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The potential for mangoes in eastern Indonesia

SADI-ACIAR research report

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prepared by	Mr Ian Baker
contributors	Muji Rahayu Assessment Institute for Agriculture Technology – Nusa Tenggara Barat Herman Suheri University of Mataram Mursal Dinas Pertanian Provinsi Nusa Tenggara Barat
approved by	David Shearer

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ACIAR's participation in the Australia–Indonesia Partnership

The Australia–Indonesia Partnership (AIP), comprising $500 million in grants and $500 million in highly concessional loans over five years, was announced in January 2005. The partnership supports Indonesia's reconstruction and development efforts, both in and beyond tsunami-affected areas. Assistance involves long-term sustained cooperation focused on economic and social development projects and Indonesia's programs of reform and democratisation.

ACIAR is committed to the partnership through the management of a component of the Smallholder Agribusiness Development Initiative (SADI), which aims to improve rural sector productivity and growth in four eastern provinces — East Nusa Tenggara, West Nusa Tenggara, South East Sulawesi and South Sulawesi.

This initiative will improve incomes and productivity for farmers and agribusiness in response to market opportunities, through a process that is underpinned by improved adaptive research and development capacity.

ACIAR's role in the initiative is to strengthen province-based agricultural research and development capacity that is market and client-driven, and effectively transfers knowledge to end users. A key part of this approach is delivered through market-driven adaptive projects which are priorities for smallholders, farmer groups, agribusiness, government and other supporting agencies.

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1 Acknowledgments

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2 Executive summary

Mangoes are one of the major fruit crops throughout Indonesia and are an important component of the horticulture industry in Nusa Tenggara Barat (NTB). They are particularly important in the drier, poorer areas of eastern Indonesia as a drought tolerant, secure source of income.

Current markets are heavily supplied with the Harumanis variety with little opportunity to develop new market opportunities in either export or out of season markets in other areas of Indonesia.

Through early flowering, it is possible to extend the season, making a longer season for the same production and thereby increasing prices to farmers.

Good out of season export opportunities exist for the variety Gedung gunci, which is grown exclusively in Indonesia. This variety needs to be properly evaluated for its performance as an export and domestic supermarket variety.

Appropriate production technologies such as bagging, post harvest fruit fly treatments, post harvest fungicide treatments, and better control of sap marks at harvest will improve quality, especially in the context of developing export capability.

Other varieties should be introduced and evaluated for adaptation to the unique lowland tropical conditions in Indonesia, for domestic supermarkets and export.

Export will be dependent on building a national capacity to develop access protocols in government, including disinfestation research. This also includes the capacity to manage chemical registration and MRL issues for access.

Indonesia has strong competitive advantages in export. An initial requirement will be to assess export issues and opportunities in both phyto markets and non-phyto markets. The development of an export supply chain must include exporters.

3 Introduction

This report is part of ACIAR's contribution to the Smallholder Agribusiness Development Initiative (SADI) in eastern Indonesia. The concept for the scoping study arose from a series of priority setting workshops.

This scoping study operated from a supply chain approach, looking at ways income could be increased for smallholders as part of a supply chain. This analysis operated from the position of researching issues in profitable sustainable supply chains, rather than an identification of technical constraints. There are many technical constraints however the only ones that matter are those that support profitable and sustainable supply chains. A number of project concepts were developed, identifying research required to make the supply chains work to the benefit of smallholders.

Analysis of the current situation of the technical, marketing and economic issues faced by each crop was conducted. It rapidly became apparent that for some situations it was difficult to improve incomes in the existing supply chain, despite many researchable problems. Adoption of improved technologies in this supply chain is unlikely, as margins are low for all in the chain.

Developing a new supply chain at a higher price, provides the market pull in terms of price for farmers and others to invest and adopt new technologies. Farmers will adopt new technologies where there is sufficient price pull. These benefits will spill over to existing supply chains, for example if a farmer adopts new production systems to improve quality to meet high priced export markets, the portion of the crop sold into domestic markets also benefits from this technology.

The analysis also looks at the economic situation faced by a family farming enterprise, particularly in relation to the ability of the farm to generate sufficient revenue to maintain a standard of living similar to the rest of the population. It is a very high priority to generate economic wealth at least equal to the rest of the population and create an environment where incomes can increase relative to the increase in incomes across Indonesia.

Successful implementation requires strong involvement by all members of the supply chain as active participants in the research. These initiatives will fail if researchers proceed in the absence of input from as many potential participants in the supply chain.

The results of the analysis arose from visits to farmers, governments and private sector players in the three provinces, as well as in other areas of Indonesia where similar crops are grown. Three visits were conducted during February to June 2007. A series of project development workshops were held at the end of the consultancy to develop project concepts from the scoping mission. These workshops included a wide range of participants.

4 Production areas and characteristics

Mangoes are one of the major fruit crops in NTB (Table 1) along with jackfruit, citrus and banana. Mangoes are cultivated in all areas of NTB, but the best quality and the majority of production comes from the drier areas and as such is primarily distributed in the drier areas of north Lombok and in the dry areas of Sumbawa. It is relevant to note that these drier areas are also the poorest areas of NTB and in terms of the national economy are amongst the poorest areas of Indonesia.

Table 1: Mango tree numbers and production in NTB

	2005	2004	2003	2002
Tree Numbers	619,943	793,968	1,451,905	1,659,291
Production (tons)	66,012	54,754	39,010	31,527

Source: BPTP NTB

The size of holdings varies from single trees in house gardens that are sold to traders, to the largest farms of around 500 trees. There is no data available on farm size at a provincial level.

The number of mango farmers is probably over 5 000, the largest number of fruit tree farmers in NTB.

5 Season and climate

The season of production is from October to the end of December with the earliest production in the wetter areas and later in the drier areas. The difference in harvest time is only 1-2 weeks. Flowering generally occurs July-August. Timing of production is similar to most other mango areas of Indonesia, limiting opportunities for trade in Indonesia.

The climate for production is generally favourable in the drier areas of North Lombok and Sumbawa with 2-3 months of little or no rain.

In the areas of central and west Lombok (around Mataram), rainfall at harvest and at flowering is more likely, which impairs quality. This is commonly recognised in the market place and as such plantings are fewer in these higher rainfall areas.

The two key climate issues for mango production are:

1. Temperature and rainfall at flowering
2. Rainfall at harvest.

Cool temperatures at flowering increase flowering however rain at flowering severely impairs production and increases fruit rot. Rain at harvest reduces quality (increases skin marks) and increases fruit rot and fruit fly incidence.

Varieties of mangoes differ considerably in their adaptability to high, dry season temperatures at flowering. The varieties grown in the region flower the best during the higher temperatures of the dry months. Harumanis, the main variety in the region, is no exception and is a relatively consistent producer during the dry seasons. Both mango farmers in the region and in northern Australia agree on its performance. This adaptation is a very important consideration in selecting varieties that will be adaptable to this region. From the climate data in Table 2, there is a high probability of rain at harvest in all areas therefore varieties need to have good tolerance to anthracnose. The probability is higher in less favourable areas on Lombok around Mataram and Central Lombok. This factor will also be very important in establishing good quality fruit, which varies year-to-year depending on the extent of rainfall at harvest (dry = good quality, rain = poor quality). It is also relevant in considering varieties adaptable to the region. It is clear that Harumanis has good resistance to anthracnose, based on discussions in NTB and experience with the variety in northern Australia. Resistance to anthracnose will be an important characteristic of suitable varieties.

Table 2: Climate data for Desa Santong (10yr average)

Santong	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Rainfall mm	327	379	239	188	64	49	27.5	10	38	69	184	271
Rain days	17	20	18	15	8	5	4	2	3	8	14	17

The occurrence of any rain at flowering is a major constraint in mango production, through the increase in the incidence of post harvest diseases. Harumanis appears to have relatively good resistance to anthracnose at harvest but is still undoubtedly affected. This factor has to be considered in any attempts to manipulate the time of flowering, which will be limited to flowering in the drier months.

The occurrence of rain at harvest has a negative impact on quality. As skins are softer and less tolerant of marking, skin marks, including marks caused by mango sap, and other marks such as wind rub, will occur more prominently. It is interesting to note that farmers and researchers are not aware of many quality issues including the impact of sap on mango skin. One of the larger farmers was aware of the problem, but not aware of the systems to prevent this damage.

For the drier areas, tree crops represent a very important part of the agricultural economy, as tree crops have greater resistance to the variability in rainfall than annuals. The absence of irrigation in these areas means that farmers have to rely on more drought tolerant production systems like tree crops and cattle. While most will grow dry land rice in the wet season, wet seasons vary in their reliability and short periods of drought can severely reduce rice yields. The current wet season is an example of a poor wet season with rice crops failing throughout the drier areas of east Indonesia.

6 Production technology

There appears to be very little use of ‘normal’ management systems such as:

- irrigation
- nutrition
- canopy management
- pest control
- manipulation of flowering.

In part this is because of three issues:

- Low prices do not encourage management investment.
- Farm size is too small to utilise better technology and too small to have sufficient capital to invest in better production or post harvest technology such as spraying, cool rooms and packing lines.
- Smallholders simply use mangoes opportunistically rather than being committed to the crop. Almost all have another source of on-farm or off-farm income and will grow other crops.

Some farmers may use nutrition or supplements, either organic or inorganic (1 kg/tree). Nitrogen and potassium are the two main elements used however there appears to be no use of the elements calcium, zinc or boron, which are recognised as key elements in mango production.

Most trees are grafted and planted at reasonable spaces (8m x 8m) of around 150 trees per hectare.

Soil analysis of the main production areas indicates that the production areas do have good levels of natural nutrition especially calcium and the cation ratios. Magnesium is high in the drier area of north Lombok (Table 3), creating an unfavourable Ca: Mg ratio, impacting on productivity and quality.

Table 3: Soil analysis of mango site in NTB (Site – Basuki)

	% K	% Na	% Ca	% Mg
1	0.23	0.10	1.02	0.43
2	0.56	0.16	1.37	0.72
3	0.23	0.10	0.83	0.51

Despite very low management, yields appear to be reasonable at around 100-150 kg/tree. Accurate yield data is not available but discussion with farmers indicates yields are reasonable and also fairly consistent each year despite the variation in dry season temperatures and rainfall. This reflects the importance of the characteristics of the main variety Harumanis. This is the main management input farmers have - the genetics of the variety.

Harumanis, the main variety throughout Indonesia, is a good sized variety (3 fruit/kg) that has excellent eating quality, is not too vigorous in growth, is a consistent producer at around 100 kg/tree, and is classified as a mid season variety compared with other varieties. It is long in shape with persistent green skin when ripe. This is a peculiarity of Indonesian varieties and one that limits the penetration of Indonesian production into world markets. Indonesia should be a large exporter of mangoes, as they are produced out of season to the main producers in India, Thailand and Philippines. However is not due primarily to the green skin of Harumanis.

Harumanis may develop more yellow colour if ripened at lower temperatures than ambient (less than 20C). The variety Madu is commonly used for home consumption. It is also green skinned but smaller and may be more productive. Golek is less common.

There is very little use of any post harvest management including:

- harvesting systems to control sap burn
- post harvest chemicals for fruit fly and anthracnose
- cool chains
- packing
- grading for size and quality.

In many cases the farmer sells the fruit before harvest and a trader will pick the crop. In this system there may not be any benefit to the farmer to invest in pre-harvest management that improves size and quality grades. There does not appear to be any concern about fruit being picked immature, probably because there is no price advantage to do so.

The marketing chain is rapid with fruit sold quickly. One issue is that Harumanis is widely believed to have green skin when ripe. This may be due in part because it has never been subject to cool temperatures during ripening. It is well recognised that high temperatures during ripening (above 20C), are not favourable for development of yellow skin colour. Harumanis is tolerant of low levels of post harvest management in that it has reasonable resistance to fruit rot.

There is no recognition of the impact of sap at harvest on skin browning, an important issue in all mango varieties. Discussion with leading farmers indicated they were aware of the problem but did not have any real system to control sap burn. While sap burn may not be as important as in Australia, it is important to acknowledge that Harumanis does incur skin damage from sap burn. Minimising sap burn will become important in developing export capability.

An issue that may be of relevance is that mango harvest occurs at the same time as the planting of rice and there may be some conflicts in labour use. Similarly as the cost of living rises and the need to increase family income forces at least one member of the family to work off-farm, there may be an increasing use of traders to harvest crops with the fruit being sold off the tree.

7 Current market situation

Mangoes are sold into local markets near production centres. Seasons are similar in Lombok to Bali and East Java so there is little opportunity to sell out of season or early season to other areas of Indonesia. Mangoes mature a little earlier in the wetter area of west and central Lombok by 1 or 2 weeks and these growers may receive higher prices, albeit for a short period. Prices after this time rapidly drop to around Rp1000/kg or less. In-season market price is around Rp1500/kg.

Most fruit is sold on the tree to a trader who picks, packs, transports and sells the fruit sometimes to another wholesaler, or to the market. The mark up in the supply chain from tree to consumer is around 100%, normal for most trading (from Rp800 /kg to the farmer to Rp1500 /kg at the market). Some larger farmers (500 trees) pick the crop and sell it themselves, but this is not common, as farmers tend not to have access to transport.

There is no apparent processing. There is little opportunity to sell into the developing supermarket trade as there is only one Hero store in Mataram. Mangoes from South Africa (Kent) were on sale for around Rp21000/kg in March at the Hero supermarket in Mataram. Elsewhere in Indonesian supermarkets have not attempted to compete with wet markets in the fruit and vegetable business with 80% of supermarket fresh fruit sales originating overseas.

Current market prices in the main season, from late October to December, are so low that many farmers are considering removing trees. There appears to be little interest in new plantings. For many farmers in the drier areas, there are no options for land use other than mangoes and cashew. For farmers in the wetter areas there is a range of options to use the land more profitably e.g. rambutan, mangosteen, rice, field crops. This is probably the only reason farmers in the drier areas are not removing trees - they have little other option.

The current oversupplied situation appears to be common throughout Indonesia including South Sulawesi, Bali, East Sulawesi and NTT. Discussions with mango farmers in Bali also indicated the poor mango market with farmers earning similar prices.

There are small quantities of mango exported from Jakarta. In 2000 some 430 ton were exported, rising to 940 ton in 2004 and 918 ton in 2005. This is a very small quantity given Indonesian export potential. Clearly export potential is constrained as Indonesia has considerable export advantages having:

- low prices
- a large production base
- a Nov-Dec season compared to June-July for most of world production

- a close proximity to major markets in north Asia, and south Asia where most of the world's mangoes are consumed
- the advantage of being a southern hemisphere producer compared to most mango production occurring in the northern hemisphere. Southern hemisphere production is around 5 million tons while northern hemisphere production is over 80 million tons. Other southern hemisphere producers are South Africa, Australia and Brazil. Major Northern hemisphere producers are India, Philippines, Thailand, China, Pakistan, and Mexico.

Investing in the current supply chain thru the domestic wet market appears to be difficult. There is little financial incentive in the chain for growers or for traders. Growers are highly unlikely to invest in new production technology. Traders are unlikely to invest in grading, standards, food safety, cool rooms or ripening if as there is no price premium due to oversupply.

Mango farmers need to operate in a new or parallel supply chain that is more profitable, or else they will pull out trees. If other profitable chains can be identified there may be sufficient profit for farmers to gain benefits from using new technologies developed through research.

8 Economics of production

The total gross sales per hectare for mangoes are around Rp12 million at the farmer level. This is similar to the gross income from one crop of wet rice, though the costs of inputs for mango are currently lower, as there are effectively no inputs. However rice farmers will usually get 2 or 3 crops per year. For this gross sale per hectare all the farmer may have to do is pick the crop and cut weeds in the orchard, maybe a total of 2-3 months labour. In this context the Rp10-12 million gross sales is effectively a wage, and for two months work a good wage. However in these drier poor areas there is often little other employment so this may represent the total family income – essentially a poverty income.

The income from mangoes is based on the farmer doing very little, in some cases not even harvesting, leaving them free to carry out other work on or off their farm. Many mango farms are less than 1 hectare. Most farmers grow other crops so their family income per year would be considerably higher. However the low return per hectare is a significant constraint to encourage any investment in higher inputs for production and post harvest management.

For farmers in the poor dry areas of north Lombok and Sumbawa this may be their only crop, as cropping options in these areas are limited. Many need to seek off farm income to survive, making it difficult to improve the standard of production to meet the requirements of new markets. To commit the total area of land they own, which may only be one hectare to mangoes, represents a significant decision.

In social terms, the current mango situation is difficult. It must be remembered that mangoes are one of the largest tree crops in NTB. For farmers in the dry areas, where options are limited, this becomes a significant social issue. In these drier areas, tree crops are a very important part of the agricultural system. Farmers in the drier areas of eastern Indonesia have fewer cropping options than the wetter areas. Annual dry cropping of rice or other field crops is at risk if wet season rainfall has periods of no rain. If these crops fail, as they do, then farmers are in a very precarious situation. They become very reliant on cattle, cassava, or drought tolerant tree crops like mango and cashews to provide a living for the year. For farmers in the wetter areas where two crops of wet rice are possible, the risk of failure is much lower. They also have other income sources that are more reliable due to rainfall, and higher value horticulture.

9 Future prospects

It is clear the key constraint to developing mango production in the immediate future is the poor market situation. This is a significant constraint, limiting the adoption of better technologies, and limiting the growth of the crop into new markets. Low prices are the most severe constraint for producers to adopt better management practices. More importantly low prices for mangoes pose a significant social risk for farmers in the poorer districts of eastern Indonesia.

Engaging in a research program in this environment is difficult unless the program is based on a significant change in market prices.

The options for developing an export industry are very limited as it is unlikely the existing variety, Harumanis, has any export market future because of its green skin colour when ripe. This is reflected in the low level of current exports (940 ton 2004, 918 ton 2005). However there may be a future for this variety in processing as it has excellent eating characteristics.

Exporters in Jakarta have attempted to export Harumanis to the Arab states. Importers are not interested in Harumanis, as consumers are not familiar with a green skin variety, even though its taste may be very good.

The time difference in production around Indonesia does not appear to be sufficient to offer higher priced market opportunities within Indonesia, particularly for the farmers of NTB. It appears there may be some eco-zones in South Sulawesi that can produce mangoes in June-July and these are worthy of further investigation, as prices for mangoes at this time will be high throughout Indonesia.

There appears to be no mango fruit processing in NTB. It appears there is little juice processing in Indonesia other than fruit stalls selling fresh juice. Even in Java it appears there is no processing with significant quantities of juice concentrate imported for tetra packs.

One possible option is home processing or drying. There is a large tobacco industry in central Lombok that is very well supported technically by the buying companies. These farmers all have access to drying flues for tobacco. The temperature of drying (60-70C) is the right temperature for mango drying. As it is not commonly available, Prices for dried mango in Indonesia are high at around Rp100 000/kg retail. It is not commonly available. The recovery rate is 10%. It is feasible to dry mango, without preservatives and keep it for some months, longer under refrigeration.

Most dried mango on the world market comes from Philippines and Thailand that add large amounts of sugar, destroying the flavour. It wholesales in Australia for around Rp55 000/kg whereas good dried mango sells for around Rp120 000/kg. The excellent flavour of Harumanis makes it very suitable for drying. In Indonesia dried mango will sell well and it has the opportunity for export.

There are a number of options for future development:

1. Extending the season to spread out production.
2. Evaluating new varieties.
3. Developing export supply chains.
4. Exploring processing opportunities for Harumanis.

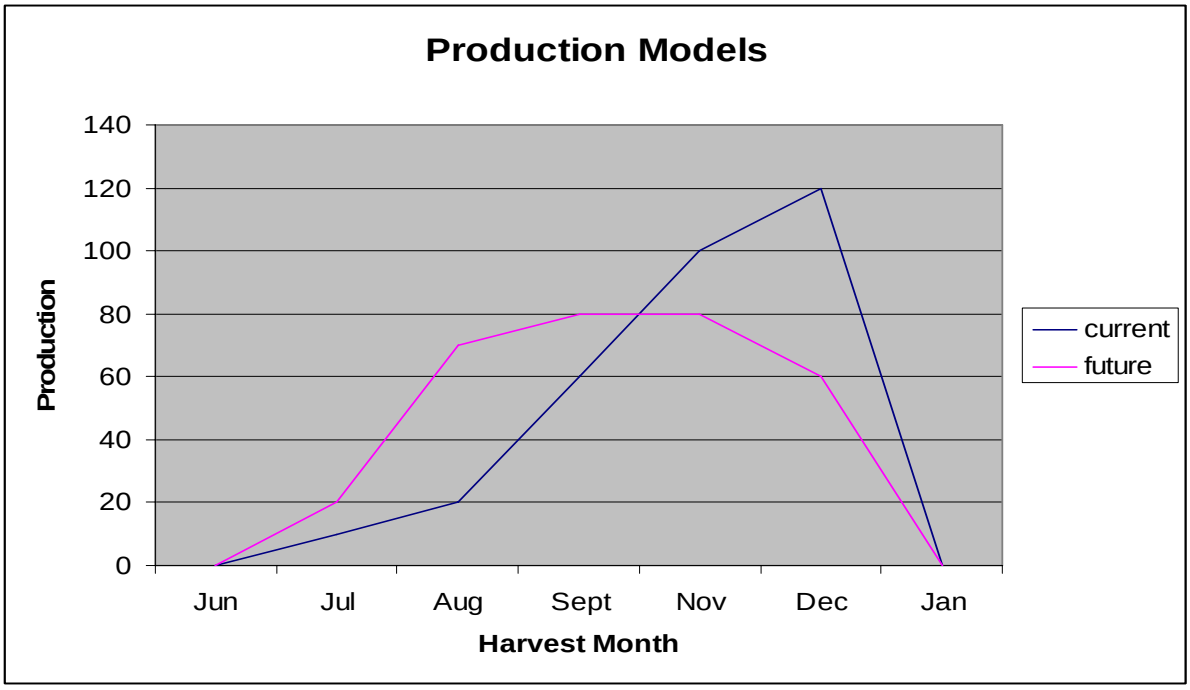
9.1 Extending the season

Lengthening the season for Harumanis by making flowering and harvest earlier extends the season with the result that daily domestic wet market supply is reduced, and prices increased. Current supply is October-December. Paclobutrazol offers the opportunity to extend supply from August-December. The experience of the only farmer in Lombok to have tried this is that the prices early in the season rose to around Rp4 000 /kg rather than < Rp1 000 /kg.

Harumanis appears to be very responsive to paclobutrazol. This is used in most mango producing countries but farmers in NTB are not aware of its benefit. There has been a small amount of research conducted in Lombok in 1 season on 1 site only trialling paclobutrazol at low rates. The results are very promising with flowering and harvest advanced by 1-2 months. Discussions were held with 1 large farmer who had similarly tried paclobutrazol in 1 season with a similar result at quite low rates.

Paclobutrazol has the potential to double the current supply period of around 2.5 months to 5 months. With the level of total production remaining the same (at least for some years), the impact is that the weekly supply is significantly reduced, increasing prices. For early adopters of the technology, there are very large benefits, with prices as high as 4,000Rp/kg. The possible impact of paclobutrazol is demonstrated in Figure 1.

Figure 1: Models for current and future monthly production in response to paclobutrazol



There are a number of issues with using paclobutrazol that require research at a local level including:

- dosage rates for each variety, tree age, and soil type
- time of application
- repeat dose applications
- adjunct treatments e.g. cincturing, potassium nitrate sprays.

It has implications for the time of flowering, size of crop and possibly fruit size. As the climate for flowering and harvest is changed, there are impacts on fruit quality.

There are limits to the use of paclobutrazol to control harvest time, imposed by the effects of rain at flowering and at harvest. It is likely that the commercial impact of paclobutrazol will be limited to flowering no earlier than May with harvest no earlier than August.

Paclobutrazol offers the opportunity to move a much greater proportion of the crop earlier, spreading the season and increasing prices. Prices are primarily determined by daily supply. If supply drops, prices can rise by four fold. Provided paclobutrazol does not lead to a significant increase in plantings, i.e. an increase in total production, then current production by farmers will benefit considerably in price. Over time it is possible that plantings will increase, but in the transition farmers who adopt the technology will benefit considerably. Widespread adoption may take up to 10 years.

Paclobutrazol fits into the current system as it is easily applied as a manual soil drench (1litre mix) around the tree trunk. It is available from the major agricultural supplier in Mataram at the price of 160 000Rp for 250cc. Applications rates around 5-10cc/tree appear to be effective. This is a cost per tree of 6,400Rp/tree. The financial implications for an average tree producing 100kg/tree at a higher price of around 2 000Rp compared to currently 1 000Rp is clearly significant. In the long term it should be possible to increase sales per hectare to 24 million rupiah from the current 12 million.

There are other research techniques to extend the flowering including:

- cincturing
- foliar spray of ethrel (available in Mataram) approx 60days before flowering
- foliar spray of paclobutrazol after pruning
- foliar spraying potassium nitrate in the period just prior to flowering
- combinations of the above and with paclobutrazol.

These various techniques are used around the world to extend the season and have had a significant impact in most countries. Depending on the response of the predominant variety, the impact can be very considerable. In Australia, paclobutrazol is widely used with potassium nitrate sprays just prior to flowering. Some growers combine this with cincturing about two months after harvest, and ethrel sprays around 60 days before flowering. In Thailand, on the variety Nam Dok Mai, a mixture of pruning + paclobutrazol + potassium nitrate has seen Thailand significantly extend its season. Philippine growers have used potassium nitrate sprays for many years to ensure earlier flowering of their variety Carabao.

This appears to be a reasonable short-term strategy with a high degree of success. Research can be conducted in a demonstration system with farmers at relatively low cost and a large potential impact within the existing supply chain. Earlier flowering benefits will directly benefit farmers.

9.2 New varieties

Another option for research in Lombok, that will have significant long-term impact, is the introduction of the variety Gedung gunci. This variety has been widely planted in West Java. It is apparent at least one farmer in Lombok has introduced this variety with around 200 trees, most up to five years with one tree ten years. This enterprise has extended to grafting and selling trees (Rp 5 000/tree)

It appears to be very suitable to the climate, with similar characteristics to Harumanis but with the yellow skin colour when ripe, necessary to develop for international trade. This variety appears to have:

- excellent eating characteristics
- similar resistance to anthracnose when ripe
- yellow when ripe with a very attractive pink blush over a large portion of the fruit
- similar consistent production to Harumanis
- even earlier than Harumanis without the application of paclobutrazol
- fruit size a little smaller than Harumanis

Initial sales price in Lombok is approximately Rp4 000/kg. This variety has significant potential to change the nature of mango production in Indonesia. It represents an access into the higher priced, growing domestic supermarket trade and is probably the best opportunity for mango exports from Indonesia. For it to be successful it has to have good agronomic characteristics and perform along the supply chain.

This variety is worthy of proper evaluation of its performance. This includes:

- post harvest life – stored at a range of temperatures
- susceptibility to anthracnose (and other rots) – test in high rainfall seasons
- yield
- consistency of yield over time
- response to flower inducers (paclobutrazol, potassium nitrate, ethrel, cincturing)
- fruit size distribution and impact of better nutrition on size
- quality classes
- define nature of defects and solutions to minimise
- sap burn susceptibility
- any pest/disease susceptibility.

From discussions with researchers in West Java, it appears this variety has not been assessed formally, though it has been widely planted in West Java.

A part of this program should include its distribution to farmers for them to evaluate and its distribution to a range of markets to test its performance. This needs to be part of the formal evaluation of the variety. Selection of a variety is not done by scientists but by the market place. A key part of farmers and traders input is to identify problems and for researchers to deal with the problems identified.

This may include through BBI (Govt. nursery – Balai Benih Induk) and must include Dinas Pertanian staff at the Kabupaten, Kecamatan and Desa level. The focus should be in the dry areas of North Lombok and Sumbawa.

This program will take some time to develop – however it fits well with the principle of a supply chain project either for export markets or for domestic supermarkets. It could be sped up initially by sourcing significant quantities of plants from west Java at a relatively small cost.

It may be that the development of Gedung gunci would focus initially on the domestic supermarket trade, while the necessary resources are put in place for developing export capability. This gives the project the opportunity to learn about the variety's performance in the trade. The project would be sped up considerably if it included an introduction component in NTB and a supply chain component in West Java that was extended to NTB as production increases.

9.3 Developing export potential

Indonesia may be able to take advantage of its considerable advantages in mango production in export markets if it can successfully make the change to exportable varieties.

Indonesia has some advantages in the world market including:

- price competitiveness
- period of supply in Asia different to the main producers in India, Thailand and the Philippines
- closeness in proximity to large markets in Asia, South Asia, and the Arab states.

The principle of introducing new varieties to the Indonesian mango supply chain applies whether it is for Gedung or for other varieties. It is clear Indonesia will not be able to export Harumanis mangoes, despite its significant advantages in the market, unless it makes a move to a new variety. Existing varieties are not marketable in world mango markets, based on the experience of Jakarta wholesalers.

Indonesia needs to embark on a selection program to test varieties that are suitable for the production system and export. The conditions for mango production throughout Indonesia are peculiar in that temperatures at flowering are higher than in most other countries. This will exclude many varieties, as they will fail to flower in the equatorial climate due to a lack of cold to initiate flowering.

The first step in developing this variety will be to prove its agronomic potential, but along side this evaluation there must be support given to ensuring its performance in the supply chain. No variety is perfect; all have problems that have to be managed appropriately.

The success of the variety will be determined by the ability of support services to deal with problems as they arise and ensure all in the supply chain perform their roles in managing the variety appropriately.

A relevant example is the development of the variety Calypso in Australia. The introduction of this variety has been technically supported in the field and in the market place to ensure problems are resolved and all in the supply chain have the resources and information to ensure the customer is delivered with a great product. The supply chain is closed to one wholesaler, though it is sold through a wide range of retail outlets. Their supply chain is managed externally by a third party, which ensures consistent communication up and down the supply chain.

Gedung gunci appears to be worthy of this level of support. There have been some attempts to export this variety from Jakarta by sea to the Arab states (12-14 days), which have proven unsuccessful due to the incidence of rots on arrival (apparently due to rain at harvest). This is despite the wholesaler making use of good post harvest handling technologies including packaging, forced air cooling, CA reefer containers, post harvest fungicide and hot water treatments. Despite this apparent initial failure, there are other technologies that could be employed to deal with the issue of rots caused by rain at

harvest. The exporter made one attempt to export but could not sustain the effort to deal with the issues that arose. To be successful this variety (as for any variety) needs to be supported technically throughout the supply chain to ensure its success.

The creation of new export market outlets will have a flow on effect in terms of domestic marketing with a portion of the crop achieving higher prices. It will also prepare growers to be better able to service the growing domestic trade thru emerging supermarkets, which will have higher requirements, though may not necessarily pay higher prices. It is likely Gedung will have a place in the local supermarket trade as a point of difference to Harumanis in the wet market. It is unlikely supermarkets will compete in the very low priced Harumanis mango market.

The current export position with mangoes is difficult to resolve in the short term due to:

- wrong varieties for export
- the time and expense to develop access protocols
- some essential chemicals not registered for use in Indonesia
- no size or quality standards
- no widely accepted and simple HACCP (Hazards and Critical Control Points) program required as part of food safety
- the cost of implementing protocols e.g. Vapour Heat Treatment (VHT)
- unfavourable rainfall distribution in production areas that currently grow exportable varieties.

Indonesia does not appear to have the capacity to successfully negotiate access protocols nor are officials aware of the issues required to successfully develop access protocols. In discussions with key fruit exporters in Jakarta, all commented on the need for the government to develop access protocols for Indonesian horticulture. There are six issues for negotiating quarantine protocols:

1. Having good records of pest incidence.
2. Having the capability to conduct pest surveys by crop to create accurate pest lists.
3. Having a disinfestation research capability.
4. Having an inspection and monitoring capability to supervise protocols which foreign countries can trust.
5. Having insect rearing facilities especially in the case of fruit flies.
6. Having a legislative/regulatory power to enforce protocols.

The creation of these new export market supply chains would assist farmers in a number of ways such as:

- selling a proportion of their crop at higher prices i.e. an average higher price for the crop
- making it attractive to develop systems that are useful domestically particularly the growing supermarket sector
- taking fruit off the domestic market
- providing a price stimulus to allow the introduction of new production technology
- attracting new investment.

If we are to have a successful supply chain, all participants need to change and all need to make new investments e.g. production technology, cool chains etc. Developing new profitable supply chains that can adopt new technology with in the chain has significant spin off benefits for other markets e.g. domestic markets.

So farmers who are adopting new production technology for a new supply chain will still sell a portion of their crop to current standard domestic markets and this production will benefit from the adoption of new technology, e.g. better quality, better control of anthracnose. Similarly for collectors or traders, participating in a new supply chain that is sufficiently profitable for them to invest in new technology, will also use this technology in existing supply chains.

In Indonesian chains, more so than in other countries, other post-farm gate participants play an even greater role in determining the success of the chain and have taken over some of the roles and responsibilities of farmers e.g. the collectors are responsible for harvest, packaging, transport to wholesalers, roles that would normally be fulfilled by farmers in other countries. Thus the research efforts cannot focus on the farmer alone. Collectors are more than traders who operate on a commission – they buy the crop taking risks associated with market failure, quality etc. They invest in the crop in terms of harvesting and they absorb significant risks. In fact the farmer can opt to whom he sells his crop on the tree and in that sense he is not just a price taker. The collector bears a significant portion of the risk and the input costs. He may be financed by a wholesaler but he bears significant risk as much if not more than other participants in the chain.

This supply chain includes farmers, collectors, wholesalers and in some cases retailers. Successful farmers are part of successful and profitable supply chains, not just farmers. Nor should farmers be considered to have some preferential treatment in a supply chain – all are equal participants and for profit all must be successful. Each has specific roles to play in delivering the product to the consumer. Research is about researching a profitable supply chain.

The development of export, based on a new variety, must be based on a parallel supply chain, a new supply chain, not involving the current wet market supply chain. Exporters are prepared to invest, but if there is a lack of coordination and control the benefits of investing in and developing the supply chain will be eroded. It is unlikely the existing collectors will ever have the ability to understand the issues required – they may participate but under the control of a single exporter or group of exporters. This can be controlled with the introduction of a new variety.

This new supply chain will have the ability to invest in the supply chain. The introduction of new variety, combined with access protocols must be accompanied by a dedicated supply chain that includes private and public investment.

Introducing a new variety to the area should be under the control of the supply chain. This allows the participants to invest in the supply chain infrastructure (e.g. cool rooms) and allows the supply chain to open up communication, with investment back into dealing with problems. It allows the supply chain (the exporter directly or via a levy) to invest in technical support for participating farmers and collectors.

A good model for development of supply chains in Indonesia is the tobacco industry in Lombok. This is controlled by a number of large companies. They have a fully integrated supply chain with significant investment in the chain in terms of credit and technical support. Company support staff visits farmers at least three times a week. Each extension staff is monitored for the performance of their farmers to ensure they are meeting targets. The companies provide credit to growers. Sales are directly to the company. This is a good example of a profitable, closed supply chain with significant investment with little

input from public sector, which has passed on considerable economic benefits to farmers participating in the supply chain. It has allowed the supply chain to control production, quality and marketing.

The development of a mango export supply chain is a new concept in directing research for both ACIAR and for Indonesian organisations. It requires developing closer linkages with private sector players particularly marketers and exporters. In the case of exports, to be successful it may require supporting closed supply chains to ensure that all participants in the chain are using the appropriate technology.

9.4 Dried mangoes

The large existing production base of Harumanis is a significant advantage, in terms of volume and price. The main outlet in Indonesia is wet markets at very low prices. It is worthy to consider what can be done with this significant production base. Finding alternative market outlets for this production at a higher price will have a significant impact on many farmers. Harumanis has excellent eating characteristics. It is worthy to consider options for processing. This may develop into an export opportunity for processing.

The economics of the possible processing market deserves further evaluation. Indonesia has significant advantages in world export processing markets. These are currently dominated by the large producers in Philippines, Thailand, South America, and south Asia. Indonesia also has a large domestic market for processed mango.

The best initial option for NTB mango production may be dried mango. This simply involves on-farm processing, with little or no capital cost. Other options require large capital investment by large companies, which may already have sufficient processing supply from bases in Java.

The best initial area to develop the concept would be the tobacco farmers' of central Lombok, many of who also have mango trees. They have access to tobacco driers that operate at the same temperature as mango driers. Tobacco companies provide credit and extension services – one company up to 70 extension staff, who visit farmers three times per week. They are looking for other crop options to build closer relations with their farmers – especially as companies are exposed thru credit that they do not always get back.

This technology is simple. The dried product is likely to be very good. It has a reasonable life if dried sufficiently. It does not include any preservatives. Naturally dried mango is far superior to current dried mango from Thailand and Philippines that includes large amounts of sugar, disguising the unique mango flavour. Large amounts of sugar are added to extend shelf life. Dried mango from Thailand and Philippines sells for around $A8/kg wholesale in Australia whereas naturally dried mango sells for around AUD$20/kg. Harumanis will dry very well with excellent flavour.

In Indonesia dried mango retails for approximately Rp100 000/kg. At a 10% recovery this equals 10 000Rp/kg fresh. It is possible to peel and slice around 10kg fresh mango/man hour. It is conceivable that home processing is an economically attractive, technically feasible and a good potential market.

If a farmer sold dried mango at Rp50 000/kg, he could turn income for a tree yielding 100kg from the current 80 000Rp/tree sold into the wet market, to Rp500 000/tree sold wholesale into dried mango markets.

The issues will be to:

- develop a good linkage with a suitable trader
- ensure the process is technically feasible
- ensure the economics are feasible
- clarify the domestic and export market options
- deal appropriately with key food safety issues
- establish the post harvest life of the dried product.

This is potentially a fairly simple product development model that has a significant impact on farm income. Using the existing tobacco farmer extension system this project idea could be developed up at relatively low cost. Rolling it out to other provinces will take some investment. In central Lombok we have a system to assist with uptake, and the capital requirements in place in terms of a drier, to test and develop this market option.

The tobacco farmer infrastructure in Lombok has other potential benefits in developing supply chains for mangosteen and rambutan for export. One of the current tobacco companies is exporting mangosteen as many tobacco farmers in central Lombok also have mangosteen.