Australian Aid

Australia-Indonesia Partnership for Promoting Rural Income through Support for Markets in Agriculture (AIP-PRISMA)

MAIZE SUB-SECTOR GROWTH STRATEGY IN EAST NUSA TENGGARA

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Abbreviations

AIP-PRISMA	Australia-Indonesia Partnership for Promoting Rural Income through Support for Markets in Agriculture
CAGR	Compound annual growth rate
GAP	Good Agricultural Practices
GM	Genetically modified
ha	hectare
ILAF	Intervention Logic Analysis Framework
NTB	Nusa Tenggara Barat (West Nusa Tenggara)
NTT	Nusa Tenggara Timur (East Nusa Tenggara)
OPV	Open pollinated varieties
ppb	parts per billion
RDKK	Rencana Definitif Kebutuhan Kelompok
TTS	Timor Tengah Selatan
TTU	Timor Tengah Utara
UPSUS	Upaya Khusus

1 Executive summary

The demand for maize in Indonesia has been increasing at an annual rate of 5.6% with much of the growth being fuelled by the rapidly expanding poultry industry. Animal feed has surpassed human consumption as the main use for maize in Indonesia. Both the animal feed and poultry industries are projected to continue experiencing robust growth as population and incomes increase.

NTT, which is largely characterised by drylands and a dry climate, is among the top 10 maize producing provinces in Indonesia. However, despite being among the top producers, its contribution to maize production was only 3.8% of national production in 2013. Unlike other provinces that enjoy more advantageous climatic and topographic conditions, NTT relies heavily on the availability of rainwater for maize farming. Maize production has been growing slowly, and average yields, which reached a high of 2.67 tonnes/ha in 2010, are well below potential and also below the current national average of 4.8 tonnes/ha. Maize production in NTT is mainly for subsistence needs, with an estimated 522,612 households involved in 2013. Since most subsistence farmers will deplete their maize stocks by September, households will often supplement their production with maize purchases during the scarcity months.

There is market opportunity to expand NTT's maize production in order to meet the province's growing demand for maize, which is currently being supported by imports from Java, Sulawesi, and NTB. Increased local production would mean that households would improve their food security, particularly from September to the next harvest, and would have to rely less on purchasing maize to supplement their household stocks. There is also potential to supply the growing demand for maize by the livestock industry in NTT, much of which is also being met through inter-regional imports.

Analysis of the market reveals a number of problems that currently constrain the ability of NTT farmers to take advantage of this opportunity. Since maize is farmed as a subsistence crop, farmers tend to use retained seeds of low-yielding local varieties and limited fertiliser. Limited access to higher yielding seeds, fertiliser, and information on good agricultural practices affects the ability of farmers to improve their productivity. Also, while traditional drying and storage practices are well suited for local maize varieties, we can anticipate that losses from such storage methods will become a problem as farmers increase their productivity and need to store maize for extended periods. It is over these longer periods that maize can be more susceptible to weevil attacks. Furthermore, if the increase in productivity is associated with the use of hybrid and composite seeds, there will also be greater risk of weevil attacks under traditional storage conditions.

The vision of change at the sector level is to: (1) increase smallholder productivity and overall production and (2) reduce potential high losses from shifting to higher yielding seed varieties and from extended storage periods. At the service level, it is envisaged that farmers will have improved access to: (1) seed, (2) fertiliser, (3) information and extension, and (4) storage services. To realise this vision, this report recommends four intervention areas:

- Promote the use of composite seeds
- Promote the use of hybrid seeds
- Introduce affordable commercial fertilisers

- Introduce more effective, affordable farm-level storage solutions

We envision that seed, fertiliser, and information and extension services will be provided through a range of market actors including local seed producers, seed companies, fertiliser companies, agricultural input stores/distributors, and possibly even feed millers and local maize traders. Storage services will be provided through potential manufacturers, distributors, and traders of storage solutions.

It is recommended that the intervention areas in the NTT maize sector be implemented in three phases. In the first phase, the focus will be on *promoting the use of composite seeds*, which require less intensive farming practices than hybrid seeds. The second phase will *promote the use of hybrid seeds* in certain areas alongside *introducing affordable commercial fertilisers.* Fertilisers are necessary for hybrid seed production but can also improve productivity when used with composite seeds. Since better storage solutions will only be necessary once there has been a significant improvement in productivity, the final stage involves *introducing more effective, affordable farm-level storage solutions.*

2 Background

The Australia-Indonesia Partnership for Promoting Rural Income through Support for Markets in Agriculture (AIP-PRISMA) is a multi-year program that is a part of the Government of Indonesia's midterm development strategy to accelerate poverty reduction through inclusive economic growth. With the support of the Government of Australia, the program aims to achieve a 30% increase in the net incomes of 300,000 male and female smallholder farmers in eastern Indonesia by June 2017. PRISMA works in East Java, West Nusa Tenggara (NTB), East Nusa Tenggara (NTT), Papua, and West Papua.

This Sector Report aims to provide a logic and rationale for market-based interventions which can support the maize sector to the benefit of smallholder farmers in NTT.

3 Sector description

3.1 Sector profile

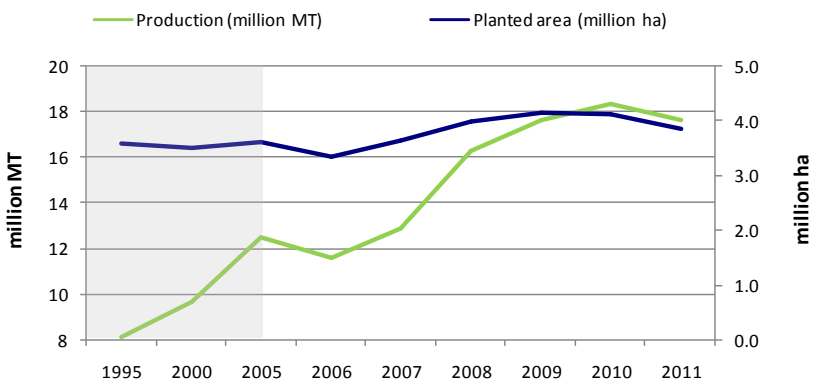
The sector profile provides information on the current status and potential of the target sector. This has been derived mainly from secondary data and literature relevant to the maize sector.

3.1.1 Overall context

Global demand for maize is growing, mainly as a result of increased usage as animal feed and in ethanol production, and is predicted to surpass the production of both rice and wheat by 2025. In 2012, maize was grown on more than 174 million hectares (ha) across 163 countries globally, and 839.7 tonnes of maize was produced. World production of maize is dominated by the United States, followed by China. Maize consumption is on the rise, with ethanol production alone accounting for 36% of the US corn crop in 2013. Between now and 2050, it is projected that the demand for maize in the developing world will double.

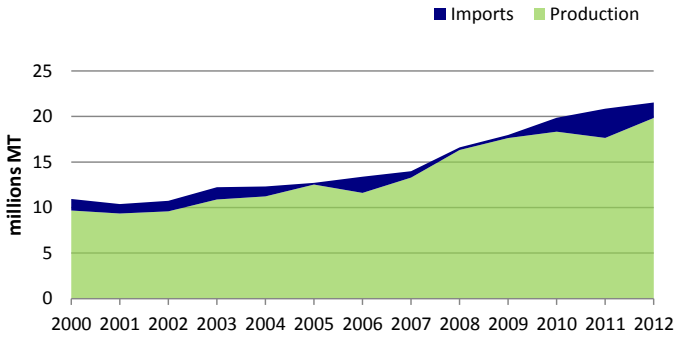
Maize is a dynamically expanding crop both internationally and in Indonesia. Indonesia is the largest maize producer in Southeast Asia and the eighth largest globally. Indonesia contributed to nearly 2% of global production with 18.51 million tonnes in 2013. From 1995 to 2011, production and productivity in Indonesia has roughly doubled while the harvested area has fluctuated between 3.3 to 4.2 million ha for the same period. After rice, maize is the second most important cereal crop in Indonesia and plays an important role in Indonesia's food security policy.

Figure 1: Production and harvested areas in Indonesia (1995-2011)



Despite upward trends in production and goals by the Government of Indonesia to be self-sufficient in maize, Indonesia imports on average 8% of its annual maize consumption needs. In 2012, this was equivalent to 1.7 million tonnes of maize, making it the second largest importer of maize in Southeast Asia next to Malaysia.[1] Indonesia imports maize primarily from India (37%) and Argentina (34%). The volume of maize imports into Indonesia is typically 100,000 to 200,000 tonnes/month but can reach over 500,000 tonnes/month. According to the Indonesian Feed Millers' Association, "there will always be a requirement for imports due to the seasonal concentration of production in Indonesia."

Figure 2: Indonesian maize production vs imports

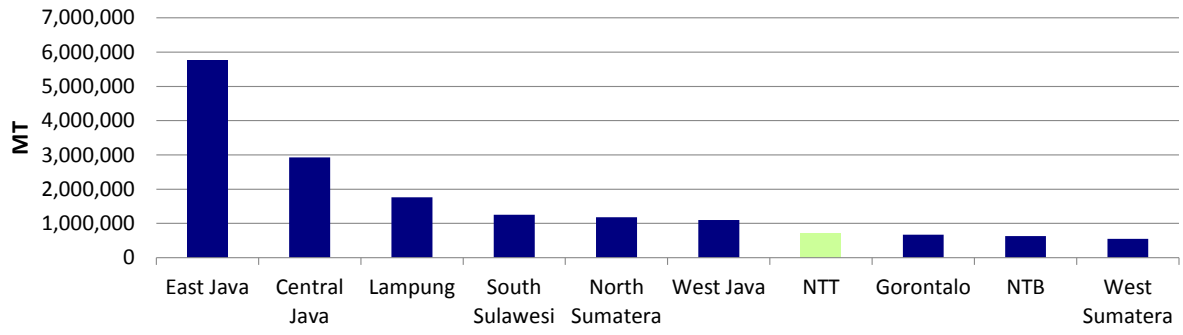


The demand for maize in Indonesia has been increasing at an annual rate of 5.6% with much of the growth being fuelled by the rapidly expanding poultry industry. Animal feed has surpassed human consumption as the main use for maize in Indonesia. As incomes increase in Indonesia, consumers are diversifying their diets and sources of protein. Poultry products are the most affordable animal protein source in Indonesia. As a result of increasing per capita consumption of chicken, corresponding demand for poultry feed has also experienced robust growth and is expected to continue rising. According to PT ICRA Indonesia, the average annual growth of the feed industry was 11% between 2008 and 2012. Maize alone contributes 50-55% of the raw material cost for animal feed.

3.1.2 Local context

NTT, which is largely characterised by drylands and a dry climate, is among the top 10 maize producing provinces in Indonesia. However, despite being among the top producers, its contribution to maize production was only 3.8% of national production in 2013 (or 707,642 tonnes). In comparison, East Java, the leading maize producer, contributes more than 30% of national production. Unlike other provinces that enjoy more advantageous climatic and topographic conditions, NTT relies heavily on the availability of rainwater for maize farming.

Figure 3: Top 10 maize producing provinces (2013)



[1] FAOStat

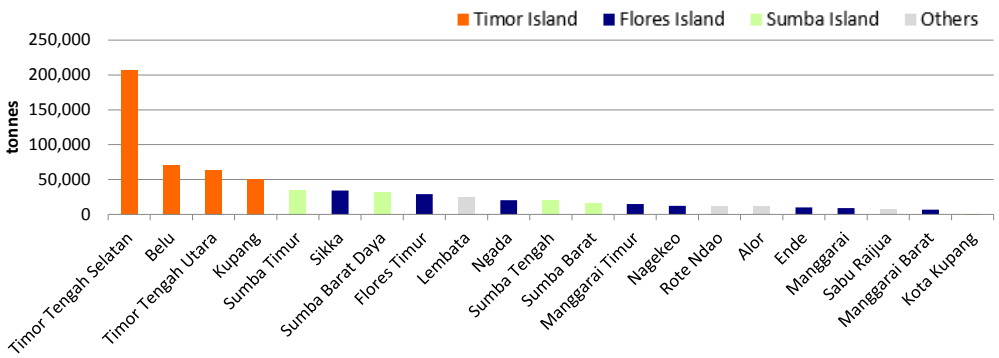
Maize production has been growing slowly. Average yields, which reached a high of 2.67 tonnes/ha in 2010, are well below potential and also below the current national average of 4.8 tonnes/ha. Maize production in NTT has increased at a compound annual growth rate (CAGR) of 2.6% between 2009 and 2013. Over the same period, harvested area for maize fluctuated between 244,000 to 270,000 ha while productivity was an average of 2.5 tonnes/ha. In contrast, West Java and West Sumatra, which have the highest average yields in Indonesia, recorded yields of 7.2 tonnes/ha and 6.7 tonnes/ha respectively in 2013. Average smallholder maize farms in NTT range from 0.25 to 1 ha. Similar to NTB, maize production in NTT is not land constrained, and there is potential to increase production through increased harvested area as well as through intensification of maize farming.

Maize production in NTT is mainly for household consumption, with an estimated 522,612 households involved in 2013. Maize is a staple food for the majority of the population. Approximately 67% of farmers produce maize, making it the most widely grown crop in the province. In comparison, only 48% of farmers are involved in rice farming, which is the second main crop in the province. Livestock rearing is also prevalent, and 86% of households have pigs, chicken, and/or cattle. Unlike NTB and EJ where most of the grain goes to feed milling operations, maize produced in NTT is mainly used for human consumption and for feeding household livestock. Local maize, which is the main variety grown, is popular because of its taste, cooking characteristics, and resistance to pests in storage.

Despite the large proportion of households engaged in maize farming, NTT remains a net importer of maize. Maize is mainly imported between September and January from Sulawesi, NTB, and Java. This is used to satisfy local consumption during these months. Much of the yellow maize used by large livestock farms is also imported, with the livestock industry sourcing between 50-75% of its maize (mainly hybrid) from other provinces.

At the district level, the top 4 maize producing districts are all on Timor Island. In 2013, these districts accounted for 45% of maize households in NTT and 394,284 tonnes of maize (or 57% of total provincial production). Farmers on Timor grew maize on 150,198 ha or 56% of total maize harvested area in NTT. Timor Tengah Selatan (TTS) has consistently been the leading maize producer in NTT, producing over 200,000 tonnes. It has over 76,000 ha under cultivation, which is over double that of Belu, the second largest maize producer. Flores and Sumba Islands each account for 20% and 15% respectively of provincial maize production. Sikka is the biggest production zone on Flores Island, followed by East Flores. The priority maize district on Sumba Island is East Sumba, followed by South West Sumba. East Sumba accounts for one-third of the island's total production and is also the fifth largest producer in NTT.

Figure 4: Maize production by district (2013)



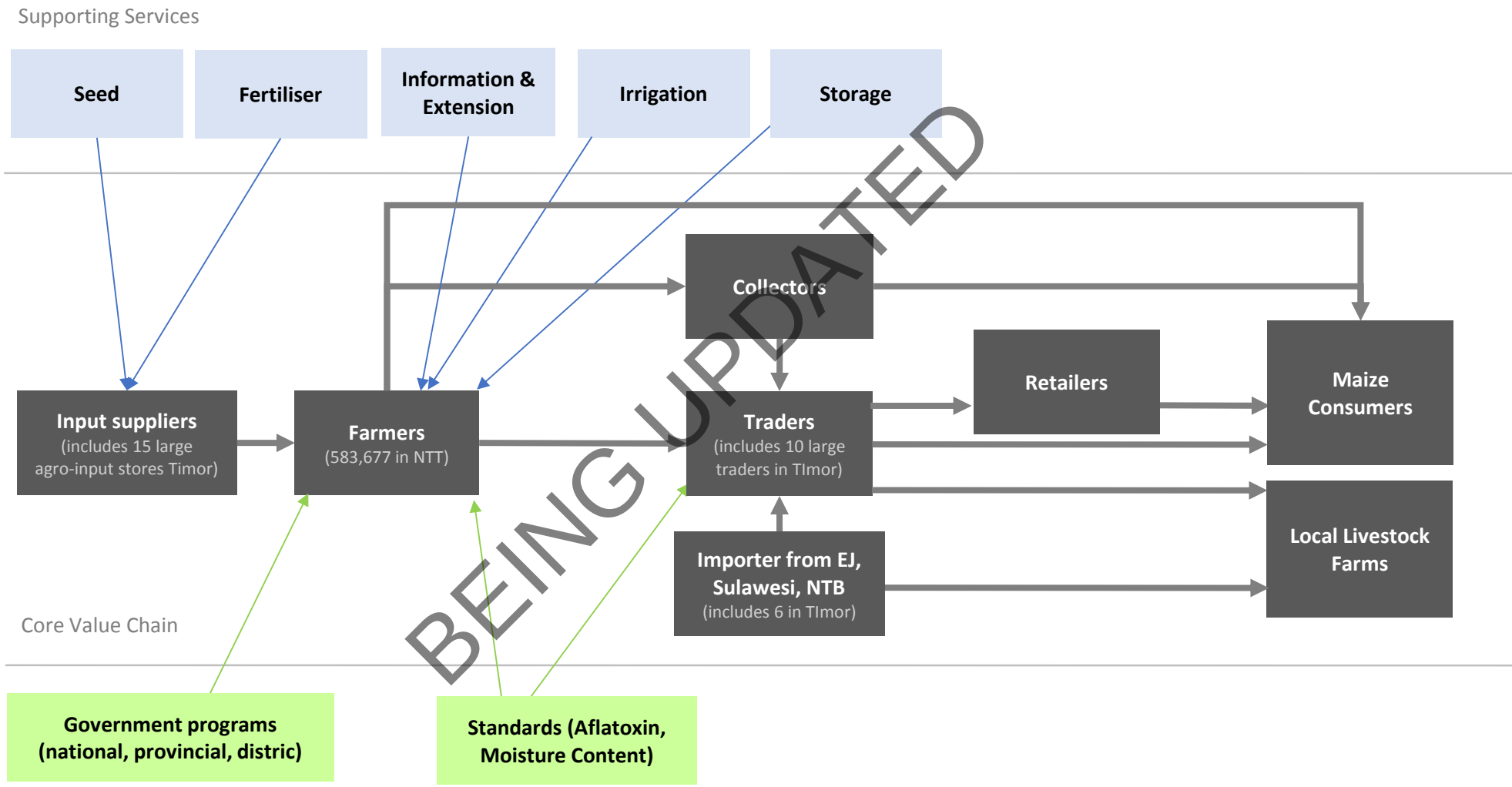
Average productivity in 2013 was 2.63 tonnes/ha in Timor, 2.56 tonnes/ha in Flores, and 2.28 tonnes/ha in Sumba. Although average yields were slightly higher on Timor Island, yields are low across the board and tend to fluctuate from year to year.

3.2 Sector dynamics

3.2.1 Market overview

Maize farming in NTT involves rain-fed production mainly for subsistence needs. It is characterised by low-input and low-output farming practices, with farmers normally growing local seed varieties from retained seeds. It is rare for farmers to use higher yielding hybrid or composite seeds unless they have received these seeds from government or NGO programs. The use of chemical inputs is also low. Unlike Flores and Timor where most farmers cultivate one season of maize during the rainy season (with a peak harvest in April and May), farmers in Sumba can cultivate two seasons of maize. Since most subsistence farmers will deplete their maize stocks by September, households will often supplement their production with maize purchases during the scarcity months. Households typically only sell small amounts of maize if they require cash or if the harvest exceeds household needs, and there is very limited flow to animal feed and livestock industries and to other provinces.

3.2.2 Sector map



3.2.3 Core value chain

Inputs

Farmers normally utilise seeds retained from the previous harvest and mainly plant stress tolerant local maize varieties. There are three types of seeds that are used in maize farming in Indonesia—local varieties, composite/open pollinated varieties (OPV), and hybrids. Genetically modified (GM) seeds are not yet available in Indonesia although Monsanto is positioning itself to enter the market and is awaiting government approval for the use of GM seeds for animal feed. As shown in the first map below, local varieties are widely used across NTT. They accounted for over 80% of seed usage or approximately 246,159 ha of maize harvested area in 2012. Given the risk of crop failure and losses from the lack of rainwater or erratic rain patterns, farmers tend to plant local varieties that are more tolerant to drought.

Figure 5: Usage of different types of maize seed (2012)[2]

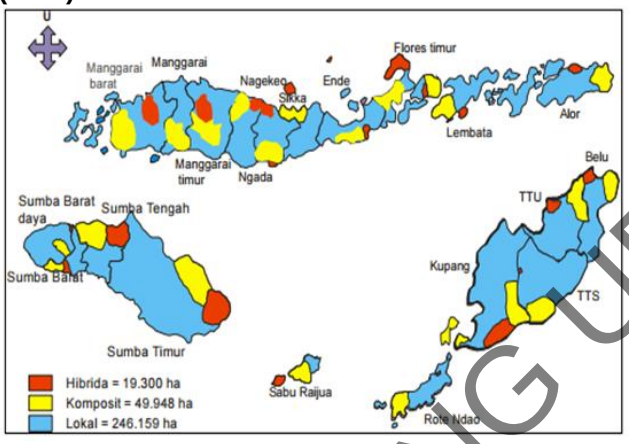
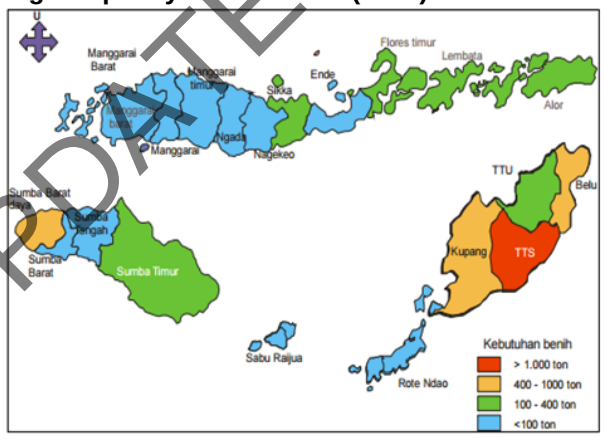


Figure 6: Estimated seed requirements for higher quality maize seeds (2012)



Although local varieties have low and declining productivity, most households prefer local varieties to composite and hybrid maize. Farmers plant on average 15-20kg of seeds per hectare. Baseline surveys found that on average local varieties yield less than 1 tonne/ha. This suggests that government BPS data is likely overestimating the productivity of maize farms, particularly since most farms are recycling local seeds from prior harvests. In contrast, hybrid varieties are yielding over 5 tonnes/ha and composite varieties are yielding on average 1.46 tonnes/ha and up to 2.7 tonnes/ha on demonstration plots in NTT.

Weevil resistance is a major driver for varietal selection, and there is a common perception that local maize varieties can be stored longer and are more resistant to weevils than composite and hybrid maize. The cultivation of higher yielding varieties is also considered to be input heavy and capital intensive, and numerous farmers have had poor experiences with hybrid seeds that were distributed under the government seed subsidy program. This has left some farmers under the impression that hybrid seeds are of lower quality than local varieties. Other key objections to hybrid or composite maize include its taste. When dried, the kernels from higher quality varieties are harder than that of local corn, making them less desirable for human consumption. White local maize

[2] BPTS (Seminar Nasional Serealia 2013) Pemetaan pengembangan varietas unggul jagung di lahan kering iklim kering

varieties are also preferred for human consumption in Timor and Sumba, but yellow varieties are often consumed due to the relatively low production of white maize. Most households will eat whatever maize is available (even hybrid maize which is more suited for animal feed) when stocks are low starting from September.

Farmers rarely use composite or hybrid seeds unless these seeds are being provided by government or NGO programs. Composite seeds accounted for only 16% of maize harvested area and hybrids accounted for a mere 6%. Based on the second map above, BPTS estimates that seed requirements for higher yielding varieties is highest in TTS, followed by Belu, Kupang, and South West Sumba. At present, composite and hybrid seed are mainly available through government seed distribution programs. But these subsidised seeds are often distributed to farmers too late (after the planting season) and are considered to be of variable quality. In some cases, farmers are selling their subsidised seeds to other farmers. Even in cases where farmers have adopted higher yielding varieties, they will often continue to grow local varieties on a part of their farm and will use local varieties predominantly for household consumption.

An impact assessment in Timor Tengah Utara (TTU) and Belu found that 32% of farmers received some seeds from government or donor projects and less than 10% purchased seeds for kiosks, farmer groups, or seed suppliers. The main varieties being distributed by the government is Lamuru for composite seeds and Pioneer, BISI, and Pertiwi for hybrid seeds. Lamuru is a drought tolerant, early maturing variety, which is particularly relevant for NTT's dry climate and topography. For 2015, BISI has received a contract to supply the NTT government with 900 tonnes of hybrid seeds.

Composite seed has all but disappeared from the open market, but a number of agro-input stores in Timor, Flores, and Sumba have expressed interest in selling composite seeds if they are able to source the seeds in time for the planting season. Prior to the government seed distribution program, composite seeds were being sold by agro-input stores, including Toko Commodore in TTS, Toko Waris in Kupang, and Sahabat Tani in Ende. Free seed distribution by the government has been a serious disincentive to maintaining and expanding commercial seed distribution channels. Not only has government aid reduced farmer demand for commercial seeds but it has also made it difficult for agro-input stores to procure blue label composite seeds. Blue label seeds (also known as extension seeds) are the certified seed type most commonly used at the farm-level. Most of the production of blue label composite seeds is now being absorbed by the government program, and there is often no additional supply available for commercial markets.

Small amounts of hybrid seeds (mainly Pioneer, BISI, and Syngenta) are still available commercially through agro-input stores in Flores and Timor. Hybrid seeds sell at approximately IDR 50,000/kg, and some stores have repackaged the seeds into smaller 250g bags (IDR 15,000/bag). BISI is actively promoting the adoption of hybrid maize varieties, with Toko Waris as the authorised distributor in NTT. This includes providing technical assistance to farmers in Semau who are participating in a hybrid maize contract farming arrangement with Toko Waris. Despite efforts to promote hybrid maize seeds, BISI's annual sales are still relatively low with only 20-30 tonnes of seed sold in Timor. There are also some progressive farmers, mainly in East Kupang, who are purchasing sweet corn hybrid maize seeds. But given the relatively high price of

sweet corn seeds (IDR 360,000/kg), sweet corn production is out of reach for most smallholder farmers.

The use of chemical inputs is low, especially when growing local varieties, and farmers who use external inputs tend to rely heavily on government subsidies. While some farmers are using organic farming approaches promoted by NGOs, most farmers are not using organic or chemical fertilisers. The government fertiliser allocation for NTT in 2015 includes 24,000 tonnes of urea and 11,000 tonnes of NPK. These allocations are for both paddy and maize, and if farmers grow rice, they will prioritise their paddy fields when applying fertiliser.

In order to receive government assistance, registered farmer groups, with the assistance of public extension agents, need to first prepare an RDKK (Rencana Definitif Kebutuhan Kelompok). The RDKK is an annual work plan which contains, among other things, details about production and planting area targets. Despite these strategic planning exercises, allocations made by the government are often lower than the amounts requested by farmer groups and delays in fertiliser distribution are a common problem. Unlike the seed program, which distributes seed directly to farmer groups, fertiliser is distributed through agro-input dealers such as CV Nusa Indah in Sumba.

Commercial chemical fertilisers, where available, is mainly used by vegetable farmers. There is also a small amount of organic branded fertiliser being sold by some input stores. Cantik, a chemical fertiliser produced by PT Santani Sejahtera, is available in agro-input stores across Flores and Timor. Although it is mainly used in vegetable farming, the product is also suitable for maize production. Unlike Flores and Timor, there are very few agro-input stores in Sumba, and those that exist mainly sell basic chemicals for land clearing. Commercial chemical fertilisers are largely absent in Sumba, except in the grey market where subsidised fertilisers are being resold.

Production and Post-Harvest Handling

Maize production in NTT is primarily rain-fed production characterised by traditional low-input and low-output farming practices. Traditional cultivation techniques are considered to require less effort and time, as well as less monetary investment. In addition to the use of local retained seeds and limited external inputs, there are no uniform good farming practices used by farmers. Although there is some evidence of practice changes, particularly on farms growing higher yielding seed varieties, most farmers are using non-standard row spacing, up to 4-6 seeds per hole, and even several seeds of different crops (sweet potato, cassava, mung bean, and sometimes even rice) in the same hole. Few farmers practice tillage, which is important for changing the top soil, and slash-and-burn farming is often the main method of land clearing. Women have a particularly active role in planting and harvesting, and in some areas of Flores, it is mainly the women who are engaged in harvesting. Planting and harvesting is also sometimes done in mixed groups of male and female farmers.

Cropping patterns vary depending on climatic conditions and access to irrigation. Farmers in Timor and Flores mainly cultivate one season of maize during the rainy season with the peak harvest in April and May. Maize is often grown as a monoculture or intercropped with cassava and rice. Maize farming in Timor and Flores is predominantly in dryland areas where farmers may only have sufficient water during the rainy season to cultivate maize. Planting typically

commences during the early rainy season, from late October to early December, and harvesting commences from March to May as the wet season subsides. In wetland areas (otherwise known as irrigated lands), government irrigation facilities are earmarked for rice cultivation during the rainy season and are only available for maize farming in the dry season. For dryland areas that are close to irrigation facilities, it is also possible to pump water to maize fields during the dry season, thus allowing for a second maize harvest.

Unlike Flores and Timor, farmers in Sumba can cultivate two seasons of maize. In Sumba, planting commences in October with the first harvest starting in January. The second season begins with planting in February. In the highlands where the climate is cooler and there are more rains, there is a small number of farmers who grow three seasons of maize. This is also possible in East Sumba where maize fields are situated close to rivers.

After the harvest season, farmers will typically dry and store maize using traditional practices. While there are no uniform post-harvest practices across NTT, in most cases, women are particularly active in the drying, storing, and threshing of maize. The range of drying practices include pre-drying plants in the field; sun-drying while enclosed in the husk on a tarpaulin, by hanging on a tree, or by tying bundles of maize to a pole; or drying by smoking the enclosed maize cob over the kitchen fire. The corn is typically stored without peeling back or removing the husk. For example in Timor, corn is stored either in the pantry or in a separate building. It is uncommon to use containers or storage drums unless farmer groups have received such equipment through a government or donor program. In Flores, there are some farmers who also store their maize outdoors, keeping the cobs tied to the poles on which they were being sundried. Finally, there are also farmers who will thresh and store smaller amounts of maize kernels for more immediate use.

Weevil infestations is common for extended periods of storage, and the traditional drying and storage practices which are used for local maize are not well suited for composite and hybrid maize varieties. According to research from the National University of Timor Lorosae in East Timor, traditional storage methods in the sheath above a fireplace, in a tree, or in an elevated house are quite effective methods for local maize varieties, with minimal weevil damage at 33 weeks. While studies conducted by BPTP in West Timor found 20-50% of losses due to pests over the course of 9 months of storage, the reality is that households tend to consume most of their maize supplies within 4-5 months. Weevil infested maize are also typically still used as feed for household animals, resulting in minimal wastage. Farmers have, however, found that traditional practices can make higher yielding maize varieties more susceptible to weevil attacks. In order to extend the shelf-life and reduce the risks of weevil attacks, this has encouraged some farmers to change their practices and to shell hybrid and composite maize before storing.

Poor post-harvest practices can result in rotten, mouldy, or discoloured maize grains, as well as aflatoxin contamination. Inadequate drying, physical damage from poor shelling methods, exposure to moisture during storage, or insect infestations can render the grain more susceptible to aflatoxin. According to a number of independent studies conducted in Indonesia, extremely high levels of aflatoxin (of up to 1,000 parts per billion (ppb)) has been found in maize products. This is well beyond acceptable levels of 20 ppb for maize. Aflatoxin has been linked with liver cancer,

paralysis, and death for humans, as well as stunted growth for poultry. Unfortunately, it is rare for farmers or even other actors along the maize value chain to have any knowledge of aflatoxin, including its genesis or dangers.

Trading

Over 70% of maize produced by rural households in NTT is for subsistence, but most subsistence farmers are unable to fulfil their yearly maize consumption needs from their own production. In comparison to East Java and NTB, there is minimal commercial maize trading in NTT. Only a small number of farmers (mostly near Kupang) are growing maize mainly for commercial purposes. For the majority of maize farmers, ensuring that there is enough maize throughout the year to feed the family and household livestock is the primary goal. Most households own livestock, and approximately 10-20% of their maize production is used to feed these animals. There is less interest in producing maize for commercial sales, and cash income is more likely to come from other sources, such as animal husbandry or crops such as betel nut and cashews.

Less than 40% of farmers who grow local seeds have enough stock to last them until September, after which they will need to purchase maize from other farmers or the market until the next harvest. Some farmers indicated that if they already know their stock will be depleted by August or September, they will buy additional maize during the peak season when prices are still low.

While households will consume most of their production and will often supplement their production with outside purchases, they may also sell small amounts if they require cash or if the harvest exceeds household needs. In these cases, farmers will usually sell to local markets, collectors, or other farmers in small quantities of 10 to 100kg. Composite or hybrid maize is usually sold before local varieties since households prefer keeping local maize for their own consumption. It is unusual for smallholder farmers to sell maize during the scarcity months from September onwards, as any remaining stocks are consumed by these households.

Given the significant price differences between seasons, collectors and traders tend to buy maize primarily between April and August and sell during scarcity months. Liberty, the biggest maize trader on Sumba, sources between 375-700 tonnes of maize from surrounding districts. The trader has the capacity to absorb more since he has 2000 tonnes of storage capacity for all crops. He usually stores and sells maize after September. Neither farmers nor traders are sorting or grading the maize. In the peak season, prices are the same for all types of maize (white, yellow, local, hybrid, and composite). Maize tends to be sold in three main forms—as grains (mainly used to feed animals), as broken kernels (for human and animal consumption), and as maize bran (also for animals).

Prices are lowest directly after the harvest, with farmers typically receiving IDR 1,500-2,500/kg for grains and collectors receiving between IDR 3,000-4,000/kg depending on the district. Retail prices range from IDR 3,000-5,000/kg during the peak harvest period while prices during the scarcity months are approximately IDR 1,000-1,500/kg higher and can reach up to IDR 6,000/kg. In some areas, white maize varieties will be more expensive (with a small price differential of at least IDR 500) during the scarcity months. In order to meet local demand, traders will also often import maize during these months.

The majority of locally produced maize that is sold commercially is ultimately sold by retailers in wet markets and is purchased by households. There is very limited flow to animal feed and livestock industries and to other provinces. Local maize varieties in Timor are small in size and have low water content, which makes them less suitable for the poultry industry. While households will use local maize for their own livestock, the feed and livestock industries prefer to use yellow hybrid maize. There is currently no commercial feed production in NTT, and most of the chicken, pig, and fish feed available in input stores are imported from Surabaya. There is, however, interest by Dinas Pertanian in Nagekeo to build a local feed milling factory, and they have approached Charoen Phokphand, one of the biggest feed mills in Indonesia. There is also a large poultry industry on Timor, which requires 900 tonnes of feed per cycle (of which maize contributes 60% of the raw material). Much of the maize used by these poultry farms is sourced from other provinces. In the case of broiler farms, feed is supplied as a package with the imported day-old-chicks.

3.2.4 Supporting functions / services

Seed services are important for stimulating the adoption of higher yielding seeds by farmers, but there are currently only a few local seed producers of certified composite seeds. The government in NTT has supported (mainly in the form of free seeds and fertiliser) a number of local seed producers throughout the province to produce certified composite seeds. On Timor Island, there are approximately 29 maize seed producers which produce approximately 180 tonnes of blue label maize seeds annually. All of this is sold to the local government for free distribution, but these amounts are insufficient to meet the needs of the distribution program.

Common problems faced by local seed producers include the drying and storing of maize. If not done properly, this can lead to high rejection rates during the certification process. While the government has several drying facilities that are available to seed producers at a small fee, some producers have had poor experiences using the government drying machines. At the same time, the government has limited personnel to supervise the growing process and ensure quality control. This can also lead to delays or rejections, and a number of seed producers have noted that there is a lack of information and transparency on why seeds have been rejected by the certification body. Rejected seeds are consumed by the household, used as seed for household maize production, or sold as grain in the market.

Few of these local seed producers have private distribution channels for certified seeds. Since the predominant focus has been on producing certified seeds for the government scheme, local seed producers have not yet developed commercial distribution channels. They lack knowledge on how to market seed through private channels, especially since private input suppliers cannot absorb the same high quantities as the government. Nonetheless, some local seed producers (including CV Intan, CV Kharisma, and CV Kokdale in Timor) and input stores are interested in establishing private distribution channels. They recognise the future market opportunities from selling to the commercial market, especially given challenges with payment delays from the government. Going forward, capital constraints will restrict how quickly these seed producers can grow. This is particularly since the government has recently decided to start enforcing

a requirement that seed producers must have acceptable and sufficient storage capacity equal to the amount of seeds being certified.

Another important support function is information and extension services. Farmers mainly obtain information through other farmers, as well as through trial and error on their own farms. They tend to use traditional farming practices and have limited technical knowledge about good agricultural and post-harvest practices, particularly for the cultivation of higher yielding maize varieties. Some farmers are receiving information on proper cultivation techniques from NGOs (such as Yayasan Sosial Donders in Sumba and YMTM in Flores and Timor), but these programs often have limited outreach and are unsustainable. On the other hand, government extension is also not able to effectively satisfy the need for technical information and training, nor is it equipped to do so. Given the large geographic areas that each extension agent has to cover, they are also unable to provide regular technical assistance to farmers. Many of these agents are also not sufficiently trained or do not have specific expertise on maize. Finally, private input companies (such as BISI) do provide some information services, but this is geared towards promoting their own products. BISI, which currently only has one field agronomist for the entire NTT, has only established a handful of demoplots for hybrid maize.

3.2.5 Supporting rules and regulations (enabling environment)

Under the new Swasembada Pangan 2015, President Joko Widodo has ambitious goals for Indonesia to be self-sufficient in corn, rice, and soybean within the next four years. In order to meet these goals, the government plans to make significant improvements to supporting infrastructure (particularly irrigation, warehouses, and post-harvest facilities). Alongside these investments, the government also plans to expand seed production; increase fertiliser subsidies while improving the distribution system; encourage the development of cooperatives; improve access to agricultural financing; and initiate land reforms. The new government has set a production target of 20 million tonnes of maize for 2016. Other national level initiatives to support the maize sector include the signing of a Memorandum of Understanding between the Ministry of Agriculture and the Feed Miller Association in May 2015 around the purchase of maize for feed milling.

In order to support national production of maize, import restrictions have been introduced in the past. In 2005, the government imposed a 5% import tax on maize. In 2011, the Association of Feed Millers lobbied to have the government relax the tax, citing that the tax was pushing up the price of feed. Currently, according to the tariff schedule published on the Ministry of Finance website, there does not appear to be any import taxes or tariffs on maize. Imports are, however, controlled by the issuance of import permits by the Ministry of Trade. Importers need to submit a proposal to the Ministry of Agriculture, which will review and make a recommendation to the Ministry of Trade. While the Ministry of Agriculture has stated that imports should not occur during the harvest, imports are arriving throughout the year including during the peak harvest months.

In line with national objectives, which has selected NTT as a priority maize province, the provincial and district governments has also demonstrated a strong commitment towards supporting the maize sector. Under the national level UPSUS (Upaya Khusus) program, 77 districts across Indonesia have been selected as priority maize districts. This includes 7 districts in

NTT (Nagekeo, West Sumba, Central Sumba, South West Sumba, TTU, Belu, and Ende). A range of national, provincial, and local level support is being provided to maize farmers. This includes free hybrid/composite seeds and subsidised fertiliser, as well as support to local seed producers. In Nagekeo district, the Head of Agriculture is trying to stimulate inter-island exports and has signed an agreement with PT Seger Agro Nusantara in Surabaya, which will buy maize at a set price from Nagekeo. They have also encouraged local traders who own shipping facilities to enter the maize trade (Oti Express, Sinar Rembulan, and Selera Baru). However, challenges include the low profitability for traders given that the selling price and farm-gate buying price have been fixed.

Other relevant enabling environment factors include standards in the sector. Although the social cost of aflatoxin in Indonesia (from maize) is estimated to be in the order of AUD 200 million annually, maximum allowable aflatoxin levels are not being enforced. According to the Indonesian National Standards (SNI01-4483-1998), permissible aflatoxin levels are 50 ppb for animal feed. This is already high compared to the standard maximum of 20 ppb for poultry feed in the US and other countries. In order to better control aflatoxin in maize and peanuts, the Aflatoxin Forum Indonesia was established in February 2006. This is an information network that brings together government, research institutions (Gadjah Mada University), and businesses (processors, traders, farmer groups) in order to increase awareness related to aflatoxin. Nevertheless, government has been reluctant to enforce maximum levels and efforts to create awareness among the public have yet to be put in place.

4 Analysis

4.1 Problems and underlying causes

The problems and underlying causes are specific to the poor target groups that AIP-PRISMA seeks to support through interventions in the maize market system in NTT. These problems have been identified through the Sector Dynamics section above and are also presented in the Intervention Logic Analysis Framework (ILAF) table. The two key problems can be summarised as:

- Farmers experience low productivity because they employ poor agricultural practices
- Farmers will experience high losses when storing maize for extended periods of time

Farmers experience low productivity because they employ poor agricultural practices. The highest average annual yield in NTT was 2.67 tonnes/ha in 2010. This is significantly below the current national average of 4.84 tonnes/ha and that of leading provinces such as West Java (7.2 tonnes/ha). Furthermore, local varieties are the most commonly grown maize and are only able to yield on average less than 1 tonne/ha. This suggests that actual productivity is likely to be lower than what is reflected in the government data. In comparison, yields are on average 1.46 tonnes/ha for composite varieties in Timor and over 5 tonnes/ha for hybrids.

Current yields are constrained by how farmers are primarily using retained seeds of low-yielding local varieties. This is largely because maize has traditionally been farmed as a subsistence crop. Relatively few farmers have adopted composite or hybrid seeds, which are perceived to be less

resistant to weevil attacks when using traditional storage methods. Fertiliser is also particularly important for boosting productivity, especially when planting higher yielding varieties. However, the use of fertilisers is low among maize farmers. Overall, farmers have poor access to higher yielding seeds and fertiliser, as well as limited knowledge of the benefits of using such productivity enhancing inputs. Good knowledge on all aspects of maize production and post-harvest handling (including spacing, seed utilisation, application of chemical inputs, appropriate storage techniques) is also lacking.

Farmers will experience high losses when storing maize for extended periods of time. This is currently not a problem for most farmers since traditional drying and storage practices are well suited for local maize varieties, which accounts for over 80% of seed usage in NTT. Some studies in East Timor have found minimal weevil damage at 33 weeks when using traditional storage practices. Other studies in West Timor have found 20-50% losses from pest attacks over a 9 month period. But since households typically deplete their maize stock within 4-5 months, losses from weevil attacks are negligible. Where maize has been infested, these grains are not being wasted as they are sorted and used to feed household livestock.

The main challenge will arise as farmers increase their productivity. As they produce greater volumes of maize, they will be better able to fulfil their household needs as long as they can store the maize for extended periods of time (i.e. beyond the typical 4-5 months). However, it is also over these longer time periods that maize is more susceptible to weevil attacks. Moreover, if the increase in productivity is associated with the use of hybrids and composite seeds, there will also be greater risk of weevil attacks under traditional storage conditions. In both scenarios, the underlying cause is the farmers' use of traditional storage methods.

4.2 Services, enabling environment, and weaknesses analysis

There are a number of services and enabling environment factors which affect the underlying causes of the problems highlighted above. In order to strengthen the market system, it is crucial that identified weaknesses in these services and enabling environment factors are the target of interventions. The key services weaknesses are detailed in the ILAF table and include:

- Few commercial providers of fertiliser and higher yielding seeds, particularly given the strong government presence in these areas
- Limited provision of information and extension services because of weak public provision and lack of private alternatives
- No suppliers of alternative, affordable storage technologies

Few commercial providers of fertiliser and higher yielding seeds, particularly given the strong government presence in these areas

Maize farmers who use fertilisers or composite and hybrid seeds rely mainly on the government distribution programs. Nevertheless, these programs are often unable to supply sufficient quantities of fertiliser or higher-quality seeds. The program is also plagued with delays and problems with the

quality of inputs. The distribution of subsidised or free inputs from the government creates disincentives for private sector input supply companies to invest in new products and distribution channels. Input supply retailers have noted decreasing sales volumes since the government seed program was introduced. Composite seeds are difficult to find in the open market since most certified seed producers are selling all their production to the government. Hybrid seeds are still available commercially, but seed companies are experiencing difficulties expanding their market.

Limited provision of information and extension services because of weak public provision and lack of private alternatives

There are few reliable sources of information for maize farmers. Government extension is not able to effectively satisfy the need for technical information, and it is rare for input suppliers and traders to provide embedded information on maize cultivation. When input suppliers do provide information services, these are geared towards promoting their own products. As a result, farmers mainly obtain information through their peers and have limited exposure to better practices and innovation in maize farming and post-harvest handling.

No suppliers of alternative, affordable storage technologies

The main storage practices employed by farmers involve traditional techniques of storing the maize while still enclosed in the husk. There is already some evidence from other countries that the use of jerry cans, plastic barrels, or storage drums have been highly effective at reducing post-harvest quality losses. A study conducted by World Bank in 2008-2011 on Evaluating Seasonal Food Security Programs in East Indonesia also found that grain storage using an airtight container (drum) can reduce post-harvest grain losses. While effective long-term storage innovations exist, they are currently not affordable for smallholder farmers, and no one is developing alternative, more affordable storage options for smallholder maize farmers.

5 Strategy for change

The strategy is designed to strengthen the weaknesses in the current service provision and enabling environment in the market system. This takes the form of (1) identifying the market potential, through calculations to show the potential of the sector; (2) a vision of change, to envisage how the value chain or market system would operate if identified problems are resolved; and (3) a set of interventions which can be targeted at specific market actors or groups of market actors which can be engaged to drive change in the system.

5.1 Market potential

There is market opportunity to expand NTT's maize production in order to meet the province's growing demand for maize, which is currently being supported by imports from Java, Sulawesi, and NTB. Increased local production would mean that households would improve their food security, particularly from September to the next harvest, and would have to rely less on purchasing maize to supplement their household stocks. There is also potential to supply the

growing demand for maize by the livestock industry in NTT, much of which is also being met through inter-regional imports.

Based on our calculations, there is potential to unlock an additional AUD XXM for the maize sector in NTT.

Table 1: Business potential in target areas

5.2 Vision of change

Focusing on achieving the potential outlined above for the maize sector in NTT, a vision of change can be outlined for both the sector and service levels. The vision of change at the **sector level** is to: (1) increase smallholder productivity and overall production and (2) reduce potential high losses from shifting to higher yielding seed varieties and from extended storage periods. At the **service level**, it is envisaged that farmers will have improved access to: (1) seed, (2) fertiliser, (3) information and extension, and (4) storage services.

We envision that seed, fertiliser, and information and extension services will be provided through a range of market actors including local seed producers, seed companies, fertiliser companies, agricultural input stores/distributors, and possibly even feed millers and local maize traders. Storage services will be provided through potential manufacturers, distributors, and traders of storage solutions.

5.3 Intervention areas

It is crucial that interventions are designed which are 'systemic' so that outcomes are not dependent upon the project or development partner for sustainability. This means that AIP-PRISMA should not seek to provide services (or at least only temporarily) but rather enter the market system in a catalytic manner to tackle the service weaknesses in existing market actors. Based on our analysis, four key intervention areas will be necessary to transform the maize sector in NTT:

- **Intervention Area 1:** Promote the use of composite seeds
- **Intervention Area 2:** Promote the use of hybrid seeds
- **Intervention Area 3:** Introduce affordable commercial fertilisers
- **Intervention Area 4:** Introduce more effective, affordable farm-level storage solutions

Intervention Area 1: Promote the use of composite seeds

Of all the inputs used in maize production, none has the ability to affect productivity as much as seed. If farmers can obtain improved maize seed that performs well under local conditions, the efficiency of all other inputs is increased and productivity rises. The promotion of composite seeds alone, without changing any farming practices, can increase yields by 30%.

Local seed producers need to develop the appropriate strategy to penetrate the market, which is particularly challenging given the tradition of subsistence maize farming. To promote the use of

composite seeds, AIP PRISMA has already been working with several seed producers, such as CV Intan and CV Karisma in Timor. It has worked with these partners to (1) stimulate the demand for composite seeds (including through social marketing to educate farmers, the establishment of demonstration plots, and promotional materials at the point of sale) and (2) improve supply side development through technical assistance on seed production and certification. New seed packaging sizes were also introduced to make certified seeds more accessible to smallholders. Since women are active participants in the cultivation of maize, it will be important to involve women when strengthening farmer technical capacity in good agricultural practices. Trainings and demoplots will need to be accessible for women (e.g. in terms of timing and locations), and marketing campaigns need to be gender-sensitive to ensure that women and men have equal access to information on the use and benefits of improved seeds.

Going forward, AIP-PRISMA will continue working with CV Intan and CV Kharisma to improve the sustainability and outreach of the business model. Additional activities include building the management capacity of seed producers, conducting an area mapping, establishing a "Campion Jagung" club, and developing an effective marketing program. Alongside continued support to existing partners, which may include expanding their private distribution network to Flores, there is also potential to support additional intervention partners in Timor, Sumba, and Flores.

Intervention Area 2: Promote the use of hybrid seeds

The use of hybrid seeds is another means by which farmers can significantly improve their productivity. Adoption of hybrid seeds will be more challenging than composite varieties since hybrids require investments in external inputs and other more intensive farming practices. In order to promote the business case for switching a proportion of maize farms from local varieties to hybrid seeds, options include testing models where the seed company may also provide embedded finance and training, as well as linkages to maize buyers.

Some seed companies, in particular BISI, are already trying to promote hybrid seeds in NTT. Despite active promotion efforts by BISI, their outreach is limited, and there is potential to partner with BISI to improve their efforts to stimulate demand for hybrids. Toko Waris, an input retailer, who has established a hybrid maize contract farming arrangement in Semau is interested in scaling up their contract farming model to other locations. However, they are struggling to identify target areas and farmers to work with. This presents another potential entry point for AIP-PRISMA. There is also high potential for introducing hybrid maize in Sumba, especially to farmers who are growing two seasons of maize. One of the main challenges for growing hybrids in Sumba would be the lack of commercial fertiliser, which is a necessary input for hybrid maize production. Fortunately, there are some retailers, such as Setia Jaya, who have expressed interest in sourcing and selling commercial seed and fertiliser if there is an available supply at the right time. Similar gender considerations as those outlined above will apply to the promotion of hybrid seeds.

Intervention Area 3: Introduce affordable commercial fertilisers

The ultimate goal is to ensure the availability and use of fertiliser, which is essential for maximising yields from hybrid seeds and can also improve yields from composite seeds. There is potential to

work with fertiliser companies and agro-input dealers to develop fertiliser products and private distribution channels to target smallholder farmers. Although government subsidised fertilisers have created disincentives for the growth of a commercial fertiliser market, there are opportunities for private sector involvement since the supply of subsidised fertiliser is insufficient. Furthermore, delays in the government distribution scheme often means that subsidised fertilisers arrive at the wrong times in the planting season. Again, this also provides an opportunity for private sector involvement.

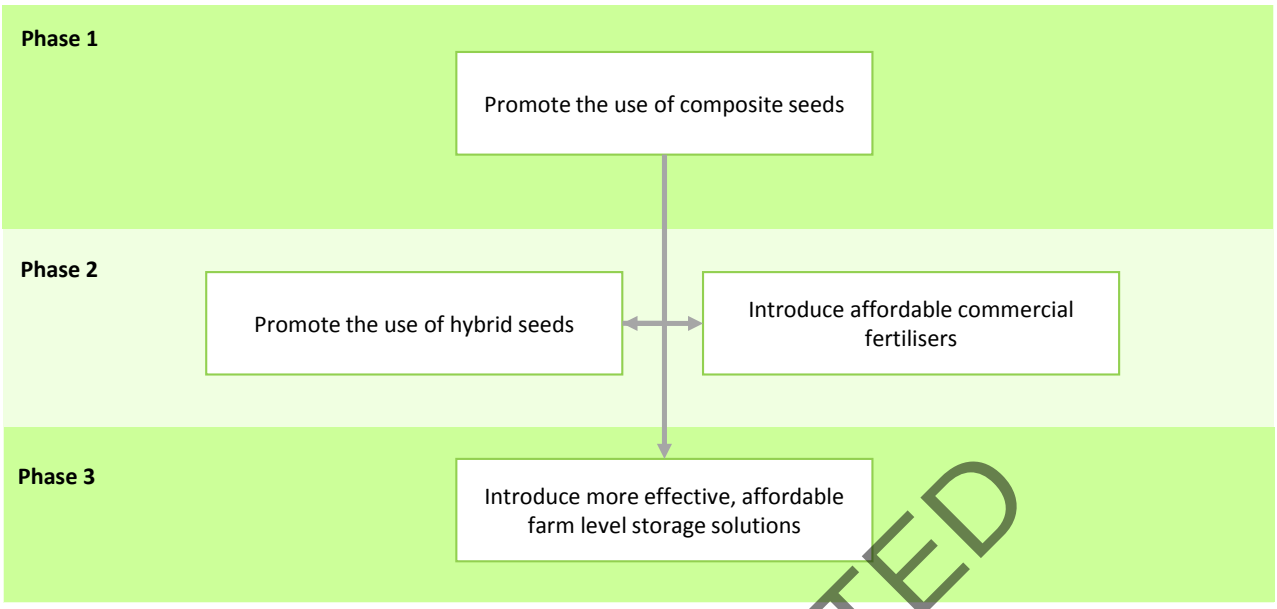
Intervention Area 4: Introduce more effective, affordable farm-level storage solutions

The introduction of effective, affordable farm-level storage technologies will be important for reducing losses once farmers have increased productivity and are growing more composite and hybrid seeds. There is potential to work with manufacturers, distributors, and traders of storage equipment, and possibly research institutions, to develop alternative, cost-effective technologies. This may involve using PIC bags or other forms of airtight containers.

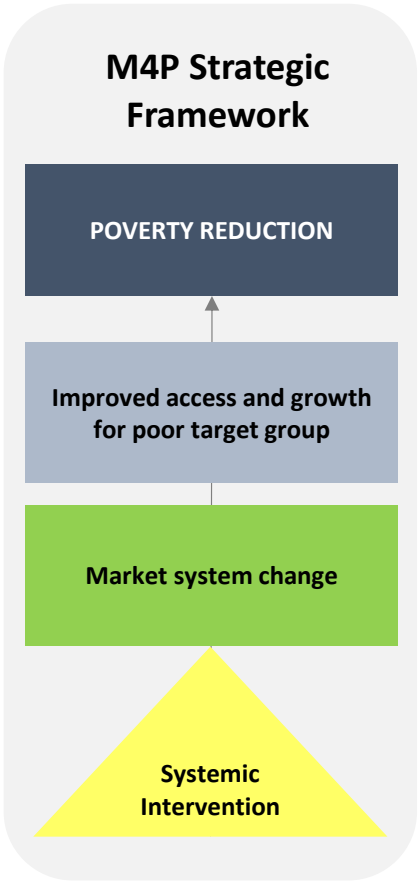
In some districts, social convention dictates only women can assess storage facilities to collect the maize for consumption or before cooking. Even in areas that do not have such strict social rituals, women still tend to play a major role in the storing of maize. Hence, it will be important that any new storage technologies are designed to be appropriate for women and that training is provided to women on better storage methods and technologies.

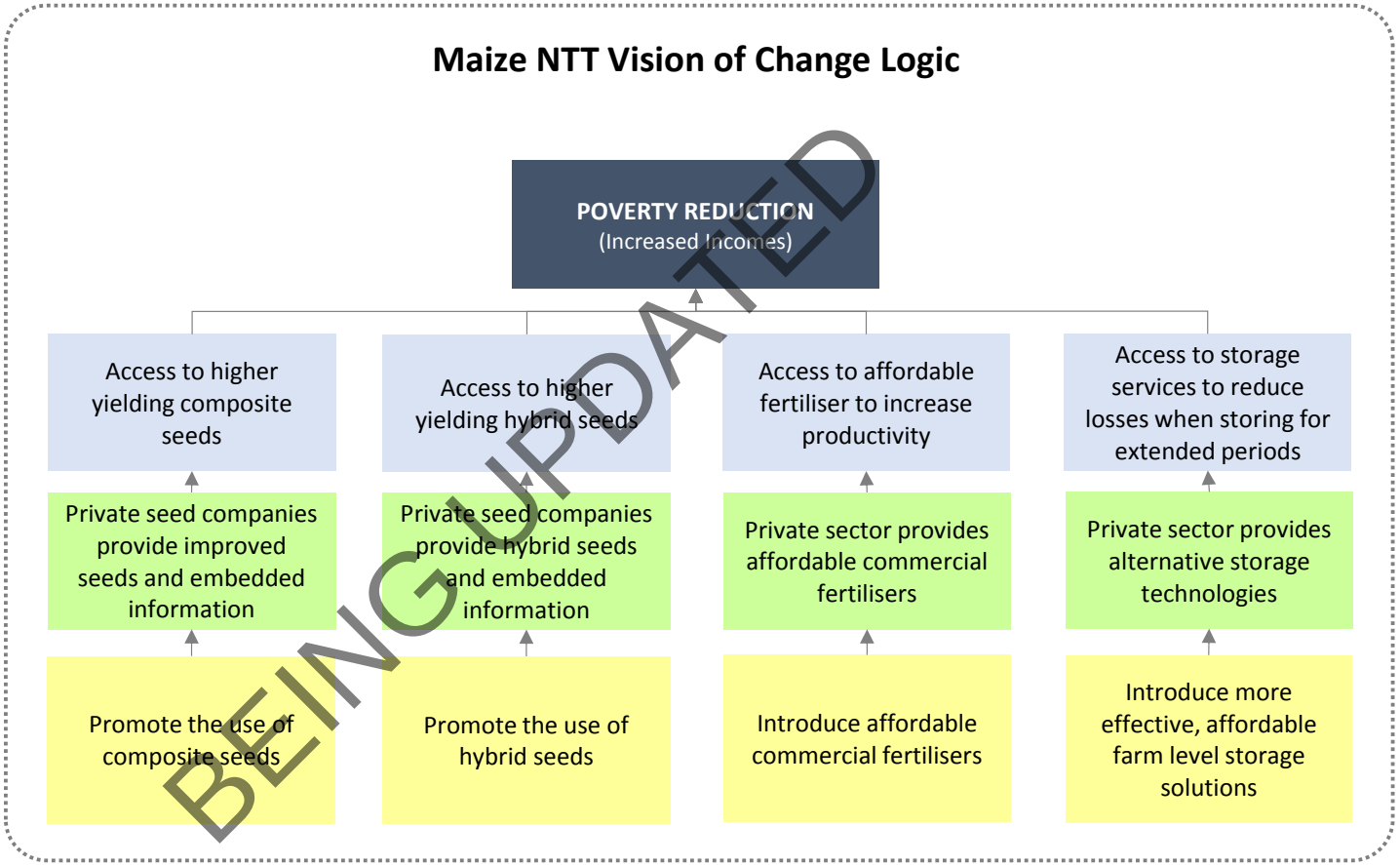
5.4 Sequencing and prioritisation of intervention areas

It is recommended that the intervention areas in the NTT maize sector be implemented in three phases. In the first phase, the focus will be on *promoting the use of composite seeds*, which require less intensive farming practices than hybrid seeds. The second phase will *promote the use of hybrid seeds* in certain areas alongside *introducing affordable commercial fertilisers.* Fertilisers are necessary for hybrid seed production but can also improve productivity when used with composite seeds. Since better storage solutions will only be necessary once there has been a significant improvement in productivity, the final stage involves *introducing more effective, affordable farm-level storage solutions.*



5.5 Sector vision of change logic





Annex 1: Intervention Logic Analysis Framework (ILAF)

(1) Problem/ Symptom	(2) Underlying cause	(3) (4) Services and Enabling Environment	(5) Service weaknesses/ underlying causes	(6) Intervention Areas	Service Provider/Partner
Farmers experience low productivity because they employ poor agricultural practices	Farmers primarily use retained seeds and limited fertiliser. They have poor access to higher yielding seeds and fertiliser, as well as limited knowledge on good agricultural practices and the benefits of using these inputs.	Seed services Fertiliser services Information & extension services	Subsidised inputs from the government are not reaching farmers in sufficient quantities, do not arrive on time, and are of variable quality. Limited or no commercial providers of fertiliser or higher yielding seeds for maize farming. Weak public provision of extension services and lack of private alternatives. Existing traders provide limited embedded information.	**Intervention Area 1:** Promote the use of composite seeds	• Local seed producers • Seed companies • Agricultural input stores/distributors
				Intervention Area 2: Promote the use of hybrid seeds	• Seed companies • Agricultural input stores/distributors • Livestock farms/ traders • Feed millers • Maize traders
				Intervention Area 3: Introduce affordable commercial fertilisers	• Fertiliser companies • Agricultural input stores/distributors • Local maize collector/trader
Farmers will experience high losses when storing maize for extended periods of time	Farmers use traditional storage methods which are susceptible to weevil attacks	Storage services	No suppliers of alternative, affordable storage technologies for smallholder maize farmers.	**Intervention Area 4:** Introduce more effective, affordable farm-level storage solutions	• Manufacturers/ distributors/ traders of appropriate storage solutions (PIC bags, airtight containers, etc.)