixed effects on modern market channel participation. The combination of a larger farm and a higher opportunity cost of time would result in limited time for farmers to be challenged by the time needed by the labor-demanding modern market. However, the combination of a larger farm and a higher opportunity cost of time may result in modern market participation, considering that the nonfarm income as source of liquidity to more advanced mango farming practices. With high quantity (from many trees) and quality (from advance mango cultural practice), it is more likely farmers will choose to participate in modern channel.

Sixth, **access to credit,** is proxied using the availability of micro finance at the village level. It is expected that this variable has positive effect to modern market participation.

Seventh, **shifters,** are proxied by: (1) Household location: this variable is defined as a binary variable and captures whether the farm household is located in West Java. I expect that a household that is located in West Java would tend to participate in the modern market more than household located in East Java because West Java is nearer to the capital city; (2) Concentration area: this variable is defined as a binary variable and captures whether the farm household located in mango concentration (cluster) area. I expect that a household that is located in a concentration area would tend to participate in the modern market channel more than household that is not located in concentration area; (3) Use of ST: this variable is defined as a binary variable - whether the household uses an ST for its mango farm. It is expected that the use of ST has positive impact on the modern market participation. The ST is expected to fill in the gap of lack of technical expertise, equipment, time, and/or finances to manage the production and marketing aspects of mango household.

Eight, **instrumental variable** that is used in the modern market channel participation equation is a binary variable concerning whether or not the farm household has relative/s that work in the modern market channel or participate in modern market channel in 2005 prior to accessing the modern market channel in 2009. I would expect this variable can have a positive effect on modern channel participation, as it can link farmers in terms of information or direct access to participate in a modern market channel. This variable serves as an instrumental variable because it is expected to correlate with the decision of participation in modern market, after controlling for other factors, but that is not correlated with the error terms (unobserved household characteristics).

4.2.2 Sprayer Trader Adoption

A general model of ST adoption is based on contract participation "adoption" drawing from the behavioral function used in technology adoption. Feder et al. (1985) found that this decision process can be modeled as a standard static adoption decision, and is determined by the incentives and capacities of the farmer. The decision of the farmer to participate in the contract (using ST) in a given period is assumed to be derived from the maximization of expected profit subject to land availability, labor availability, access to credit, access to market, and other constraints.

Patrick (2004) states that participation in a contract is a function of ownership of land, and physical, human, and community capital. Key and Runsten (1999) also discuss in their paper that scale of grower and the availability of access to credit have significant effect on determining the contract adoption between agro-processing firms and out- grower production. Da Silva (2009) and Esham (2006) found that non-farm income also significantly affects contract participation. Thus, the implementation model that will be used in this study is:

P = f (input and output prices, farm assets, nonfarm assets, community assets, exogenous transfer, access to credit) (4.9)

Where P is when household use ST.

Based on conceptual and empirical models above, I construct the specific implementation model for sprayer trader use as follows:

ST Use = f (*Number of adults in the HH, Dependency ratio in the HH, Education of the head of HHH, lag of Number of mango trees owned, Irrigated mango orchard, Share of niche variety owned, Lag of value of nonfarm income, Has more than 100 trees and had lag off farm income, Lag own rice field, Lag own truck/other vehicle, travel time*

from farm to province road, located in west java, located in concentration area, number of input supplier in village, existence of micro finance in village, lag Field school in village level). (4.10)

I construct the regression specification which shows variables to be used in the estimation of each empirical model. For the dependent variable, s**prayer trader adoption,** I have a binary dependent variable that shows farmers' choice of ST use (use ST =1, otherwise= 0). The independent variables in the ST use equation are chosen by the above conceptual and general implementation models and are as follows.

First, **vector of exogenous prices**, are proxied by: (1) Travel time from the farm to the province road: the exogenous input prices should vary by the transaction costs that involve transporting the inputs from the manufacturer/distributor to the farm, therefore distance measures are appropriate. It is hypothesized that travel time has positive sign in which the longer time needed means higher input prices faced by household. As a result, the household is likely to use ST; (2) Input supplier population at the village level: this variable is expected to have a negative relationship with the probability to use ST. the higher the population, the higher the probability for households to access inputs by their own, thus reducing the probability of households to depend on an ST.

Second, human capital assets, ara proxied by: (1) Years of education of the head of household: this variable has ambiguous expectations. More education would help the growers to be able to innovate and increase their production. However, with more education, the household's time reservation wage higher (and thus the grower may prefer off-farm employment); (2) Number of adults (15 to 64 years old) in the household: I expect that more available household labor will decrease the probability of contract/use ST, as there would

presumably be more labor available to work on mango farm; (3) Dependency ratio in the household: I expect that higher the dependency ratio, the greater the probability of use of an ST, as the higher ratio creates a relative lack of adult labor.

Third, **farm physical assets**, are proxied by: (1) Lagged total mango trees owned as a proxy of wealth and farm size. This variable also has ambiguous expectations. For farmers with few trees, the use of an ST can help them since the ST may link them to the market. For farmers with many trees less likely to use an ST because such large farmers may already have capital to access technology and the market. But many trees also mean a strain on the household labor resources and an inducement to seek help from an ST; (2) Lagged irrigation: This variable is a binary variable on whether the farm has irrigation in 2005; (3) Access to transportation means: This variable is defined as a binary variable and captures whether the farm household is equipped with transportation means. I would expect a negative effect on the use of ST as an ST might be counted on for his truck as a trader, beside other tasks; (4) Lagged rice farm: This variable is defined as a binary variable and captures whether the farm household has a rice farm in 2005. This variable serves as a proxy for wealth, as explained in the market channel section. It is expected that households who have rice farm less likely to use ST; (5) Share of commercial niche variety trees owned by household: it is expected to have a positive relationship with the use of ST. Our scoping study revealed that farmers see STs as having more technical knowledge of mango farming and have wider market information about the niche varieties.

Forth, **rural off-farm income** is used as proxy to nonfarm assets. It is expected that households who have rural nonfarm income is more likely to use ST due to the limited time to work on the farms and the opportunity cost of working in the off-farm sector.

Fifth, **interaction between farm physical assets and nonfarm income** is a variable defined as the farm having more than 100 trees (thus medium farmers) and having nonfarm income in 2005. This variable is hypothesized to positively relate with the use of ST.

Sixth, **access to credit** is proxied by the availability of micro finance at the village level. This variable may have a negative effect on the use of ST as it provides alternative credit sources to what may be a credit supply from the ST to the farmer.

Seventh, **shifters**, are proxied by: (1) Household location: this variable is defined as a binary variable and captures whether the farm household is located in West Java. I expect that a household that is located in West Java tends to use ST more than household located in East Java; (2) Concentration area: this variable is defined as a binary variable and captures whether the farm household located in mango concentration (cluster) area. I expect that a household that is located in concentration area tend to use ST more than household that is not located in concentration area.

Eight, as **instrumental variable** for the system equation, I used ***f***ield school at the village level in 2005. It is a binary variable and captures whether a field school is held in that village. This variable may influence the probability to use ST (negatively) but less likely to influence the modern market participation.

4.2.3 Outputs, Inputs, and Technology Adoption

The conceptual model for the farm decision that I used in this study is derived from Sadoulet and de Janvry (1995) as shown in model (4.6), as the model includes the farm input demands and output supply functions. The general implementation model also is similar to the one that I used in previous subsection. Feder et al. (1985) posit that the decision of the farmer in

a given period is derived from the maximization of expected profit subject to land availability, labor availability, access to credit, access to market, and other constraints. Thus, the general implementation models for input demands and output supply as follows:

$Q^S outputs = f$ *(input and output prices, farm assets, nonfarm assets, community assets, exogenous transfer, access to credit, risk)* (4.11)

$Q^D inputs = f$ *(input and output prices, farm assets, nonfarm assets, community assets, exogenous transfer, access to credit, risk)* (4.12)

I construct the specific implementation model for output and inputs demands as follows:

Output = f (*Number of adults in the HH, Dependency ratio in the HH, Education of the head of HHH, lag of number of mango trees owned, Irrigated mango orchard, Share of niche variety owned, Lag of value of nonfarm income, Has more than 100 trees and had lag off farm income, Lag own rice field, Lag own truck/other vehicle, Travel time from farm to province road, Located in west java, Located in concentration area, Number of input supplier in village, Existence of micro finance in village, Rainfall level, ST use, predicted value of modern market participation*) (4.13)

Input = f (*Number of adults in the HH, Dependency ratio in the HH, Education of the head of HHH, lag of number of mango trees owned, Irrigated mango orchard, Share of niche variety owned, Lag of value of nonfarm income, Has more than 100 trees and had lag off farm income, Lag own rice field, Lag own truck/other vehicle, Travel time from farm to province road, Located in west java, Located in concentration area, Number of input supplier in village, Existence of micro finance in village, Rainfall level, ST use, predicted value of modern market participation*) (4.14)

I construct the regression specific which shows variables to be used in the estimation of each empirical model. I estimated one output equation and four input demand equations as follows: (1) **Mango production** is defined as yield in kilograms for mango aggregated over all seasons in 2009; (2) Labor is represented as the **total expenditure in labor** (both hired and family) per tree for mango production aggregated over all seasons in 2009. For family labor we have calculated the imputed value of family labor by multiplying the amount of family days used in mango production by the average agricultural wage at the village level; (3) Fertilizers are represented as the **total fertilizer (both ground and foliar) per tree** used in mango production aggregated overall seasons in 2009 in kilograms; (4) Pesticides are represented as the total **expenditure on fungicides and insecticides per tree** for mango production aggregated over all seasons in 2009; (5) **Hormones** are represented by binary variables which indicate whether the household use this input in mango production in 2009.

Independent variables that are used in the equations are as follows. First, **vector of exogenous prices**, are proxied by: (1) Travel time from the farm to province road: the exogenous input prices should vary by the transaction costs that involve transporting the inputs from the manufacturer/distributor to the farm or transporting output to the market/buyer, therefore distance measures are appropriate. It is hypothesized that travel time has negative sign in which the longer time needed means higher input prices faced by the household and high transaction costs for output supply. This would affect negatively to the use of inputs and production of outputs; (2) Input supplier population in village level: this variable is expected to have positive relationship with the use of inputs and production of outputs. Transaction costs to buy inputs are expected to be smaller if the population of input suppliers in a village is higher. The competition

effect of many input suppliers may also lower the input price. These will encourage households to use more inputs, and increase outputs.

Second, **human capital assets**, are proxied by: (1) Years of education of the head of household: this variable has ambiguous expectations. More education may help the grower to innovate. However, with more education, the household's opportunity cost of time increases which may deter them from using labor for mango production; (2) Number of adults (15 to 64 years old) in the household: I expect that the more available household labor will decrease input demands, as presumably the more labor available to work on mango farm (labor-using compared to capital-using); (3) Dependency ratio in the household: I expect that a higher dependency ratio will decrease input demand, as presumably more labor is available to work on mango farm (labor-using compared to capital-using); (4) Participate in field school in 2005: is defined as binary variable to indicate whether or not the household participates in a field school. The field school is an extension program held by public (government) extension agents. It is usually held at a farmer's site and the topics discussions mainly consist of integrated pest management and technology introduction and application. This variable is expected to have a positive effect on input use and outputs produced. Households who participated in a field school are more likely to have more information on production practices and type of inputs; (5) HH participated in a farmer´s organization or cooperative in 2005: is defined as binary variable to indicate whether the household was a member of farmer´s organization or cooperative in 2005. It can be any kind of farmer´s organization or cooperative, not specific to mango. This variable is expected to have positive effect on input use because of the availability of credit and joint purchase of inputs (collective action to achieve economies of scale).

Third, **farm physical assets**, are proxied by: (1) Total mango trees owned as proxy to wealth and farmers size. This variable also has ambiguous expectations. The use of inputs and labor can be affected by economies of scale (up to some point, more trees will results in less inputs use per tree). However, for farmers with high density of mango trees, more input use is likely due to pest or disease attack, and higher probability of reducing the yield; (2) Own transportation means: I would expect a positive effect on inputs use because it can be use as source of liquidity, or lowering transaction cost when buy inputs (easier access to buy inputs); (3) Own rice farm: This variable is defined as a binary variable and captures whether the farm household has rice farm in 2009 and serves as proxy to wealth. It is expected to have a mixed impact. It may positively affect input use because it can be used as source of liquidity for financing the mango farm. But households who have rice farms may pay less attention to their mango farms, thus lowering the input use and lowering the outputs; (4) Land holding: This variable is defined as total metric squared of land owned (not just mango farm) by household in 2009. This variable serves as proxy to wealth.

Fourth, **value of rural nonfarm income in 2005**, is income generated from working outside the farm sector (e.g. civil servant, work in commerce/entrepreneurs (apart from mango), local manufacture labor, professional service-teacher). Income that is not generated through work is not considered as off-farm income (e.g. government aid, pension). This variable is expected to have mixed effects. Higher rural nonfarm income can be used for financing mango farm production thus increasing inputs use and increasing outputs. However, higher nonfarm income also may induce households to shift from farming and care less for their mango farms, thus reducing inputs use.

Fifth, **shifters** are proxied by: (1) Household location: this variable is defined as a binary variable and captures whether the farm household is located in West Java. I expect that households in West Java tend to use more inputs than in East Java. West Java has fewer mango trees compared to East Java. West Java is nearer the main consumption areas. Thus the need to intensify production is higher than in East Java, which leads to higher use of inputs; (2) Concentration area: This variable is expected to have mixed effects on inputs use. Being in concentration areas allows households to have more efficient of input use (due to economies of scale). However, being in concentration areas also has more exposure to pest and disease, thus increasing the use of inputs and lowering outputs; (3) Rainfall at village level: This variable is expected to have a positive impact on inputs use. Mango is vulnerable to rain and wind mainly at the flowering and fruiting stages. Rain makes the flowers fall and increases the possibilities of disease attack, thus increasing the use of pesticides. This variable is also used to satisfy exclusion restriction in the inputs equations because this variable is not in the first stage model; (4) The use of sprayer trader in 2009: This variable is expected to have positive impact on inputs use and outputs produced. Sprayer traders are believed to have more knowledge to intensify mango production thus increasing the possibility to use more inputs and increasing outputs.

Sixth, **modern market participation** is defined as fitted probability of households to participate in modern market channel. Fitted probability from the first stage results (Bi-probit) is used because participation in modern market is not an observed outcome variable and it is endogenous with the inputs use. This variable is expected to have positive effect on labor use because the modern channel requires more (relative to the traditional channel) labor-intensive cultural and harvest handling activities to ensure quality and consistency. It is also

expected to have positive effect on inputs use due to the same quality and consistency requirements to supply modern market.

4.3. Estimation Method

A system equation model is used in this study. A two-stage econometric model is specified. The first stage, the decision model, examines the market channel participation and the use of ST adoption decisions. The second stage is used to estimate the impact of adoption on output, inputs use, and technology adoption.

4.3.1. First Stage Model

A simultaneous equation model is used to model the market channel choice and the use of ST, since it is likely to have two way flow of influence. The adoption of the modern market channel is probably affected by the adoption of ST, or vice versa, which might lead to the correlation of the unobserved heterogeneities. Because the dependent variables from both equations are binary, a bi-probit regression is used in this study to estimate the equations in the system.

Alternative of using biprobit model is OLS regression. When used with a binary response variable, OLS regression model is known as a linear probability model and can be used as a way to describe conditional probabilities. However, according to Long (1997), the residuals from the linear probability model violate the normality of errors and homoscedasticity assumptions of OLS regression. Thus leads to invalid standard errors and hypothesis tests.

An alternative to using biprobit is a logit model. A Logit model provides empirical estimates of how changes in exogenous variables influence the probability of adoption of any technology. According to Long (1997), there are several drawbacks of a logit model: (1) As in

the case of an OLS model, the residuals in a logit model are heteroscedastic; (2) a large sample is needed; when using a small sample, the estimated results should be interpreted carefully; (3) there may be a multicollinearity problem.

Besides the shortcomings mentioned above, the chief difference between logit and probit is that logit has slightly flatter tails while the normal of probit curve approaches the axes more quickly that the logit curve (Vasisht, 2012). Based on the advantages compared to the alternatives, the probit model (bi-probit) is used in this study.

Because biprobit does not control for endogeneity, an IV for each equation is needed. A test is needed to prove the validity of an IV. A valid IV shall meet the requirement that covariance between the IV and the error term is zero but the covariance between the IV and the endogenous variable is not zero. This is determined by regressing the endogenous variable on the IV and other exogenous variables. For the IV in ST use equation, I use “whether or not field school training held in the village level in the lag year”. This variable affects ST use, but it does not have direct impact on modern market participation. The IV in modern market participation use is “number of relatives who supply in modern channel in the lag year”. This variable affects modern market participation but it does not have direct effect on the market channel equation. Both IVs were tested using statistics procedures as mentioned above and are proved as valid IVs.

The model was tested for multicollinearity, heteroscedasticity, and model specification. Heteroscedasticity was corrected for by making the standard errors robust. To check for multicollinearity, the VIFs for each independent variable were computed, and a VIF of more than 10 reflected the presence of multicollinearity. As the sampled strata weights do not match the true weights of those strata in the population, it was necessary to introduce a weighting procedure (WESML) to correct for sampling bias (Wooldridge, 2002).

4.3.2. Second Stage Model

The adoption process usually occurs simultaneously, as Feder, Just, and Zilberman (1985) state:

> In most cases, agricultural technologies are introduced in packages that include several components, for example, high yielding varieties (HYV), fertilizers, and corresponding land preparation practices. While the complements of a package may complement each other, some of them can be adopted independently. Thus farmers may face several distinct technological options. They may adopt the complete package of innovations introduced in the region or subsets of the package. In this case, several adoption and diffusion processes may occur simultaneously. (p. 257)

Thus the model that is used in this study is estimated using Zellner's Seemingly Unrelated Regression (SUR). SUR is used to exploit potential correlation across errors in the system impact equations and to increase efficiency of estimation.

Since I am using a variable that is not actually observed (fitted value of modern market channel participation), I use a bootstrapping procedure to obtain the correct standard errors (Wooldridge, 2002). To adjust for clustering effects (households in a village are clustered), I also add cluster procedure using vce (cluster) option by requesting the cluster-adjusted sandwich estimator of variance.

4.4. Farm Household First Stage Econometric Results In Bi-probit Model

Table 4.1. shows the first stage econometric results in bi-probit model. The following are the salient statistically significant (at 10% or better) results; I do not discuss non-significant results except where the non-significance is particularly surprising or interesting. I organize my

discussion by regressor sets, first by household participation in the modern market channel, and then by whether the household uses the services of an ST (sprayer-trader, a full or partial outsourcing of farm management/tasks and marketing tasks to a second party).

4.4.1. Probit On Modern Market Channel Choice

First, perhaps the most important and striking result is the non-significance of mango farm size. In the literature on modern channel participation, Reardon et al. (2009) show that there was a debate over the first decade of the 2000s as to whether there was small farmer exclusion from modern channels; they show that results pointed to inclusion and exclusion depending on the situation, mixed results. The result here supports "inclusion." This makes sense for labor intensive horticulture. The modern market participants appear here to be a mix of larger newer farms and smaller "intensive" farms.

Second, households whose HHH (household head) have higher education are more likely to participate in the modern channel. This makes sense as entering non-traditional arrangements can be seen as risky, but higher return; education may (roughly) help the farmer to analyze at least heuristically the risks and returns (Florez, 2004). Literacy and more education could help farmers understand production and market information and adjust their practices to what the market demands, in terms of timing, quality, volumes, and so on (Chicazunga et al., 2008).

Third, households with irrigation in their mango orchards are more likely to participate in the modern market channel. This makes sense and has been found elsewhere (such as for tomato farmers selling into modern channels in Guatemala; see Hernandez et al. 2007). On Java, although mango trees can grow under rainfed-only conditions, the trees still need water in important stages such as in fruiting and after harvest. If rain does not come at the

right time, the quality and quantity of fruit can be hurt. Irrigation addresses those gaps. Mango trees need 70 to 100 liters/tree/week during the fruiting period (when the fruit is as big as a ping-pong ball) to produce large and high quality fruit; the trees need less water when it comes to harvest time (to ensure the sweetness of the fruit), and need 70 to 80 liters/week/tree after harvest stage (to restore the trees' condition to normal) (Directorate General of Horticulture, 2006). By having irrigation on the mango farm, it is more likely that the mango trees produce high yields and better quality of fruit which appear to improve the farmers' ability to sell to the modern market channel.

Fourth, the household's having lagged off-farm income reduces the probability of selling into the modern market channel (already controlling for farm and orchard attributes). This may have to do with opportunity cost of time, conflicting with the greater time required for the modern (compared with the traditional), market: the production and marketing steps and supervision appear to be larger for the modern market; for example, traditional markets tend to have bought the fruit on the tree and come harvest it by the local trader; modern markets tend to have the fruit bought after the harvest so inspection can be made of quality, and the farmer does the harvesting. This requires then more labor for watching/guarding the trees (a big risk) and harvesting.

Fifth, the household's having a (lagged) own truck is associated with greater probability of selling to the modern market channel. Recall that this is lagged because otherwise (if it is after the market decision) the farmer may have bought the truck to facilitate continued participation or bought the truck partly from income from the modern market channel. In general this makes sense as easily accessing a vehicle in a flexible way (not competing for rented trucks or third party logistics when many farmers are seeking that) would help a farmer to access the

modern market. My field observation revealed that a number of mango orchards (with more than 10 trees) are located far from a good-quality road. It can be in a rice field area, with tiny space muddy footpath, or in a jungle like environment with very poor road infrastructure, and thus having one's own truck (as renting under those conditions is costly and hard to do) presents an advantage.

Sixth, travel time from the farm to the province road is positively related with modern market participation. This is an interesting result and significant as a contribution to the literature. Usually one expects that the higher the transaction costs, the less likely participation in the modern channels. But this expectation neglects the probability that farmers got bigger farms by clearing jungle or converting rice fields outside of the dense and small rice fields lining the roads, or the village lining the road. Getting more land means traveling further to the road. This result is related to the one above about owning a truck.

Seventh, being located in West Java and being located in a mango cluster (with a lot of mango farmers together) is positively related with modern market channel participation. This result does (controlling for the above results about distance from quality road) support the hypothesis of a negative correlation between transaction costs and entering the modern market. It also supports further the point made by Barrett et al. (2012) that procurement decisions by modern channel operators are also (as with farmers) a function of transaction costs, and they tend to buy from zones where there is a density of suppliers and road links. West Java is near the big mango markets and cities on Java (Jakarta, Bandung), where there were also a range of modern channel buyers (supermarkets, hotels and restaurants, specialized fruit stores) and also main wholesale markets (Kramat Jati in Jakarta, Caringin in Bandung). By contrast, in East Java there is no main wholesale market, only a seasonal wholesale market (Gedong Doro in Surabaya).

Recall that I also categorize inter-island trade as part of the modern channel. From our reconnaissance of trade routes, we found that Sumatra (to the west of Java) is the main market destination of inter-island wholesalers. An interisland wholesaler in Jakarta said that he gets mango from West Java (60%), Central Java (20%), and East Java (20%). Interisland trade also has mango going partly from West Java to Kalimantan (north of Java), from both West and East Java. Finally, the reconnaissance showed that large processors of mango (three large processing companies) are located in Greater Jakarta (Jakarta, Bogor, Tanggerang). They buy half processed mango (puree) mainly from Cirebon in West Java (in our survey area). By contrast, mango from East Java that is processed mainly goes to local small processors and home enterprise.

Eight, contrary to my hypothesis, the results did not show use of a sprayer-trader as being a significant determinant of marketing to a modern channel. This is at odds with the descriptive results where a correlation is found between selling to modern market and use of sprayer-traders. However, the Rho (the coefficient of correlation between the disturbances for the two equations in the biprobit system) is statistically significant from zero and has a positive sign; this indicates that modern market channel participation is correlated with the error in the ST equation. Therefore these two equations are endogenous which means that the probability of one will be dependent on the value/probability of the other. In the extreme case, when rho=1, the two variables are essentially the same.

Ninth, as an instrument to identify the system, I used households with (as lagged variable) relatives who work in the modern market, have a greater chance of selling to modern markets. This appears to be simply a case of the value of social networks to reduce transaction costs and risk.

4.4.2. Probit On Use of Sprayer-Trader (ST)

First, the lagged size of the farm (indicated by total trees owned) and the lagged value of off-farm income, separately, is each not significant. However the interaction term between these two variables is very statistically significant in determining contracting with an ST. The combination of a larger farm (thus probably more commercial orientation) and a higher opportunity cost of time (from also participating in off-farm employment) drive farmers to seek relief of their time, or ability to purchase of additional expertise, or both. The inverse, the smaller mango farmers that also have less pull on their time off-farm, appear to have less incentive to spend the effort to contract and divide the harvest with an ST given the harvest is small and also the farmer is more likely to have more time to tend their mango trees by themselves, and may not be "commercially oriented" and thus trying to bring outside expertise to bear to maximize output or quality or both. This is the first time (there is no published literature showing this) this result has been found, showing the effect of farm size and employment on the adoption of this innovative form of third-party agricultural service.

Second, (lagged) ownership of vehicle/truck shows a negative relationship with the use of ST by the household. Trucks and other farm vehicles are used to haul inputs and outputs and lower transaction costs; that lowering also reduces the need for an ST who generally has a truck for the same purposes. Having a truck might also mean the farmer has his own source of information from going himself to the market and needs less the ST at least for information. My field observation (plus the descriptive tables noted above) found farmers saying that they used ST's because they have better market access, knowledge, and equipment (sprayers and trucks and so on).

Third, the number of input suppliers in the village is positively correlated with use of ST by the household. On the one hand this is odd because with many input suppliers the farmer would perhaps find it easier to get advice and inputs on his own. On the other hand, the result could be explained by several points: (a) there may be many STs who are also input retailers or find access to input retailers also useful for the ST business; (b) there may be many input shops, but perhaps mainly with the generic chemicals or main brands used for rice, and not the specialized inputs for mango (such as growth hormones), which the ST may get from further away than the village, in cities.

Fourth, households in West Java have higher probability of using ST than those in East Java. This could be for several reasons: (a) there were more STs in West Java per 1000 mango growers (we know this because I also did an ST survey in the two provinces and needed to construct a sample frame for that); (b) while overall there were fewer mango trees in West Java, they are closer to big cities, so that may increase both the labor market "tightness" and thus opportunity cost of time, make it easier for ST to arise to sell to nearby cities, and perhaps raise the need and opportunity to intensify production for the nearby more demanding markets. Note that the second stage equations also show the West Java farmers use a lot more fertilizer, pesticides, and growth hormones per tree compared to mango farmers in East Java.

Fifth, being in a mango concentration or cluster area increases the probability that a farmer contracts an ST. There were likely economies of agglomeration for the ST business, and reduction of transaction costs by having many mango farmers close together. Also, in the cluster areas, I found that STs were also often medium to large traders (drawn to cluster areas as base), and had two businesses.

Sixth, as an instrument to identify the system, I used the existence of a field school program in a village, five years before the choice year (of 2009). The regression showed this is negatively associated with use of ST by the household. A field school is an extension program of the government, undertaken on farms themselves. The school trains farmers in pest and disease management and application of key technologies. It has a clear substitute effect with hiring STs for their skills. This also suggests the possibility that a dearth of extension and training spurred the rise of STs to fill a gap in services.

4.5. Farm Household Second Stage Econometric Results

Table 4.2. shows farm household second stage econometric results. The following are the salient statistically significant (at 10% or better) results; I do not discuss non-significant results except where the non-significance is particularly surprising or interesting. I organize my discussion by significant regressor.

First, the number of adults in the household is associated with more use of growth hormones. Some growth hormones are applied around the root area, and some are applied together with foliar fertilizer which requires the farmer to climb the tree and spray, requiring substantial labor. I observed in the field that beside foliar fertilizer application and harvesting, the application of pesticides is the most labor demanding. Farmers have to climb up 8 meter tall trees (for trees older than 10 years) and usually spray by hand with a traditional manual sprayer. This can only be done by adults, and well trained ones at that.

Second, the lower dependency ratio is associated with more use of growth hormones. The interpretation is those households who have lower number of dependent members less likely to risk averse and more daring to adopt new technology.

Third, field school participation has a positive impact on labor use and adoption of growth hormones, but a negative impact on yield. The interpretation is that more information on mango cultivation (gained from the field school) translates into the adoption of modern mango farming practices such as application of pesticide, foliar fertilizer, and growth hormones, as well as pruning and on-tree fruit bagging. All these require more labor than traditional mango farming techniques. At first the negative impact on yield appears odd. But there is a possible reason for it. If farmers learn in field school to apply growth hormones excessively but do not follow it by pruning and needed watering, the hormone can boost production by inducing early flowering, but with a high risk of killing the tree.

Fourth, the lagged of household participation in a farmer organization or cooperative positively effects growth hormones adoption. Growth hormone is a specific chemical for mango; it is an expensive input (15 USD per 250 ml and at least 20 ml is needed per tree). Collective action allows small farmers to buy together to pay a lower price for a higher volume. From my field observation, some respondents said that they get this expensive input from their coop: the coop buys it from a large input store in town; the farmers pay an additional fee for transport. They said that they are willing to pay the extra fee since it is less expensive compared to buying it individually in town. Moreover, to buy subsidized fertilizer, decree 87/2008 (revised in 2012) issued by the Ministry of Agriculture states that farmers have to buy it via farmers group or coop and present an "RDKK" ("plan of basic need"). By contrast, unsubsidized fertilizer is much more expensive.

Fifth, the size of orchard (in number of trees has a positive impact on adoption of growth hormones. This is likely mainly a wealth effect of the larger orchard, as well as some relation between commercial orientation and interest in using modern technologies.

Sixth, land holding (in meters squared) has a positive impact on the use of fertilizer and the adoption of growth hormones but negatively related to labor expenditure. This is likely again a wealth effect and a correlate with unobserved commercial orientation. This also shows that households intensify their production using labor-saving technology.

Seventh, owning a truck or other farm vehicle has a strong and positive impact on intensification - labor, fertilizer, and pesticide use, and the probability of adopting growth hormones. This is both a wealth effect, and a source of lowering transaction costs to buy inputs and acquire information.

Eight, (lagged) off farm income has negative impact on growth hormones adoption. It shows that the higher the nonfarm income, induced households to shift from farm to off-farm.

Ninth, travel time from mango farm to province road has positive impact on growth hormones adoption. As noted in the first stage discussion, many orchards that are more commercial are located relatively far from a good quality road. Also orchards in the jungle setting and that are more than 15 years old need more inputs per tree compared to young trees.

Tenth, being in West Java has negative impact on yield and labor use, but a positive impact on intensification (fertilizer use, pesticides expenditure, and growth hormone adoption). West Java farmers might be overusing growth hormones as discussed above. West Java farmers intensify with external inputs more than do those in East Java; my hypothesis is that there is the factor of close-by market demand and likelihood of profit by employing new techniques.

Eleventh, being in a mango concentration (cluster) area is associated with higher yields. The finding of higher yields can be explained by economies of agglomeration and social learning effects normally ascribed to clusters.

Twelfth, rainfall is associated with more use of pesticides and growth hormones. High rainfall level makes the probability of trees to be infected by disease is high, thus pesticides use are higher. On flowering season, high rainfall level has destructive effect. It makes the flowers to fall. This condition affect on more using of growth hormones to induce more flowering.

Thirteenth, sprayer trader use has positive impact on yield and on intensification (labor use, fertilizer use, pesticides expenditure, and growth hormone adoption). This is the most important finding that confirms the hypothesis that sprayer trader spur technological change in mango farming.

Fourteenth, controlling for other variables, the (predicted) household participation in the modern market channel only affects, and positively so, adoption of growth hormones. This is an important finding in that there is a clear logical link between the requirements of the market and the adoption of a modern input. To illustrate this, I cite from an interview with an interisland wholesaler located in Bogor; she said that the transport of mango can require more than one month by ship. She said that she has to transport the mango before the mango season starts, and it has to be in the market before the mango season, so she can get a higher price than in the peak part of the season. She noted that it is very important to her as a trader to get the mango a month or two before the bulk of mangoes arrive on the market. This spurs the need to use growth hormones on the farm: it is a timing rather than product quality requirement that induces this technical innovation.

Chapter 5: Conclusions

This thesis aims to analyze major issues in modern market channel participation, the use of ST, and the impact of the adoption of modern inputs by mango farmers in Indonesia. The results of this study are as follows.

First, the descriptive result confirms that there is a rapid change in terms of farm size in the recent past, indicated by the major shift of marginal farmers into small farmers in 2009. Apart from adding more trees, interestingly, marginal farmers and farmers in the traditional channel also diversify their mango into more marketable niche varieties. At odds with conventional wisdom, it is also found that external input use is widespread both in households in the modern channel and households in the traditional channel.

Second, the econometrics results show the non-significance of mango farm size to modern market channel participation. This result supports a hypothesis of "inclusion" of marginal and small farmers; the modern market participants appear here to be a mix of larger newer farms and smaller "intensive" farms.

Third, for the first time (there is no published literature showing this) in the literature, a test of ST adoption is made; the result shows that a combination of a larger farm and nonfarm employment induce adoption of the ST, an innovative form of third-party agricultural service.

Fourth, located in West Java (closer to big cities with good accessible infrastructures) and being located in a mango cluster (with a lot of mango farmers together) is positively related with modern market channel participation and ST use.

Fifth, farmers participation in the modern market channel only affects, and positively, the adoption of growth hormones because it is timing rather than quality requirement that induces the technical innovation.

Niche varieties diversification, technological intensification via the increased use of external non-labor inputs (pesticides, fertilizers, growth hormones) and the emerging agricultural service as a substitute to hired farm labor indicate an overall finding that the mango sector in Indonesia is moving toward the agricultural commercialization and intensification, as well as food system transformation. Thus this study contributes to the literature as empirical evidence of Pingali and Rosegrant (1995) postulate on the correlation of agricultural commercialization, agricultural diversification, and technological intensification through the increased use of external non-labor inputs and hired farm labor.

APPENDIX

Table 1. Mango Production and Export in 1999-2011

Year	Mango Production (Ton)	Export (Ton)	% of Export
1999	826,842	563.79	0.068185941
2000	876,027	430.187	0.049106591
2001	923,294	424.917	0.046021852
2002	1,402,906	1572.634	0.112098316
2003	1,526,474	559.224	0.036635016
2004	1,437,665	1879.664	0.130744228
2005	1,412,884	940.556	0.066569938
2006	1,621,997	1181.881	0.072865794
2007	1,818,619	1198.213	0.065885873
2008	2,105,085	1908.001	0.090637718
2009	2,243,440	1414.947	0.063070419
2010	1,287,287	998.545	0.077569726
2011	2,131,139	1485.429	0.069701179
Average	**1,508,743**	**1119.845**	**0.073007122**

Source: http://hortikultura.deptan.go.id/, 2012.

Table 3.1.A. Human and Social Assets of Mango Farmers in East Java and West Java, Indonesia in 2009 and 2005, by Market Channel

		Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
1	Demographics				
1.1	Number of people in the household (HH) (unweighted) in 2009	4.4	4.3		4.4
1.2	Number of adults in HH (15 to 64 years old) in 2009	3.2	3.2		3.2
1.3	Female headed HH (share over all hh, SOH) in 2009	15%	10%		13%
1.4	Age of head of household (HHH) (years) in 2009	54.4	53.7		54
2	Education				
2.1	Average years of education in HH (taken over all members of the HH) in 2009	6.7	6.8		6.8
2.2	Education of HHH (years) in 2009	6.6	6.8		6.7
2.3	Average literature rate in HH (taken over all members of the HH) in 2009	84%	86%		85%
3	Organizations				
3.1	**In 2009**				
3.1.1	Member of a cooperative or farmer organization (SOH)	15%	21%		18%
3.1.2	Member of a cooperative or farmer organization specialized in mango (n= 71)	5%	21%	**	13%
3.1.3	As board member in a cooperative or farmer organization (n= 71)	24%	30%		27%

*, **, ***= show statistically different groups at 10%, 5%, and 1% significant level.

Table 3.1.A. (cont'd)

		Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
3.1.4	Received privileges as member in a cooperative or farmer organization (n= 71)for :				
3.1.4.1	Capital loan	24%	39%		31%
3.1.4.2	Input supply	34%	30%		32%
3.1.4.3	Irrigation service	34%	24%		30%
3.1.4.4	Access to collective capital (equipment) owned by co-op/farmer's group	29%	30%		30%
3.1.4.5	Access to government subsidy (for input and equipment)	42%	24%		34%
3.1.4.6	Access to training provided by government	26%	24%		25%
3.1.4.7	Access to training provided by private agent/non-government	24%	33%		28%
3.1.4.8	Collective marketing	26%	10%	*	18%
3.1.4.9	Selling to co-op/farmer's group	7%	9%		8%
3.2	**In 2005**				
3.2.1	Member of a cooperative or farmer organization (SOH)	13%	15%		13%
3.2.2	Member of a cooperative or farmer organization specialized in mango (n= 55)	6%	13%		9%
3.2.3	As board member in a cooperative or farmer organization (n= 55)	22%	30%		25%
3.2.4	Received privileges as member in a cooperative or farmer organization (n= 55)for :				
3.2.4.1	Capital loan	19%	35%		25%
3.2.4.2	Input supply	38%	26%		33%
3.2.4.3	Irrigation service	41%	17%	**	31%
3.2.4.4	Access to collective capital (equipment) owned by co-op/farmer's group	31%	22%		27%

*, **, *** show statistically different groups at 10%, 5%, and 1% significant level.

Table 3.1.A. (cont'd)

		Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	Ttest	Overall N= 404
3.2.4.5	Access to government subsidy (for input and equipment)	34%	22%		29%
3.2.4.6	Access to training provided by government	22%	26%		24%
3.2.4.7	Access to training provided by private agent/non-government	22%	22%		22%
3.2.4.8	Collective marketing	19%	13%		16%
3.2.4.9	Selling to co-op/farmer's group	3%	13%		7%
4	Networking				
4.1	**In 2009:**				
4.1.1	Had friends/relatives who sold inputs (SOH)	25%	53%	***	36%
4.1.2	Average number of friends/relatives who sold inputs (n= 144)	1.8	2.7	***	2.3
4.1.3	Had friends/relatives who worked as extension agent (SOH)	11%	33%	***	19%
4.1.4	Average number of friends/relatives who worked as extension agent (n=78)	1.8	2.2		2.1
4.1.5	Had friends/relatives who were mango wholesaler in the traditional market (SOH)	31%	67%	***	45%
4.1.6	Average number of friends/relatives who were mango wholesaler in the traditional market (n= 182)	2.5	4.5	***	3.6
4.1.7	Had friends/relatives who were mango wholesaler in the modern market (SOH)	5%	24%	***	12%
4.1.8	Average number of friends/relatives who were mango wholesaler in the modern market (n=49)	1.8	2.4		2.2

*, **, *** show statistically different groups at 10%, 5%, and 1% significant level.

Table 3.1.A. (cont'd)

		Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
4.1.9	Had friends/relatives who worked in mango processing industry (SOH)	3%	15%	***	8%
4.1.10	Average number of friends/relatives who worked in mango processing industry (n= 32)	6.4	3.7		4.4
4.2	**In 2005:**				
4.2.1	Average number of friends/relatives who sold inputs (n= 143)	1.6	2.3	***	2
4.2.2	Average number of friends/relatives who worked as extension agent (n=77)	1.7	1.9		1.8
4.2.3	Average number of friends/relatives who were mango wholesaler in the traditional market (n= 182)	2.1	4.1	***	3
4.2.4	Average number of friends/relatives who were mango wholesaler in the modern market (n=49)	1.5	2.2		2
4.2.5	Average number of friends/relatives who worked in mango processing industry (n= 32)	6.4	3.2		4
5	<u>Government aid:</u>				
5.1	**In 2009:**				
5.1.1	Share of HH who received government program/aid for mango seedlings (overall HH)	3%	3%		3%
5.1.2	Share of HH who received government program/aid for growth hormones (overall HH)	0.8%	0.6%		0.7%

*, **, *** show statistically different groups at 10%, 5%, and 1% significant level.

Table 3.1.A. (cont'd)

		Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
5.1.3	Share of HH who received government program/aid for pesticides (overall HH)	0.6%	0.4%		0.5%
5.1.4	Share of HH who received government program/aid for fertilizer (overall HH)	2%	3%		2%
5.1.5	Share of HH who received government program/aid for yellow trap (overall HH)	0%	0%		0%
5.1.6	Share of HH who received government program/aid for pheromones (overall HH)	0.4%	1%		0.7%
5.1.7	Share of HH who received government program/aid for sprayer (overall HH)	0%	0.6%		0.2%
5.1.8	Share of HH who received government program/aid for warehouse (overall HH)	%0	0%		0%
5.1.9	Share of HH who received government program/aid for capital loan (overall HH)	0.8%	2%		1%
5.1.10	Share of HH who received government program/aid for irrigation (overall HH)	2%	4%		3%
5.1.11	Share of HH who received other government program/aid (overall HH)	0.8%	0.6%		0.7%
5.2	**In 2005:**				
5.2.1	Share of HH who received government program/aid for mango seedlings (overall HH)	3%	2%		2.5%
5.2.2	Share of HH who received government program/aid for growth hormones (overall HH)	0%	0%		0%

*, **, *** show statistically different groups at 10%, 5%, and 1% significant level.

Table 3.1.A. (cont'd)

		Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
5.2.3	Share of HH who received government program/aid for pesticides (overall HH)	1%	3%		2%
5.2.4	Share of HH who received government program/aid for fertilizer (overall HH)	2.4%	4.5%		3.2%
5.2.5	Share of HH who received government program/aid for yellow trap (overall HH)	0%	0%		0%
5.2.6	Share of HH who received government program/aid for pheromones (overall HH)	0%	0%		0%
5.2.7	Share of HH who received government program/aid for sprayer (overall HH)	0%	0%		0%
5.2.8	Share of HH who received government program/aid for warehouse (overall HH)	0%	0%		0%
5.2.9	Share of HH who received government program/aid for capital loan (overall HH)	0%	0%		0%
5.2.10	Share of HH who received government program/aid for irrigation (overall HH)	2%	4%	*	3%
5.2.11	Share of HH who received other government program/aid (overall HH)	1%	1%		1%
6	Trainings				
6.1	**In 2009:**				
6.1.1	Training on field school (how to cultivate mango):				
6.1.1.1	Share of HH received field study (Over all HH).	27%	22%		25%
6.1.1.2	Number of training received in a year (n=157)	2	1		1.5

*, **, *** show statistically different groups at 10%, 5%, and 1% significant level.

Table 3.1.A. (cont'd)

		Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
6.1.1.3	Share of HH who received training from government (n=157)	100%	100%		100%
6.1.2	Training on post-harvest activities				
6.1.2.1	Share of HH received training for post-harvest activities (Over all HH).	0%	0%		0%
6.1.3	Training on marketing				
6.1.3.1	Share of HH received training for marketing (Over all HH).	0%	0%		0%
6.2	**In 2005**				
6.2.1	Training on field school (how to cultivate mango)				
6.2.1.1	Share of HH received field study (Over all HH).	23%	15%	**	20%
6.2.1.2	Number of training received in a year (n=157)	1	1		1
6.2.1.3	Share of HH who received training from government (n=157)	100%	100%		100%
6.2.2	Training on post-harvest activities				
6.2.2.1	Share of HH received training for post-harvest activities (Over all HH).	-	-	-	-
6.2.3	Training on marketing	-	-	-	-
6.2.3.1	Share of HH received training for marketing (Over all HH).	-	-	-	-

*, **, *** show statistically different groups at 10%, 5%, and 1% significant level

Table 3.1.B. Human and Social Assets of Mango Farmers in East Java and West Java, Indonesia in 2009 and 2005, by Farm Size

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
1	Demographics				
1.1	Number of people in the household (HH) (unweighted) in 2009	4.3	4.4	4.6	4.4
1.2	Number of adults in HH (15 to 64 years old) in 2009	3.1	3.1	3.2	3.2
1.3	Female headed HH (share over all hh, SOH) in 2009	32%[a]	12%[b]	6%[b]	13%
1.4	Age of head of household (HHH) (years) in 2009	54	53.7	57	54
2	Education				
2.1	Average years of education in HH (taken over all members of the HH) in 2009	7	6.7	6.8	6.8
2.2	Education of HHH (years) in 2009	6.9	6.7	6.3	6.7
2.3	Average literature rate in HH (taken over all members of the HH) in 2009	79%	85%	85%	85%
3	Organizations				
3.1	**In 2009**				
3.1.1	Member of a cooperative or farmer organization (SOH)	6%[a]	15%[a]	43%[b]	16%
3.1.2	Member of a cooperative or farmer organization specialized in mango (n= 71)	50%	8%	19%	13%
3.1.3	As board member in a cooperative or farmer organization (n= 71)	0%	25%	33%	27%

[a, b, c] show statistically different groups at 10% significant level.

Table 3.1.B. (cont'd)

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
3.1.4	Received privileges as member in a cooperative or farmer organization (n= 71)for :				
3.1.4.1	Capital loan	50%	32%	29%	31%
3.1.4.2	Input supply	100%[a]	27%[b]	38%[a,b]	32%
3.1.4.3	Irrigation service	50%	29%	29%	30%
3.1.4.4	Access to collective capital (equipment) owned by co-op/farmer's group	0%	25%	43%	30%
3.1.4.5	Access to government subsidy (for input and equipment)	0%[a,b]	29%	48%	34%
3.1.4.6	Access to training provided by government	0%	23%	33%	25%
3.1.4.7	Access to training provided by private agent/non-government	50%	27%	29%	28%
3.1.4.8	Collective marketing	0%	15%	29%	18%
3.1.4.9	Selling to co-op/farmer's group	0%	6%	14%	8%
3.2	**In 2005**				
3.2.1	Member of a cooperative or farmer organization (SOH)	3%[a]	11%[a]	40%[b]	18%
3.2.2	Member of a cooperative or farmer organization specialized in mango (n= 55)	0%	6%	16%	9%
3.2.3	As board member in a cooperative or farmer organization (n= 55)	0%	23%	32%	25%
3.2.4	Received privileges as member in a cooperative or farmer organization (n= 55)for :				
3.2.4.1	Capital loan	0%	27%	26%	25%
3.2.4.2	Input supply	1%	29%	37%	32%
3.2.4.3	Irrigation service	100%	34%	21%	31%
3.2.4.4	Access to collective capital (equipment) owned by co-op/farmer's group	0%	23%	37%	27%

[a, b, c] show statistically different groups at 10% significant level.

Table 3.1.B. (cont'd)

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
3.2.4.5	Access to government subsidy (for input and equipment)	0%[a,b]	20%[a]	47%[b]	29%
3.2.4.6	Access to training provided by government	0%	17%	37%	24%
3.2.4.7	Access to training provided by private agent/non-government	0%	20%	26%	22%
3.2.4.8	Collective marketing	0%[a,b]	9%[a]	32%[b]	16%
3.2.4.9	Selling to co-op/farmer's group	0%	3%	16%	7%
4	Networking				
4.1	**In 2009:**				
4.1.1	Had friends/relatives who sold inputs (SOH)	15%[a]	37%[b]	42%[b]	36%
4.1.2	Average number of friends/relatives who sold inputs (n= 144)	1.6	2.4	2	2.3
4.1.3	Had friends/relatives who worked as extension agent (SOH)	6%[a]	20%[b]	25%[b]	19%
4.1.4	Average number of friends/relatives who worked as extension agent (n=78)	1	2.2	2.6	2.1
4.1.5	Had friends/relatives who were mango wholesaler in the traditional market (SOH)	12%[a]	48%[b]	52%[b]	45%
4.1.6	Average number of friends/relatives who were mango wholesaler in the traditional market (n= 182)	1.5	3.7	3.9	3.6
4.1.7	Had friends/relatives who were mango wholesaler in the modern market (SOH)	0%[a]	12%[a]	23%[b]	12%
4.1.8	Average number of friends/relatives who were mango wholesaler in the modern market (n=49)	-	2.2	2.4	2.2

[a, b, c] show statistically different groups at 10% significant level.

Table 3.1.B. (cont'd)

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
4.1.9	Had friends/relatives who worked in mango processing industry (SOH)	0%	8%	10%	8%
4.1.10	Average number of friends/relatives who worked in mango processing industry (n= 32)	-	4.5	3.2	4.4
4.2	**In 2005:**				
4.2.1	Average number of friends/relatives who sold inputs (n= 143)	1	2.1	1.9	2
4.2.2	Average number of friends/relatives who worked as extension agent (n=77)	1	1.9	1.5	1.8
4.2.3	Average number of friends/relatives who were mango wholesaler in the traditional market (n= 182)	1.3	3.3	3.6	3
4.2.4	Average number of friends/relatives who were mango wholesaler in the modern market (n=49)	-	1.9	2.5	2
4.2.5	Average number of friends/relatives who worked in mango processing industry (n= 32)	-	4.3	3	4
5	Government aid:				
5.1	**In 2009:**				
5.1.1	Share of HH who received government program/aid for mango seedlings (overall HH)	3%[a,b]	2%[a]	8%[b]	3%
5.1.2	Share of HH who received government program/aid for growth hormones (overall HH)	0%	1%	2%	1%

[a, b, c] show statistically different groups at 10% significant level.

Table 3.1.B. (cont'd)

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
5.1.3	Share of HH who received government program/aid for pesticides (overall HH)	0%	1%	0%	0.5%
5.1.4	Share of HH who received government program/aid for fertilizer (overall HH)	3%	2%	6%	2%
5.1.5	Share of HH who received government program/aid for yellow trap (overall HH)	0%	0%	0%	0%
5.1.6	Share of HH who received government program/aid for pheromones (overall HH)	3%	1%	2%	1%
5.1.7	Share of HH who received government program/aid for sprayer (overall HH)	0%[a,b]	0%[a]	2%[b]	1%
5.1.8	Share of HH who received government program/aid for warehouse (overall HH)	0%	0%	0%	0%
5.1.9	Share of HH who received government program/aid for capital loan (overall HH)	3%	1%	4%	1%
5.1.10	Share of HH who received government program/aid for irrigation (overall HH)	3%	3%	4%	3%
5.1.11	Share of HH who received other government program/aid (overall HH)	3%	1%	0%	1%
5.2	**In 2005:**				
5.2.1	Share of HH who received government program/aid for mango seedlings (overall HH)	0%[a]	2%[a]	8%[b]	2.5%
5.2.2	Share of HH who received government program/aid for growth hormones (overall HH)	0%	0%	0%	0%

[a, b, c] show statistically different groups at 10% significant level.

Table 3.1.B. (cont'd)

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
5.2.3	Share of HH who received government program/aid for pesticides (overall HH)	0%	2%	0%	1.7%
5.2.4	Share of HH who received government program/aid for fertilizer (overall HH)	3%	3%	4%	3%
5.2.5	Share of HH who received government program/aid for yellow trap (overall HH)	0%	0%	0%	0%
5.2.6	Share of HH who received government program/aid for pheromones (overall HH)	0%	0%	0%	0%
5.2.7	Share of HH who received government program/aid for sprayer (overall HH)	0%	0%	0%	0%
5.2.8	Share of HH who received government program/aid for warehouse (overall HH)	0%	0%	0%	0%
5.2.9	Share of HH who received government program/aid for capital loan (overall HH)	0%	1%	0%	1%
5.2.10	Share of HH who received government program/aid for irrigation (overall HH)	3%	2%	4%	3%
5.2.11	Share of HH who received other government program/aid (overall HH)	0%	1%	0%	0.7%
6	Trainings				
6.1	**In 2009:**				
6.1.1	Training on field school (how to cultivate mango):				
6.1.1.1	Share of HH received field study (Over all HH).	15%[a]	24%[a]	42%[b]	25%
6.1.1.2	Number of training received in a year (n=157)	2	1		1.5

[a, b, c] show statistically different groups at 10% significant level.

Table 3.1.B. (cont'd)

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
6.1.1.3	Share of HH who received training from government (n=157)				
6.1.2	Training on post-harvest activities				
6.1.2.1	Share of HH received training for post-harvest activities (Over all HH).	0%	0%	0%	0%
6.1.3	Training on marketing				
6.1.3.1	Share of HH received training for marketing (Over all HH).	0%	0%	0%	0%
6.2	**In 2005**				
6.2.1	Training on field school (how to cultivate mango)				
6.2.1.1	Share of HH received field study (Over all HH).	9%[a]	19%[a]	35%[b]	20%
6.2.1.2	Number of training received in a year (n=157)	1	1		1
6.2.1.3	Share of HH who received training from government (n=157)	100%	100%		100%
6.2.2	Training on post-harvest activities				
6.2.2.1	Share of HH received training for post-harvest activities (Over all HH).	-	-	-	-
6.2.3	Training on marketing	-	-	-	-
6.2.3.1	Share of HH received training for marketing (Over all HH).	-	-	-	-

[a, b, c] show statistically different groups at 10% significant level.

Table 3.2.A. Non-Mango Physical Assets of Mango Farmers in East Java and West Java, Indonesia in 2009 and 2005, by Market Channel

		Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
1	In 2009:				
1.1	Had other commodity (non-mango) farm income	70%	78%	**	73%
1.2	Had unskilled on farm income	10%	10%		10%
1.3	Had rural off-farm employment income	67%	52%	***	61%
1.4	Had income from pensions and other sources	6%	7%		6.5%
1.5	Annual non-mango farming income (USD 100s) (n=295)	15.09	14.41		14.91
1.6	Annual non-mango farming income (USD 100s) (over all hh/zeroed out)	10.51	11.29		10.81
1.7	Annual unskilled on farm income (USD 100s) (n=41)	4.09	4.32		4.18
1.8	Annual unskilled on farm income (USD 100s) (over all hh/zeroed out)	0.41	0.44		0.42
1.9	Annual rural non-farm employment income (USD 100s) (n=247)	19.06	16.22		18.12
1.10	Annual rural non-farm employment income (USD 100s) (over all hh/zeroed out)	12.73	8.48		11.08
1.11	Income from pensions and other sources (USD 100s) (n=42)	9.18	19.81	**	12.72
1.12	Income from pensions and other sources (USD 100s) (over all hh/zeroed out)	1.04	1.76		1.32
1.13	Total non-mango income (USD 100s) (over all hh/zeroed out)	12.73	8.48	***	11.07
1.14	HH owns rice field (SOH)	46%	48%		47%
2	In 2005:				
2.1	Had other commodity (non-mango) farm income	69%	77%	*	72%

*, **, *** show statistically different groups at 10%, 5%, and 1% significant level

Table 3.2.A. (cont'd)

		Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
2.2	Had unskilled on farm income	11%	9%		10%
2.3	Had rural off-farm employment income	60%	47%	**	56%
2.4	Had income from pensions and other sources	6%	7%		6.5%
2.5	Annual non-mango farming income (USD 100s) (n=291)	14.86	12.42		13.85
2.6	Annual non-mango farming income (USD 100s) (over all hh/zeroed out)	10.23	9.57		9.97
2.7	Annual unskilled on farm income (USD 100s) (n=42)	3.06	3.46		3.2
2.8	Annual unskilled on farm income (USD 100s) (over all hh/zeroed out)	0.33	0.33		0.33
2.9	Annual rural non-farm employment income (USD 100s) (n=233)	16.74	12.68	**	15.38
2.10	Annual rural non-farm employment income (USD 100s) (over all hh/zeroed out)	9.96	5.97	***	8.41
2.11	Income from pensions and other sources (USD 100s) (n=40)	8.76	17.35	*	12.28
2.12	Income from pensions and other sources (USD 100s) (over all hh/zeroed out)	0.82	1.77		1.18
2.13	Total non-mango income (USD 100s) (over all hh/zeroed out)	10.29	6.3	***	8.7
2.14	HH owns rice field (SOH)	69%	77%	**	72%

*, **, *** show statistically different groups at 10%, 5%, and 1% significant level

Table 3.2.B. Non-Mango Physical Assets of Mango Farmers in East Java and West Java, Indonesia in 2009 and 2005, by Farm Size

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
1	In 2009:				
1.1	Had other commodity (non-mango) farm income	65%	72%	85%	73%
1.2	Had unskilled on farm income	18%	10%	4%	10%
1.3	Had rural off-farm employment income	62%	63%	50%	61%
1.4	Had income from pensions and other sources	15%	6%	4%	6.5%
1.5	Annual non-mango farming income (USD 100s) (n=295)	11.25[a]	12.53[a]	29.62[b]	14.81
1.6	Annual non-mango farming income (USD 100s) (over all hh/zeroed out)	7.28[a]	9.25[a]	25.30[b]	10.81
1.7	Annual unskilled on farm income (USD 100s) (n=41)	3.16	4.36	4.43	4.18
1.8	Annual unskilled on farm income (USD 100s) (over all hh/zeroed out)	0.56	0.45	0.18	0.42
1.9	Annual rural non-farm employment income (USD 100s) (n=247)	15.32	18.12	20.50	18.12
1.10	Annual rural non-farm employment income (USD 100s) (over all hh/zeroed out)	9.46	11.37	10.25	11.08
1.11	Income from pensions and other sources (USD 100s) (n=42)	9.03	12.97	18.66	12.72
1.12	Income from pensions and other sources (USD 100s) (over all hh/zeroed out)	1.86	1.28	1.17	1.32
1.13	Total non-mango income (USD 100s) (over all hh/zeroed out)	21.34	24.48	21.85	23.90
1.14	HH owns rice field (SOH)	53%	46%	46%	47%
2	In 2005:				
2.1	Had other commodity (non-mango) farm income	65%	71%	81%	72%

[a, b, c] show statistically different groups at 10% significant level.

Table 3.2.B. (cont'd)

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
2.2	Had unskilled on farm income	18%	11%	4%	10%
2.3	Had rural off-farm employment income	61%	56%	48%	56%
2.4	Had income from pensions and other sources	18%[a]	6%[b]	2%[b]	6.5%
2.5	Annual non-mango farming income (USD 100s) (n=291)	10.59[a]	11.06[a]	32.13[b]	13.85
2.6	Annual non-mango farming income (USD 100s) (over all hh/zeroed out)	6.85[a]	7.89[a]	26.11[b]	9.97
2.7	Annual unskilled on farm income (USD 100s) (n=42)	3.03	3.23	3.33	3.2
2.8	Annual unskilled on farm income (USD 100s) (over all hh/zeroed out)	0.54	0.34	0.14	0.33
2.9	Annual rural non-farm employment income (USD 100s) (n=233)	11.02[a]	15.37[a,b]	19.27[b]	15.38
2.10	Annual rural non-farm employment income (USD 100s) (over all hh/zeroed out)	6.48	8.49	9.23	8.41
2.11	Income from pensions and other sources (USD 100s) (n=40)	6.39	13.01	21.95	12.28
2.12	Income from pensions and other sources (USD 100s) (over all hh/zeroed out)	1.32	1.21	0.91	1.18
2.13	Total non-mango income (USD 100s) (over all hh/zeroed out)	15.22[a]	17.96[a]	36.39[b]	19.92
2.1.4	HH owns rice field (SOH)	65%	71%	81%	72%

[a, b, c] show statistically different groups at 10% significant level.

Table 3.3.A. Mango Farm Characteristics in East Java and West Java, Indonesia in 2009, by Market Channel

		Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
1	Share of HH who owned mango and non-mango plots in 2009	41%	49%	*	45%
2	Share of HH who owned only mango plots in 2009	59%	51%	*	56%
3	Average number of mango and non-mango plots owned by HH in 2009	2.7	3.3	***	2.9
4	Average number of mango plots owned by HH (within overall HH) in 2009	1.8	2.1	**	2
6	Average number of non-mango plots owned by HH (within overall HH) in 2009	0.7	0.8		0.7
7	Total mango land owned (Ha) in 2009	0.48	1.3	**	0.8
8	Total non-mango land owned (Ha) in 2009	0.24	1.4		0.69
9	Total land owned (mango land + non-mango land) in 2009 (Ha)	0.7	2.7	*	1.5
10	Location of mango plot:				
10.1	Percentage of mango plots located in the same village as HH house (taken as aggregate value per hh then take the average over all hh)	96%	93%		95%
10.2	Percentage of mango plots located in different village but still the same sub district	3%	5%	*	4%

*,**, *** = show statistically different at 10%, 5%, and 1% significant level.

Table 3.3.A. (cont'd)

		Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
11	**Number of trees and characteristics:**				
11.1	Number of mango trees owned by HH in 2009	43	79	***	57
11.2	Number of mango trees which has not bearing fruits (<5 years old)	4	5		4.5
11.3	Number of fruit bearing mango trees	39	74	***	53
11.4	Number of fruit bearing mango trees, more than 40 years old.	10	20	*	16
12	Number of mango trees owned by HH in 2003	25	51	***	35
13	Number of mango trees owned by HH in initial planting	22	43	***	30
14	By variety: (zeroud out)				
14.1	Average share of Harumanis variety planted in the plots	48%	47%		47%
14.2	Average share of Gedong Gincu variety planted in the plots	8%	18%	**	12%
14.3	Average share of Manalagi variety planted in the plots	13%	10%		12%
14.4	Average share of Madu variety planted in the plots	2%	1%		1%
14.5	Average share of Cengkir/Dermayu variety planted in the plots	12%	11%		12%
14.6	Average share of Gadung variety planted in the plots	13%	14%		13.5%
14.7	Average share of other varieties planted in the plots	13%	6%	***	10%

*,**, *** = show statistically different at 10%, 5%, and 1% significant level.

Table 3.3.B. Mango Farm Characteristics in East Java and West Java, Indonesia in 2009, by Farm Size

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
1	Share of HH who owned mango and non-mango plots in 2009	50%	45%	35%	45%
2	Share of HH who owned only mango plots in 2009	50%	55%	65%	56%
3	Average number of mango and non-mango plots owned by HH in 2009	2[a]	2.7[a]	5[b]	2.9
4	Average number of mango plots owned by HH (within overall HH) in 2009	1.2[a]	1.8[b]	3.9[c]	2
6	Average number of non-mango plots owned by HH (within overall HH) in 2009	0.8	0.7	0.8	0.7
7	Total mango land owned (Ha) in 2009	0.1[a]	0.7[a]	1.9[b]	0.8
8	Total non-mango land owned (Ha) in 2009	0.2	0.8	0.5	0.7
9	Total land owned (mango land + non-mango land) in 2009 (Ha)	0.3	1.5	2.4	1.5
10	Location of mango plot:				
10.1	Percentage of mango plots located in the same village as HH house (taken as aggregate value per hh then take the average over all hh)	96%[a,b]	96%[a]	89%[b]	95%
10.2	Percentage of mango plots located in different village but still the same sub district	3%[a,b]	3%[a]	1%[b]	3%

[a, b, c] show statistically different groups at 10% significant level.

Table 3.3.B. (cont'd)

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
11	**Number of trees and characteristics:**				
11.1	Number of mango trees owned by HH in 2009	3.9[a]	30.2[a]	276[b]	57
11.2	Number of mango trees which has not bearing fruits (<5 years old)	0.1[a]	1.4[a]	21[b]	3.6
11.3	Number of fruit bearing mango trees	3.8[a]	28.5[a]	251.6[b]	53
11.4	Number of fruit bearing mango trees, more than 40 years old.	2.3[a]	10[a]	39.4[b]	16
12	Number of mango trees owned by HH in 2003	7.2[a]	26.7[a]	109[b]	35
13	Number of mango trees owned by HH in initial planting	7.6[a]	22.2[a]	99.5[b]	30
14	By variety: (zeroud out)				
14.1	Average share of Harumanis variety planted in the plots	50%	48%	41%	47%
14.2	Average share of Gedong Gincu variety planted in the plots	3%[a]	11%[a]	28%[b]	12%
14.3	Average share of Manalagi variety planted in the plots	15%	12%	5%	12%
14.4	Average share of Madu variety planted in the plots	3%	1%	1%	1%
14.5	Average share of Cengkir/Dermayu variety planted in the plots	10%	12%	12%	12%
14.6	Average share of Gadung variety planted in the plots	6%[a]	13%[a]	25%[b]	13.5%
14.7	Average share of other varieties planted in the plots	8%	10%	11%	10%

[a, b, c] show statistically different groups at 10% significant level.

Table 3.3.C. Comparison on Number of Households in East Java and West Java, Indonesia in 2003 and 2009, by Farm Size

	Marginal in 2003	Small in 2003	Medium in 2003	total
Marginal in 2009	29	5	0	34
Small in 2009	150	160	12	322
Medium in 2009	8	22	18	48
Total	187	187	30	404

Table 3.4.A. Adoption of Mango Trees in East Java and West Java, Indonesia in 2009, by Market Channel

		Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
1	Share of household who add mango trees from initial planting year to 2009 (SOH)	26%	38%	***	30%
2	Number of trees addded[1] (n=282)	15	13		14
3	**Variety adopted[1] (n=282)**				
3.1	Harumanis	27%	36%	*	32%
3.2	Gedong gincu	15%	26%	**	21%
3.3	Manalagi	8%	13%		11%
3.4	Madu	2%	1%		1%
3.5	Cengkir/dermayu	11%	9%		10%
3.6	Gadung	22%	4%	***	13%
3.7	Other	14%	11%		12%
4	**Person who suggested[1] (n=282)**				
4.1	Government extension agent	19%	10%	**	14%
4.2	Input supplier staff	0%	0%		0%
4.3	Friends and relatives	34%	26%		29%
4.4	Sprayer trader	2%	5%		4%
4.5	Buyer	3%	0%	**	2%
4.6	Other	41%	59%	***	51%

*,**, *** = show statistically different at 10%, 5%, and 1% significant level.

Table 3.4.A. (cont'd)

		Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
5	**Reason of adoption[1] (n=282)**				
5.1	Higher productivity	22%	29%		26%
5.2	More resistance to pest	2%	1%		1.7%
5.3	Higher selling price	37%	50%	**	44%
5.4	Constant price over the year	7%	4%		6%
5.5	Other	32%	15%	***	23%
6	**Source of seedlings[1] (n=282)**				
6.1	From government for free	26%	10%	***	18%
6.2	From government with lower price (subsidy)	0%	4%	**	4%
6.3	From private breeder	24%	61%	***	43%
6.4	Buying from neighbor (who is not a breeder)	12%	1%	***	7%
6.5	From own trees	13%	15%		14%
6.6	Other	25%	8%	***	16%
5	**Year of adoption[1]: (n=282)**				
5.1	Less than 5 years ago (2005 to 2009)	47%	45%		46%
5.2	5 to 10 years ago (1999 to 2004)	22%	20%		21%
5.3	More than 10 years ago (before 1999)	31%	35%		33%

1 Taken over all the occurrence of adoption (not aggregated per sample). Samples who adds mango trees more than once with one variety or more than one varieties and sample who add mango one time but having more than one variety planted, each is considered as one observation. *,**, *** = show statistically different at 10%, 5%, and 1% significant level.

Table 3.4.B. Adoption of Mango Trees in East Java and West Java, Indonesia in 2009, by Farm Size

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
1	Share of household who add mango trees from initial planting year to 2009 (SOH)	12%[a]	29%[b]	52%[c]	30%
2	Number of trees addded[1] (n=282)	1.8[a]	4.9[a]	33[b]	13.6
3	**Variety adopted[1] (n=282)**				
3.1	Harumanis	20%	30%	36%	32%
3.2	Gedong gincu	0%	19%	25%	21%
3.3	Manalagi	0%	13%	7%	11%
3.4	Madu	0%	2%	1%	1%
3.5	Cengkir/dermayu	40%[a]	9%[b]	9%[b]	10%
3.6	Gadung	0%	12%	16%	13%
3.7	Other	40%[a]	15%[b]	5%[b]	12%
4	**Person who suggested[1] (n=282)**				
4.1	Government extension agent	0%[a]	5%[a]	34%[b]	14%
4.2	Input supplier staff	0%	0%	0%	0%
4.3	Friends and relatives	0%	33%	25%	29%
4.4	Sprayer trader	0%[a,b]	1%[a]	10%[b]	4%
4.5	Buyer	0%	2%	0%	1.4%
4.6	Other	80%[a]	59%[a]	30%[b]	51%
5	**Reason of adoption[1] (n=282)**				
5.1	Higher yield	0%	27%	25%	26%
5.2	More resistance to pest and disease	0%	3%	0%	2%
5.3	Higher selling price	20%[a,b]	37%[a]	59%[b]	44%
5.4	Constant price over the year	0%[a,b]	4%[a]	10%[b]	6%
5.5	Other	80%[a]	30%[b]	5%[c]	23%
6	**Source of seedlings[1] (n=282)**				
6.1	From government for free	0%[a]	10%[a]	37%[b]	18%
6.2	From government with lower price (subsidy)	0%[a,b]	0%[a]	7%[b]	2%
6.3	From private breeder	60%	42%	44%	43%
6.4	Buying from neighbor (who is not a breeder)	0%	9%	2%	7%
6.5	From own trees	0%	16%	10%	14%

Table 3.4.B. (cont'd)

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
6.6	Other	40%[a]	23%[a]	0%[b]	16%
7	**Year of adoption[1] (n=282)**				
7.1	Less than 5 years ago (2005 to 2009)	100%[a]	41%[b]	39%[b]	46%
7.2	5 to 10 years ago (1999 to 2004)	0%	21%	22%	21%
7.3	More than 10 years ago (before 1999)	0%	38%	39%	39%

1 Taken over all the occurrence of adoption (not aggregated per sample). Samples who adds mango trees more than once with one variety or more than one varieties and sample who add mango one time but having more than one variety planted, each is considered as one observation.
[a, b, c] show statistically different groups at 10% significant level.

Table 3.4.C. Adoption of Mango Trees in East Java and West Java, Indonesia in 2009, by Province

		Households that located in East Java (n= 204)	Households that located in West Java (n= 200)	ttest	Overall N= 404
1	Share of household who add mango trees from initial planting year to 2009 (SOH)	22%	39%	***	30%
2	Number of trees addded[1] (n=282)	15	13		14
3	**Variety adopted[1] (n=282)**				
3.1	Harumanis	29%	32%	*	32%
3.2	Gedong gincu	0%	30%	**	21%
3.3	Manalagi	25%	4%		11%
3.4	Madu	3%	1%		1%
3.5	Cengkir/dermayu	0%	15%		10%
3.6	Gadung	37%	2%	***	13%
3.7	Other	4%	16%		12%
4	**Person who suggested[1] (n=282)**				
4.1	Government extension agent	21%	19%	**	14%
4.2	Input supplier staff	0%	0%		0%
4.3	Friends and relatives	43%	23%		29%
4.4	Sprayer trader	4%	3%		4%
4.5	Buyer	1%	2%	**	2%
4.6	Other	29%	61%	***	51%
5	**Reason of adoption[1] (n=282)**				
5.1	Higher productivity	36%	21%	***	26%
5.2	More resistance to pest	0%	3%		1.7%
5.3	Higher selling price	44%	44%	**	44%
5.4	Constant price over the year	12%	3%	***	6%
5.5	Other	9%	30%	***	23%
6	**Source of seedlings[1] (n=282)**				
6.1	From government for free	28%	13%	***	18%
6.2	From government with lower price (subsidy)	0%	3%	**	4%
6.3	From private breeder	22%	53%	***	43%

Table 3.4.C. (cont'd)

		Households that located in East Java (n= 247)	Households that located in West Java (n= 157)	ttest	Overall N= 404
6.4	Buying from neighbor (who is not a breeder)	12%	4%	**	7%
6.5	From own trees	32%	5%	***	14%
6.6	Other	4%	22%	***	16%
5	Year of adoption1: (n=282)				
5.1	Less than 5 years ago (2005 to 2009)	9%	57%	***	46%
5.2	5 to 10 years ago (1999 to 2004)	18%	22%		21%
5.3	More than 10 years ago (before 1999)	73%	21%	***	33%

*,**, *** = show statistically different at 10%, 5%, and 1% significant level.

Table 3.5.A. Technology Used by Mango Farmers in East Java and West Java, Indonesia in 2009 by Market Channel

		Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
1	Growth hormone				
1.1	HH uses growth hormone (Share over all hh, SOH)	19%	43%	***	28%
1.2	Introduced by: (SOH)				
1.2.1	Government extension agent	3%	4%		3%
1.2.2	Private extension agent (from input supplier)	0%	1%	*	0.5%
1.2.3	Other farmers	13%	24%	***	17%
1.2.4	ST	1%	6%	***	2.5%
1.2.5	Mango buyer	0.1%	2%		1.2%
1.2.6	Other	2%	6%	**	3%
2	Fertilizer				
2.1	HH uses fertilizer (SOH)	67%	73%		70%
2.2	Introduced by: (SOH)				
2.2.1	Government extension agent	5%	7%		6%
2.2.2	Private extension agent (from input supplier)	0%	0%		0%
2.2.3	Other farmers	36%	39%		37%
2.2.4	ST	1%	5%	***	2.5%
2.2.5	Mango buyer	0.1%	2%		1.2%
2.2.6	Other	24%	18%		22%
3	Pesticides				
3.1	HH uses pesticides (SOH)	30%	52%	***	39%
3.2	Introduced by: (SOH)				
3.2.1	Government extension agent	4%	5%		4.2%
3.2.2	Private extension agent (from input supplier)	0%	1%		0.7%
3.2.3	Other farmers	19%	29%	**	23%
3.2.4	ST	0%	6%	***	3%
3.2.5	Mango buyer	1%	1%		1%
3.2.6	Other	4%	10%	**	6%

*,**, *** = show statistically different at 10%, 5%, and 1% significant level.

Table 3.5.A. (cont'd)

	Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
4. HH do pruning on their trees (SOH)	40%	54%	***	45%
5 Non land asset: (SOH)				
5.1 HH owns manual sprayer in 2009	36%	55%	***	43%
5.2 HH owns manual sprayer in 2005	32%	46%	***	37%
5.3 HH owns power sprayer in 2009	5%	14%	***	8%
5.4 HH owns power sprayer in 2005	1%	7%	***	3%
5.5 HH owns *Anclong* (harvesting tools) in 2009	41%	48%		44%
5.6 HH owns *Anclong* (harvesting tools) in 2005	38%	41%		39%
5.7 HH own truck and other vehicles in 2009	47%	71%	***	8%
5.8 HH own truck and other vehicles in 2005	38%	63%	***	3%

*,**, *** = show statistically different at 10%, 5%, and 1% significant level.

Table 3.5.B. Technology Used by Mango Farmers in East Java and West Java, Indonesia in 2009, by Farm Size

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
1	Growth hormone				
1.1	HH uses growth hormone (Share over all hh, SOH)	3%[a]	25%[b]	63%[c]	28%
1.2	Introduced by: (SOH)				
1.2.1	Government extension agent	0%[a]	3%[a]	10%[b]	3%
1.2.2	Private extension agent (from input supplier)	0%	0%	2%	0.04%
1.2.3	Other farmers	3%[a]	15%[a]	44%[b]	17%
1.2.4	ST	0%	3%	4%	3%
1.2.5	Mango buyer	0%	2%	0%	1%
1.2.6	Other	0%	4%	2%	3%
2	Fertilizer				
2.1	HH uses fertilizer (SOH)	56%[a]	67%[a]	92%[b]	69%
2.2	Introduced by: (SOH)				
2.2.1	Government extension agent	3%[a,b]	5%[a]	13%[b]	7%
2.2.2	Private extension agent (from input supplier)	0%	1%	0%	1%
2.2.3	Other farmers	32%[a]	34%[a]	60%[b]	37%
2.2.4	ST	0%	2%	2%	2%
2.2.5	Mango buyer	0%	2%	0%	1%
2.2.6	Other	21%	23%	17%	22%
3	Pesticides				
3.1	HH uses pesticides (SOH)	6%[a]	36%[b]	79%[c]	39%
3.2	Introduced by: (SOH)				
3.2.1	Government extension agent	0%	3%	15%	4%
3.2.2	Private extension agent (from input supplier)	0%	0.6%	2%	0.7%
3.2.3	Other farmers	6%[a]	21%[a]	50%[b]	23%
3.2.4	ST	0%	3%	4%	3%
3.2.5	Mango buyer	0%	1%	2%	1%
3.2.6	Other	0%	7%	6%	6%

[a, b, c] show statistically different groups at 10% significant level.

Table 3.5.B. (cont'd)

	Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
4. HH do pruning on their trees (SOH)	26%[a]	43%[a]	72%[b]	45%
5 Non land asset: (SOH)				
5.1 HH owns manual sprayer in 2009	21%[a]	40%[b]	83%[c]	44%
5.2 HH owns manual sprayer in 2005	21%[a]	33%[a]	77%[b]	37%
5.3 HH owns power sprayer in 2009	3%[a]	5%[a]	31%[b]	8%
5.4 HH owns power sprayer in 2005	3%[a]	2%[a]	15%[b]	3%
5.5 HH owns *Anclong* (harvesting tools) in 2009	24%[a]	43%[b]	64%[c]	44%
5.6 HH owns *Anclong* (harvesting tools) in 2005	23%[a]	37%[a,b]	63%[b]	39%
5.7 HH own truck and other vehicles in 2009	32%[a]	56%[b]	77%[c]	57 %
5.8 HH own truck and other vehicles in 2005	29%[a]	48%[a,b]	63%[b]	48%

[a, b, c] show statistically different groups at 10% significant level.

Table 3.6.A. Output Produced and Inputs Used by Mango Farmers in East Java and West Java, Indonesia in 2009, by Market Channel

	Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
1 Outputs for Mango production for the year 2009				
1.1 Total production (kg)	2786	5693	***	3915
1.2 Yield (kg/tree)	72.8	95.5	**	81.6
2 Variable costs (per tree for 2009)				
2.1 Fertilizer expenditure[1](USD)	0.6	0.9		0.7
2.2 Pesticides expenditure (USD)	0.4	0.5		0.44
2.3 Hired labor wages (USD)	28.3	12.8		22.3
2.4 Family labor, imputed [2] (USD)	9.2	17.5		12.5
2.5 Total labor expenditure (USD)	37.5	30.3		34.7

1. Total expenditure on fertilizer for mango production is defined as the total expenditure aggregated over all seasons in 2009.
2. Family labor is calculated by aggregating over all seasons in 2009, the total number of family days worked in mango production, multiplied by the average village farm wage.

*,**, *** = show statistically different at 10%, 5%, and 1% significant level.

Table 3.6.B. Output Produced and Inputs Used by Mango Farmers in East Java and West Java, Indonesia in 2009, by Farm Size

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
1	Outputs for Mango production for the year 2009				
1.1	Total production (kg)	294.3[a]	2067.3[a]	18881.3[b]	3916
1.2	Yield (kg/tree)	74.4	82.5	80.2	81.6
2	Variable costs (per tree for 2009)				
2.1	Fertilizer expenditure[1](USD)	0.2	0.8	0.5	0.7
2.2	Pesticides expenditure (USD)	0.01	0.46	0.57	0.44
2.3	Hired labor wages (USD)	1.4	24.1	24.5	22.3
2.4	Family labor, imputed [2] (USD)	1.4	13.4	14.3	12.5
2.5	Total labor expenditure (USD)	2.8	37.5	38.8	34.7

[a, b, c] show statistically different groups at 10% significant level.

Table 3.7.A. Contract Arrangements between ST and Mango Farmers in East Java and West Java, Indonesia in 2009, by Market Channel

		Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
1	Use ST in 2009	3%	12%	***	7%
2	Reason of using ST:	n=8	n=19		n=27
2.1	Better knowledge in specific activity	40%	63%		56%
2.2	Better knowledge in cultivating mango	13%	68%	***	52%
2.3	Better information and access to market	38%	68%		59%
2.4	Better capital	63%	63%		63%
2.5	Better access to credit and input	0%	32%	**	22%
2.6	Buyer' demand	0%	11%		7%
2.7	Buyer provides ST	0%	5%		4%
2.8	HH has other more important occupation	13%	58%	**	44%
2.9	Too little mango trees	0%	0%		0%
2.10	Too many mango trees	25%	32%		29%
3	Contract arrangement between Owner and ST in 2009:	n=8	n=19		n=27
3.1	HH receives a fixed amount (lease holding) from ST	88%	84%		85%
3.2	HH receives a share on % basis	13%	16%		15%
4.	Timing when contract agreed:	n=8	n=19		n=27
4.1	Before the tree flowering	88%	79%		81%
4.2	When the tree flowering	13%	0%		4%
4.3	When the tree bearing small fruit	0%	11%		7%
4.4	When the tree almost ready to harvest	0%	5%		4%
5.	Duration of the contract (years)	2.9	3.3		3.2
6.	Payment method:	n=8	n=19		n=27
6.1	Cash	100%	100%		100%
6.2	Goods (mango)	-	-		-
6.3	Cash and goods (mango)	-	-		-

*,**, *** = show statistically different at 10%, 5%, and 1% significant level.

Table 3.7.A. (cont'd)

		Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
7	Number of ST who offers a contract before HH decides to deal with an ST	n=8	n=19		n=27
7.1	Only one ST	63%	68%		67%
7.2	More than one ST	38%	32%		33%
8	From prior years, HH knows how much the tree will yield:	n=8	n=19		n=27
8.1	Know for sure	13%	0%		4%
8.2	Know, but not sure	25%	32%		29%
8.3	No idea at all	63%	68%		67%
9	HH decides the buyer for the trees under contract	13%	10%		11%
10.	Base to determine the value of contract arrangement between HH and ST:	n=8	n=19		n=27
10.1	Per activity	-	-		-
10.2	Per tree	33%	5%	**	13%
10.3	Per plot	22%	43%		37%
10.4	All mango trees that HH has	44%	52%		50%
11.	Value of contract arrangement per tree[1] (USD)	11.8	11.7		11.7
12	HH receives fully payment on the day of contract agreed (n=27)	9%	81%		85%
13	HH receives payment between the contract agreed and before the harvest (n=27)	0%	6%		4%
14	HH receives fully payment after harvest day (n=27)	10%	13%		11%

*,**, *** = show statistically different at 10%, 5%, and 1% significant level.

Table 3.7.B. Contract Arrangements between ST and Mango Farmers in East Java and West Java, Indonesia in 2009, by Farm Size

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
1	Use ST in 2009	0%[a]	6%[a]	15%[b]	7%
2	Reason of using ST:	n=0	n=20	n=7	n=27
2.1	Better knowledge in specific activity	-	55%	57%	56%
2.2	Better knowledge in cultivating mango	-	50%	57%	52%
2.3	Better information and access to market	-	50%[a]	86%[b]	59%
2.4	Better capital	-	55%	86%	63%
2.5	Better access to credit and input	-	20%	29%	22%
2.6	Buyer' demand	-	10%	0%	7%
2.7	Buyer provides ST	-	5%	0%	4%
2.8	HH has other more important occupation	-	50%	29%	44%
2.9	Too little mango trees	-	0%	0%	0%
2.10	Too many mango trees	-	10%[a]	86%[b]	29%
3	Contract arrangement between Owner and ST in 2009:	n=0	n=20	n=7	n=27
3.1	HH receives a fixed amount (lease holding) from ST	-	90%	71%	85%
3.2	HH receives a share on % basis	-	10%	29%	15%
4.	Timing when contract agreed:	-	n=20	n=7	n=27
4.1	Before the tree flowering	-	80%	86%	81%
4.2	When the tree flowering	-	5%	0%	4%
4.3	When the tree bearing small fruit	-	10%	0%	7%
4.4	When the tree almost ready to harvest	-	5%	0%	4%
5.	Duration of the contract (years)	-	3.2	3.1	3.2
6.	Payment method:	-	n=20	n=7	n=27
6.1	Cash	-	95%	100%	100%
6.2	Goods (mango)	-	-		-
6.3	Cash and goods (mango)	-	-		-

[a, b, c] show statistically different groups at 10% significant level.

Table 3.7.B. (cont'd)

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
7	Number of ST who offers a contract before HH decides to deal with an ST	n=0	n=20	n=7	n=27
7.1	Only one ST		70%	57%	67%
7.2	More than one ST		30%	43%	33%
8	From prior years, HH knows how much the tree will yield:		n=19		n=27
8.1	Know for sure		5%	0%	4%
8.2	Know, but not sure		25%	43%	29%
8.3	No idea at all		70%	57%	67%
9	HH decides the buyer for the trees under contract		15%	0%	11%
10.	Base to determine the value of contract arrangement between HH and ST:	n=0	n=20	n=7	n=27
10.1	Per activity	-	-		-
10.2	Per tree		17%	0%	13%
10.3	Per plot		35%	43%	37%
10.4	All mango trees that HH has		48	57%	50%
11.	Value of contract arrangement per tree[1] (USD)		13.76	6.17	11.7
12	HH receives fully payment on the day of contract agreed (n=27)		84%	85%	85%
13	HH receives payment between the contract agreed and before the harvest (n=27)		5%	0%	4%
14	HH receives fully payment after harvest day (n=27)		11%	14%	11%

a, b, c show statistically different groups at 10% significant level.

Table 3.7.B. (cont'd)

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
15.1	HH is fully responsible to pay all production cost	-	-		-
15.2	ST is fully responsible to pay all production cost	-	84%	11%	88%
15.3	HH and ST are responsible to pay all production cost	-	100%	0%	8%

1. Value of contract per tree is calculated by divided the contract value by number of trees under contract.

a, b, c show statistically different groups at 10% significant level.

Table 3.8.A. Mango Price Received by Mango Farmers in East Java and West Java, Indonesia in 2009, by Market Channel

		Households that participate only in the traditional market channel (n= 247)	Households that participate in the modern market channel (n= 157)	ttest	Overall N= 404
1.	Type of selling:				
1.1	Per tree	14%	15%		14%
1.2	By tebasan[1]	51%	44%	**	48%
1.3	Per unit (kg)	35%	41%		38%
2	Price if per tree selling:	(n=34)	(n=31)		(n=65)
2.1	Average price (USD/tree)	21	31		26
2.2	Maximum average price	99	221		221
2.3	Minimum average price	2	6		2
2.4	Standard deviation	23.8	37		31
3	Price if *tebasan* selling:	(n=125)	(n=70)		(n=195)
3.1	Average price (USD/tree)[2]	32	42		36
3.2	Maximum average price	454	665		665
3.3	Minimum average price	1.1	1.7		1.1
3.4	Standard deviation	71.8	104		85
4	Price if per Kg selling for Harumanis[3]:	(n=74)	(n=68)		(n=142)
4.1	Mango is sorted (share overall hh who sold harumanis)	28%	69%	***	48%
4.1.1	Average price for non-sorted (USD/kg)	.36	0.57	***	0.4
4.2	Sorted price:				(n=68)
4.2.2	Average grade 1 price (USD/kg)	0.58	0.73		0.7
4.2.3	Average grade 2 price (USD/kg)	0.47	0.66		0.63
4.2.4	Average grade 3 price (USD/kg)	0.33	0.41		0.4

1. *Tebasan* is a selling system which the price for the selling is for all mango trees that a household has and usually done before harvest.
2. The price per tree when farmer selling by tebasan, is calculated by dividing tebasan price (that a household received over all seasons in 2009) by number of trees selling under tebasan, then averaging over all households within the same stratum.
3. Only calculated for Harumanis mango variety since it is the most common owned by HH.

*,**,*** = means are statistically different at 10,5,1 % significant level.

Table 3.8.B. Mango Price Received by Mango Farmers in East Java and West Java, Indonesia in 2009, by Farm Size**.**

		Marginal grower (4-10 trees) n= 34	Small grower (11-100 trees) n= 322	Medium grower (>100 trees) n= 48	Overall N= 404
1.	Type of selling: (SOH)				
1.1	Per tree	29%[a]	14%[a]	2%[b]	14%
1.2	By tebasan[1]	50%[a]	49%[a]	25%[b]	48%
1.3	Per unit (kg)	21%[a]	34%[a]	71%[b]	38%
2	Price if per tree selling:	(n=10)	(n=53)	(n=2)	(n=65)
2.1	Average price (USD/tree)	26	25.8	19.9	26
2.2	Maximum average price	77.6	221.7	33.2	221
2.3	Minimum average price	5.5	1.67	6.65	2
2.4	Standard deviation	20.4	33.36	18.8	31
3	Price if *tebasan* selling:	(n=64)	(n=164)	(n=15)	(n=195)
3.1	Average price (USD/tree)[2]	15	36	57	36
3.2	Maximum average price	33.3	454.5	665	665
3.3	Minimum average price	2.8	1.1	2.4	1.1
3.4	Standard deviation	8.35	77.8	168.6	85
4	Price if per Kg selling for Harumanis[3]:	(n=5)	(n=103)	(n=34)	(n=142)
4.1	Mango is sorted (share overall hh who sold harumanis)	0%[a]	47%[a,b]	59%[b]	48%
4.1.1	Average price for non-sorted (USD/kg)	-	0.4[a]	0.6[b]	0.4
4.2	Sorted price:	(n=0)	(n=13)	(n=6)	(n=19)
4.2.2	Average grade 1 price (USD/kg)	-	0.66	0.79	0.7
4.2.3	Average grade 2 price (USD/kg)	-	0.65	0.55	0.63
4.2.4	Average grade 3 price (USD/kg)	-	0.42	0.36	0.4

[a, b, c] show statistically different groups at 10% significant level.

Table 3.9. Technology Used by Mango Farmers in East Java and West Java, Indonesia in 2009, by Sprayer Trader Use

		Households that does not participate in ST arrangement (n= 377)	Households that participate ST arrangement (n= 27)	ttest	Overall N= 404
1	Growth hormone				
1.1	HH uses growth hormone (Share over all hh, SOH)	25%	67%	***	28%
1.2	Introduced by: (SOH)				
1.2.1	Government extension agent	3%	7%		3%
1.2.2	Private extension agent (from input supplier)	1%	0%		0.5%
1.2.3	Other farmers	17%	22%		17%
1.2.4	ST	0%	37%	***	2.5%
1.2.5	Mango buyer	1%	0%		1.2%
1.2.6	Other	3%	0%		3%
2	Fertilizer				
2.1	HH uses fertilizer (SOH)	67%	93%	***	70%
2.2	Introduced by: (SOH)				
2.2.1	Government extension agent	5%	11%		6%
\	Private extension agent (from input supplier)	1%	0%		0%
2.2.3	Other farmers	38%	29%		37%
2.2.4	ST	0%	33%	***	2.5%
2.2.5	Mango buyer	1%	0%		1.2%
2.2.6	Other	22%	19%		22%
3	Pesticides				
3.1	HH uses pesticides (SOH)	36%	78%	***	39%
3.2	Introduced by: (SOH)				
3.2.1	Government extension agent	4%	4%		4.2%
3.2.2	Private extension agent (from input supplier)	0%	0%		0.7%
3.2.3	Other farmers	23%	22%		23%
3.2.4	ST	0%	41%	***	3%
3.2.5	Mango buyer	1%	4%		1%
3.2.6	Other	6%	4%		6%

*,**, *** = show statistically different at 10%, 5%, and 1% significant level.

Table 3.9. (cont'd)

	Households that does not participate in ST arrangement (n= 377)	Households that participate ST arrangement (n= 27)	ttest	Overall N= 404
4. HH do pruning on their trees (SOH)	45%	41%		45%
5 Non land asset: (SOH)				
5.1 HH owns manual sprayer in 2009	44%	41%		43%
5.2 HH owns manual sprayer in 2005	38%	26%		37%
5.3 HH owns power sprayer in 2009	9%	4%		8%
5.4 HH owns power sprayer in 2005	3%	3%		3%
5.5 HH owns *Anclong* (harvesting tools) in 2009	45%	37%		44%
5.6 HH owns *Anclong* (harvesting tools) in 2005	40%	26%		39%
5.7 HH own truck and other vehicles in 2009	58%	33%	**	57%
5.8 HH own truck and other vehicles in 2005	49%	33%		48%

*,**, *** = show statistically different at 10%, 5%, and 1% significant level.

Table 4.1. Bi-probit Results of Participation in the modern Market Channels and Use of Sprayer Trader (ST) Services by Mango Farmers in West Java and East Java in 2009

	Household participates in modern market channel[1]	**Household uses the services of a ST**
1. Number of adults (aged 15 or older) in the household (HH)	-0.033 (0.46)	-0.0809 (1.03)
2. Dependency ratio in the HH in 2009	0.001 (0.45)	-0.002 (0.78)
3. Education of the head of HH (years)	0.054 (2.30)**	-0.028 (0.91)
4. Number of mango trees that the HH owned in 2008	0.003 (1.28)	-0.001 (0.36)
5. Irrigated mango orchard in 2005 (Yes = 1, No = 0)	0.759 (3.84)***	-0.156 (0.48)
6. Share of niche variety trees owned in 2009	-0.000 (0.07)	0.001 (0.38)
7. Value of Nonfarm income in 2005 (usd)	-0.000 (4.06)***	0.000 (0.03)
8. Had more than 100 trees and had off-farm income in 2005	0.234 (0.36)	2.658 (2.90)***
9. Owned rice field in 2005 (Yes = 1, No = 0)	0.285 (1.36)	-0.319 (1.03)
10. HH owned a truck or other farm vehicle in 2005 (Yes = 1, No = 0)	0.348 (1.90)**	-0.723 (3.09)***
11. HH had a relative who worked in the modern Market channel in 2005 (Yes = 1, No = 0)	0.863 (2.71)***	
12. Travel time from farm to province road (minutes)	0.015 (3.42)***	0.003 (0.52)
13. Located in West Java (Yes = 1, No = 0)	0.550 (2.93)***	0.478 (1.74) *
14. Located in mango concentration area (Yes = 1, No = 0)	0.445 (2.07)**	0.703 (2.02)**
15. Input supplier population in village in 2009	-0.005 (0.08)	0.195 (1.92) *
16. Existence of micro finance institution in village level in 2009 (Yes = 1, No = 0)	0.330 (1.39)	-0.056 (0.17)
17. HH uses a ST (1= Yes, 0=No)	-0.529 (1.28)	
18. Field school in village level held in 2005 (1= Yes, 0=No)		-0.705 (2.11)**

Table 4.1. (cont'd)

	Household participates in modern market channel[1]	Household uses the services of a ST
19. Constant	-2.122	-1.544
	(4.69)***	(2.56)***
Observation	404	404
Wald Chi2(34)	182.03	
Prob > Chi2	0.000	
Rho	0.904	
Prob > Chi2	0.014	

1. Participation in the modern Market channel is defined as selling to a first or second buyer from the following options: wholesalers in Jakarta and Surabaya (by-passing the local traders – thus shortening the chain), specialized/dedicated wholesalers (modern agents who sell mainly to supermarkets), mango processors, hotels, restaurants, exporters, and modern retail).

Coefficients with asterisks (*,**,***) imply statistical significance at (10,5,1)% level

Table 4.2. Outputs, Inputs, and Technology Adoption by Mango Farmers in Java in 2009

	Mango Production[1]	Labor[2]	Fertilizers[3]	Pesticides[4]	Hormones[5]
1. Number of adults (aged 15 to 64) in the HH in 2009	2.169 (0.63)	0.146 (0.38)	0.146 (0.38)	0.061 (1.16)	0.024 (1.979) **
2. Dependency ratio in the HH in 2009	-0.042 (0.62)	0.001 (0.11)	0.002 (0.12)	-0.001 (1.01)	-0.001 (1.64)*
3. Education of the head of HH (years)	1.578 (1.52)	0.116 (0.82)	0.116 (0.82)	-0.005 (0.28)	-0.001 (0.09)
4. Participate in field school in 2005 (Yes = 1, No = 0)	-20.756 (1.81) **	0.849 (0.59) ***	0.849 (0.59)	-0.038 (0.50)	0.175 (2.62) ***
5. HH participated in a farmer´s organization or cooperative in 2005 (Yes = 1, No = 0)	9.07 (0.82)	0.066 (0.05)	0.066 (0.05)	0.043 (0.44)	0.149 (2.29) **
6. Number of mango trees that the HH owned in 2009	0.013 (0.44)	-0.002 (0.18)	-0.002 (0.18)	0 .001 (1.16)	0.001 (4.08) ***
7. Has rice field in 2009 (Yes = 1, No = 0)	-6.35 (0.98)	0.118 (0.09)	0.118 (0.09)	0.07 (1.10)	-0.003 (0.08)
8. Land holding in 2009 (in metric squared)	-0.001 (0.56)	-0.001 (5.47)***	0.001 (5.47)***	-0.001 (0.12)	0.001 (6.37) ***
9. HH owned truck or other vehicle in 2009 (Yes = 1, No = 0)	-0.859 (0.08)	3.589 (2.19) **	3.589 (2.19) **	0.222 (2.75) ***	0.227 (5.26) ***
10. Off-farm income in 2005 (in USD)	-0.003 (1.32)	-0.001 (1.22)	-0.001 (1.22)	0.001 (0.16)	-0.001 (1.61)*

Table 4.2. (cont'd)

	Mango Production[1]	Labor[2]	Fertilizers[3]	Pesticides[4]	Hormones[5]
11. Travel time from mango farm to province road (minutes)	0.185 (0.54)	0.086 (1.25)	0.086 (1.25)	-0.001 (1.07)	0.003 (2.66) ***
12. Located in West Java (Yes = 1, No = 0)	-36.381 (3.57) ***	7.207 (3.54)***	7.206 (3.54) ***	0.226 (2.19)**	0.082 (1.41)**
13. Located in mango concentration area (Yes = 1, No = 0)	35.597 (3.57) ***	-0.104 (0.05)	-0.104 (0.05)	0.085 (1.10)	-0.058 (0.92)
14. Rainfall level in 2009 (mm/year)	0.003 (0.22)	-0.001 (0.34)	-0.001 (0.73)	0.001 (2.81)***	0.001 (2.40)**
15. ST use in 2009 (Yes=1, No=0)	81.626 (1.78)*	3.793 (1.89)*	3.793 (1.89)*	0.908 (3.35)***	0.509 (7.18)***
16. HH participates in the modern market channel (fitted probability)[6]	-89.199 (1.71)	11.994 (1.47)	11.99 (1.47)	-0.595 (1.20)	0.428 (1.78)*
17. Constant	73.992 (3.17) ***	14.38 (0.35)	-1.87 (0.45)	-0.276 (1.07)	-0.276 (2.13)**
Observations	404	404	404	404	404
P-value	0.000	0.000	0.000	0.002	0.000
P > Chi squared	0.000	0.000	0.000	0.000	0.000

1. Mango production is defined as yield in kilograms for Mango aggregated over all seasons in 2009.
2. Labor is represented as the total expenditure in labor (both hired and family) per tree for mango production aggregated over all seasons in 2009. For family labor we have calculated the imputed value of family labor by multiplying the amount of family days used in mango production by the average agricultural wage at the village level.
3. Fertilizers are represented as the total fertilizer (both ground and foliar) per tree used in mango production aggregated overall seasons in 2009 in kilograms.

Table 4.2. (cont'd)

4. Pesticides are represented as the total expenditure on fungicides and insecticides per tree for mango production aggregated over all seasons in 2009.
5. Hormones are represented by binary variables which indicate whether the household use this input in mango production in 2009.
6. Participation in the modern markets is Not an observed outcome variable, but rather the predicted probability of participation derived from the Bi-probit model.
7. Coefficients with asterisks (*,**,***) imply statistical significance at (10,5,1)% level.

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