TOMAK

To'os ba Moris Di'ak

Farming for Prosperity

Potential for Improving On-farm Productivity of Selected Agricultural and Livestock Enterprises

Technical Report 2

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Adam Smith International

MERCY CORPS

Australian Aid

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Abbreviations & Acronyms

ACIAR	Australian Centre for International Agricultural Research
AI-Com	Agricultural Innovations for Communities for Intensified and Sustainable Farming Systems in Timor-Leste (ACIAR)
ASI	Adam Smith International Pty Ltd
AVANSA	Avansa Agricultura Project (USAID)
BOSS	Business Opportunities and Support Services Project (ILO)
CA	Conservation Agriculture
CCT	Co-operative Café Timor
CSF	Classical Swine Fever
DAC	Developing Agricultural Communities Project (USAID)
DFAT	Australian Government Department of Foreign Affairs and Trade
FAO	Food and Agriculture Organisation of the United Nations
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GoTL	Government of Timor-Leste
Ha	Hectare
HH	Household
IEP	Support to Peaceful Development through the Innovative Employment Program (GIZ)
IIWZ	Inland Irrigated Watershed Zone
ILO	International Labour Organisation
KJ	Kilojoules
LW	Live Weight
MAF	Timor-Leste Ministry of Agriculture and Fisheries
MDF	Market Development Facility (DFAT)
Mt	Metric Tonnes
N	Nitrogen
P	Phosphorus
R&D	Research and Development
RDP3	Rural Development Program Phase III (European Commission)
SE	*Septicemia Epizootic*
SOL	Seeds of Life Program (ACIAR)
TOMAK	To'os ba Moris Di'ak / Farming for Prosperity
ToR	Terms of Reference
TSP	Triple Superphosphate
UNTL	Universidade Nacional Timor Lorosa'e
USAID	United States Agency for International Development
VC	Value Chain

Executive Summary

The aim of this study was to assess various farm-level aspects of selected crop and livestock production systems, including current production practices, constraints, and opportunities for improvement.

Gross margin analyses have been conducted to combine information on inputs, outputs, productivity and labour required for each commodity. Analyses has been conducted for a range of scenarios for each enterprise. These scenarios are based on introducing proven improved technologies and practices that could result in increased production and incomes. The scenarios are different for each commodity, but generally involve using improved varieties and agronomy to increase yields, as well as introducing labour saving devices.

Given that labour supply is the critical limiting factor for most households (HHs), the key measurement used to report the analyses is gross margin per day of labour required (i.e. return to labour) (Table 1). In the analyses, there is no division between family and paid labour, all labour (whether paid or unpaid) is pooled. Gross margin per labour day therefore represents the effective return to total labour (paid and unpaid) for the enterprise. Note that these returns need to compete with an opportunity cost of around US$5 per day, plus meals, equal to the prevailing rural wage labour rate.

Table 1. Gross margin per labour day for 11 commodities (for the current system of production, semi-improved system and fully improved system) applying current known technologies

	Gross margin / labour day US($)		
Commodity	**Current system**	**Semi improved**	**Fully improved**
Pig fattening	6.2	6.1	9.3
Cattle	6.0		2.0
Mung bean	4.0	6.4	9.1
Soybean	3.6	5.1	7.2
Maize (as animal feed)	4.2	5.9	12.4
Cassava (as animal feed)	4.3	5.1	5.5
Peanuts	5.8	6.5	9.7
Upland Black/Red rice	4.4	No known innovations	
Irrigated red rice	4.4	5.5	9.1
Potato	Low	No known innovations	
Onions	17		20

Source: Mission estimates[1]

Cattle. The current system of raising cattle based on open grazing of unimproved pasture and crop residues produces low growth rates but reasonable returns to labour based on a herd size of 12 cattle. Intensive finishing using improved forages for a limited period prior to sale would result in cattle that are in better condition and therefore attract higher interest from buyers. Besides being heavier, intensive fattening may also result in a small price premium ($/kg), especially if cattle can be finished ready for sale at a time of the year when supply is limited. However, intensive cattle fattening requires significant labour for the duration of the fattening period, and the return to labour over this period (if viewed in isolation) is reasonably low. Profitability of finishing systems could possibly be improved through use of forages other than tree legumes, and also possibly through development of finishing systems based on *in situ* grazing of improved forages such as greenfeed maize or elephant grass, but more research and development (R&D) is required. Given that the Australian Centre for International Agricultural Research (ACIAR) has recently begun a new cattle project in Timor-Leste, aimed at testing new technologies for improved beef production, it is recommended that TOMAK defer support related to cattle finishing until such time as viable models have been better defined and tested, and are ready for scale-up.

Pigs. Pig fattening is an activity that is highly suited to TOMAK's target group, given that it is a backyard activity, investment costs are relatively low, it has a relatively short production cycle, and it is an activity that can generate particular benefits for women. The current extensive system of pig fattening (based on local

[1] Prices applied for the various commodities are: pigs $4/kg live weight, cattle $2.5/kg live weight, mung bean 70c/kg, Paddy rice 35c/kg, paddy red rice 70c/kg, soybean 75c/kg, maize 40c/kg, cassava 16c/kg dry, peanuts 75c/kg (in shell), red onions $2.5/kg

breeds and a ration that is largely comprised of kitchen scraps and garden waste, occasionally supplemented with edible food such as rice bran and mung bean) produces a reasonable return to labour but is not scalable due to the low-cost feed resource being finite. A more intensive feeding system based on improved breeds and use of a formulated ration costing $1/kg has recently been trialled but is not financially viable. Preliminary analysis suggests that the cost of formulated feed could be halved by using imported high-protein soybean meal mixed with locally-produced carbohydrate (maize or cassava), rather than more expensive local sources of protein. With a feed cost of $0.50/kg intensive pig production becomes far more attractive, providing the basis for an expanded smallholder production sector. It is therefore recommended that TOMAK undertake additional assessment to confirm the proposed ration based on using imported soybean meal as a protein source, and then design an appropriate smallholder pig production support activity. Parallel activities would need to include: (i) improving the delivery of vaccination services especially for Classical Swine Fever, along with improving access for farmers to other pig-related animal health services; and (ii) together with the DFAT Market Development Facility (MDF), assisting the private sector to develop a small plant for mixing and bagging a pre-mix formulation that can be bought by farmers to add to a local source of carbohydrate. Support for establishing specialised pig breeding households based on Duroc (*Fahi Macau*) sows should also be investigated, providing the basis for an expanded semi-intensive fattening industry.

Maize. Maize is one of the most commonly grown crops in Timor-Leste. At present, it is used overwhelmingly to meet HH subsistence needs – some estimates suggest as little as 7% is traded. In the absence of established markets of any size, infrastructure and services for aggregating, storing and quality assuring the product are poorly developed. Maize yields and productivity can be significantly improved through the introduction of a range of well-proven technologies and improved management practices, including use of improved varieties and small amounts of fertiliser, and application of conservation agriculture practices. Increased production could provide the basis for a range of commercial value-added activities, such as using maize for manufacture of human food products (e.g. Timor Vita), or livestock feeds.

TOMAK's initial work with maize is likely to be under the food security and nutrition component of the Program, focused on improving productivity and reducing storage losses. Once marketable surpluses have increased there is scope for extending this into a range of value chain (VC) development activities.

Peanuts and mung bean. Peanuts and mung bean are examples of cash crops that are already being grown by significant numbers of HHs to generate income, with good returns. Productivity of peanuts could be further improved through the promotion of improved varieties, use of fertiliser, and use of labour-saving devices for post-harvest operations. The same applies for mung bean through introduction of new varieties, use of fertiliser, and improved storage. For mung bean there is also potential to expand the production area by planting it as a short duration dry season crop following paddy, provided it can be protected from damage from grazing animals. There is good potential for further developing both the peanut and mung bean VCs under TOMAK, subject to available markets.

Red rice and black rice. Production of red rice as an irrigated crop in paddy areas is financially viable for producers, particularly with the use of fertiliser and use of herbicides to minimise labour required for weeding. Subject to available markets, there is reasonable potential for developing the red rice VC under TOMAK as a substitute for white rice production, which is uneconomic. However, red rice is likely to remain a niche product – market demand is likely to be limited.

Black rice can only be grown under upland rainfed conditions. There are no known innovations that could increase farm level profitability. This option does not warrant further consideration.

Soybean. Soybean production is financially viable for producers, although less profitable than peanut and mung bean. There are good opportunities for improving productivity through introduction of new varieties and moderate use of fertiliser. There is also good potential for expanding the area of soy bean planted as a second crop after rice. Subject to available markets, there is therefore potential for developing the soybean VC under TOMAK. However, market risk is probably higher than for other crops given the challenge of competing against cheap imports from major producers such as United States, Brazil, Argentina and China.

Cassava. Cassava is an important subsistence crop in Timor-Leste**.** Relatively little is traded. There is no industrial-scale processing of the crop for human and livestock feed as is common in many other major producing countries. Adoption of new varieties, use of fencing for animal control, and small amounts of herbicide and fertiliser have good potential for increasing yields, food security and potentially HH incomes. However, the high labour requirements for harvesting, drying and cleaning tubers post-harvest mean that there is little scope for improving returns to labour, which are generally low compared with other cropping options. Given the current situation of a constrained (and possibly reducing) total rural labour supply, cassava should not be a priority VC for TOMAK, at least until such time as viable options for mechanised harvesting have been developed. This recommendation may change if TOMAK supports the development of intensive livestock production enterprises where cassava can be used as a feedstock.

Onions. Red onions are the most profitable crop assessed. Productivity could be further improved through the use of improved quality planting material, and increased use of fertilisers and fungicides. Subject to available markets, there is good potential for developing the red onion VC under TOMAK, although the size of the market – and therefore the number of farmers involved – will always be somewhat limited. Note also that due to the high production costs, red onion farming is an activity that will be better suited to HHs that are already reasonably well capitalised. In addition to red onions, the production of Bombay onions from seed, in the same locations where red-onions are currently grown, could be further investigated.

European potato. Due to the cost and length of time required to control potato blight, there is little potential for developing the European potato VC under TOMAK. It is recommended that this VC should not be considered further.

Cross-cutting market systems. There are several cross-cutting issues that are common to multiple VCs where TOMAK could possibly provide development assistance. The most important of these include:

- Many of the plant-based VCs rely on access to improved planting material. Simply by changing variety, farmers are able to increase their average return to labour from an estimated $4.6 to $6.2/day, a 35% increase. To do this they need access to improved varieties. The supply of improved seeds and planting material to farmers could be considered as a separate target VC for TOMAK assistance, building on previous investments from the Seeds of Life (SoL) Program.
- To realise the productivity gains on offer, farmers need ready access to a range of farm inputs e.g. planting material/ seeds, fertilisers, herbicides, pesticides, durable fencing material, and various labour saving devices. In most areas, farm input supply businesses are poorly developed, despite some improvement in recent years. TOMAK could provide assistance to further catalyse the development of these businesses. Training in the appropriate selection and use of agrichemicals is also essential.
- There is a serious lack of market information available to farmers who are trying to produce commodities for sale. Many farmers never obtain independent information regarding the true value of the goods they are selling. In this information vacuum sellers sometimes have unrealistic price expectations based on ill-founded rumours, and traders often have an unfair negotiation advantage. TOMAK could investigate ways of improving the supply of independent price information for farmers in Timor-Leste.
- Low levels of soil fertility reduce yields in almost all crops in Timor-Leste. The ability to identify problem soils is highly desirable for lifting crop yields through use of fertiliser. TOMAK could investigate the feasibility of supporting the establishment of a private soil testing service, or support the Timor-Leste Ministry of Agriculture and Fisheries (MAF) soils lab to provide soil testing services on a commercial basis.

Main Report

1. Background

The To'os Ba Moris Diak Program (TOMAK) is a A$25 million, five (plus five) year agricultural livelihoods program funded by the Australian Government in Timor-Leste. Its goal is to ensure rural households live more prosperous and sustainable lives. TOMAK will achieve this through parallel and linked interventions that aim to:

- Establish a foundation of food security and good nutrition for targeted rural households.
- Build their capacity to confidently and ably engage in profitable agricultural markets.

The primary target area comprises inland mid-altitude areas that have some irrigation capacity. This zone (the Inland Irrigated Watershed Zone (IIWZ)) includes around 70-80 sukus, located mainly in the Maliana basin (including most of Bobonaro); the eastern mountain regions (including large parts of Baucau and Viqueque) as well as parts of Lautem and Manatuto; and Oecussi. The Program will initially focus its activities in Baucau, Viqueque and Bobonaro municipalities.

TOMAK will develop an early focus on target value chains (VCs) that have the strongest market potential and offer the best economic returns.

This assignment comprises step two of a three-step process designed to identify high-potential VCs where TOMAK will provide development assistance from early 2017. The three steps are as follows:

- Step 1: Conduct of a broad market scan to identify commodities with best market potential (completed) [2];
- Step 2: Assessment of farm-level aspects of selected crop and livestock production systems, including current production practices, constraints, and opportunities for improvement, providing a basis for an informed initial selection of VC for more detailed analysis (this assignment); and,
- Step 3: Conduct of detailed analysis for VCs that are assessed to have both market potential, and clear opportunities for productivity improvement on-farm[3].

Specific tasks included in the Terms of Reference for this assignment included:

- Review available secondary data on the target production systems;
- Where necessary, validate secondary data with key informants in TOMAK's three initial target municipalities (e.g. MAF staff at national and municipal levels and key farmers);
- Describe present production practices for the selected enterprises, including cropping season, use of inputs, labour requirements (paid vs unpaid), yields, disposal of harvest, and contribution to HH income;
- Identify major production constraints;
- Identify key opportunities for improvement, on the basis of proven technologies and practices;
- Review and update crop/livestock enterprise models showing the financial returns available to producers, both in the status quo 'without project' situation, and under an improved 'with project' scenario;
- Identify key projects and programs, current and in the recent past, that are particularly relevant to the subsector;
- Describe dominant HH farming systems, including seasonal calendar (differentiated in terms of south and north coast, irrigated and non-irrigated areas);
- Organize an internal workshop to present findings to the TOMAK and MDF teams and kickstart the final selection of value chains; and,

[2] TOMAK Technical Report #1: '*Market Analysis of Selected Agricultural Products'*. October 2016.
[3] TOMAK Technical Report #3: '*Value Chain Assessments for Selected Agricultural Products'*. November 2016.

- Prepare a final report that incorporates all activities and results of the consultancy.

Based on the initial assessment of market potential (Step 1), 10 crop and livestock production activities were shortlisted for further assessment as part of this assignment (

Table **2**).

Table 2. List of high and medium market potential value chains (from Step 1)

High market potential	Medium market potential
Pigs	Maize (as animal feed)
Cattle	Cassava (as animal feed)
Mung bean	Peanuts
Soybean	Black/red rice
	Potato
	Onions

This report is presented in four main sections:

- Section 1 (this section) contains background information to the study;
- Section 2 provides a general description of farming systems and household characteristics in TOMAK target areas;
- Section 3 describes present production practices, constraints and outlines development potential for each of the 10 crop and livestock production activities shortlisted; and,
- Section 4 identifies and assesses a number of cross-cutting constraints (and development opportunities) that are common to most of the targeted subsectors.

The assessment is based on secondary data to the extent possible, cross-checked and verified with primary sources as necessary. During the course of the assignment, interviews have been conducted with MAF staff in each of the three target areas and also with lead farmers who have experience in one or more of the target crop and livestock enterprises[4].

2. Farming systems and household farming characteristics in inland irrigated areas

2.1. Introduction

Farming in Timor-Leste is based on farming HHs as production units. Households tend to vary in membership and age structure, but on average have 5.5 members. Most HHs are involved in subsistence farming, producing little surplus for sale above consumption needs. They have a long record of practicing low-input/ low-output systems of food production. HH's tend to produce a wide range of food crops and also raise various kinds of livestock, all in small volumes and quantities. Limited production surpluses (over HH consumption needs) are sold to meet relatively limited cash requirements. These surpluses tend to be sold in local markets due to poor roads, lack of transport and few traders.

Labour at peak times has traditionally been organised through mutual labour groups (Tetun: *servisu hamutuk*). This allows farmers to engage relatives and neighbours in common forms of assistance in agriculture. Arrangements of this nature are important as a risk diversification measure, and as a means of strengthening food security and social capital within close-knit rural communities. In recent times the mutual labour system has been breaking down, with people more likely to seek payment for providing labour to other HH's.

[4] The assignment was carried out by Acacio Amaral (Livestock Specialist Universidade Nacional Timor Lorosa'e); together with Robert L. Williams, Modesto Lopes (TOMAK), and Luis de Almeida (ex-SoL agronomy and seed production system staff member).

2.2. Crops cultivated

Rice, maize, cassava and sweet potato are the main staple food crops grown in the inland irrigated zone. Maize is most common, grown by 69% of HHs, with rice and cassava grown by more than 60% of HHs (Table 3). Over 50% of HH also produce fruit, vegetables and coconuts.

Table 3. Cropping characteristics for the seven livelihood zones based on analysis of 2010 census data

	Rice	Maize	Cassava	Vegetables	Fruit Temp.	Fruit Perm.	Coffee	Coconut	Temporary Crops	Permanent Crops
1. North coast irrigated	61	63	50	50	53	49	11	55	52	49
2. Inland irrigated areas	62	69	64	53	59	59	19	62	57	60
3. South coast irrigated	61	64	62	57	60	55	15	60	57	55
4. Mid-elevation uplands	23	83	83	69	77	78	72	62	73	75
5. High elevation uplands	10	80	71	63	62	64	75	20	62	62
6. Northern rainfed areas	13	53	45	31	41	41	16	43	39	41
7. Southern rainfed areas	13	47	47	39	40	40	16	41	37	39
F prob.	<0.00	<0.00	<0.00	<0.00	<0.00	<0.00	<0.00	<0.00	<0.00	<0.00
L.S.D. (P<0.05)	9	8.4	8.8	9.6	10	9	6.20	9.5	9.8	9.60
CV %	65	27	31	41	36	35	36	42	39	38

Source: Analysis using data from the Timor-Leste National Population and Housing Census (2010)
Notes:

- Crop data are % of HH's growing each crop.
- F probability and LSD are based on one-way ANOVA.

2.3. Cultivated area

In terms of cultivated production areas, there is a clear distinction between rice and non-rice farming HHs. Rice farming HHs have an average area of 0.8 to 1.0 ha of irrigated paddy, with 0.2-0.4 ha of dryland farming. Non-rice farming HHs typically have around 1.0 ha of dryland farming (Table 4). Rice farming HHs are more likely to grow vegetables than non-rice farming HHs.

Table 4. Area of rice, dryland farming and vegetables for HHs in the inland irrigated zone

	Rice farming HH's (ha)	Non rice farming HH's (ha)
Rice	0.81	0
Dryland farming (mixed maize cropping)	0.2-0.4	1.0
Vegetables/ other crops	Small areas	Very small areas

Source: Mission estimates

Dryland farming systems are based mainly on maize with a wide range of intercrops. The most common intercrop species are cassava, sweet potato, pumpkin, pigeon-pea, yams, red beans, rice bean and yam bean.

Rice is always grown as a monoculture crop (monocrop) as are most vegetable crops.

Peanuts, mung bean and soybean are also generally grown as a monocrop.

Although many types of crops are grown by rural HHs, planted areas on average are very small. Statistics on production areas, quantities and yields are generally limited to the major crops, but even these are of dubious quality.

2.4. Crop production and utilisation

Different crops have a different function in terms of providing food and/or cash. Vegetables are generally grown for cash sale, and rarely used for home consumption. Peanuts and beans (mung bean, red bean and soybean) are mostly grown for sale but some are consumed in the HH as a snack food for visitors, and as part of a boiled corn dish (Tetun: *batar daan)*.

Crop yields are generally low, although have been improving in some areas due to increasing adoption of new varieties introduced and promoted by the SoL Program. Storage losses are high. For example, it is estimated that storage losses for maize are up to 30%.

Most of the rice (70%), maize (80%) and cassava (50%) that is produced is consumed by the producing HH. Maize and cassava are also commonly used to feed livestock, particularly chickens and pigs. What is not consumed, fed to livestock, or wasted/ spoiled, is sold. Small amounts of various other crops are generally eaten by the HH. Most farming HHs also collect wild foods, and these are almost all consumed within the HH.

As HHs become more commercial, a higher percentage of total production is sold. Disposal of production for one such HH is shown below. This HH consumes only 10% of the maize produced, but consumes most (70%) of the rice produced (Table 5). Market-oriented HHs of this nature do exist, but they are not common.

Table 5. Utilisation of production by a typical HH selling surplus grain

Crops	Amount allocated (%)					
	Consumption	Seeds	Animal feeds	Give away (relatives)	Sales	Total
Maize	10	5	20	5	60	100
Rice	70	5	0	5	20	100
Peanuts	10	5	0	5	80	100
Cassava	50	0	30	5	15	100

Source: Household interview, Sr Augusto, Ritabou Maliana

There are a number of locations in Timor-Leste where farmers are producing a surplus of non-rice staple food crops to sell, then purchasing rice to eat if they cannot produce rice. These include Ritabou in Maliana, the flood plain of the Loes river, and the Los Palos plateau. These areas have reasonable tracts of flat land that can be managed as one unit, located close to settled areas.

2.5. Livestock ownership

More than 80% of HHs in the inland irrigated zone raise chickens and pigs, one of the highest rates for the country. Around one quarter of households also raise cattle and buffalo. The number of cattle and buffalo per HH is also among the highest in Timor-Leste (Table 6).

Table 6. Livestock characteristics for the seven livelihood zones based on analysis of 2010 Census data

	Chickens (% HH)	Chicken holding	Pig (% HH)	Pig holding	Sheep (%)	sheep holding	Goat (%)	Goat holding	Horse (%HH)	Horse holding	Cow (%HH)	Cow holding	Buffalo (%HH)	Buffalo holding
1. North coast	74	5.2	74	2.7	9	17.5	37	4.4	9	2.8	28	3.5	12	5.5
2. Inland irrigated	81	5.5	81	2.6	10	4.8	35	3.4	26	2.2	26	4.1	23	5.0
3. South coast	82	7.2	82	3.7	4	5.1	24	3.6	22	2.7	35	5.5	22	6.3
4. Mid elevation	82	4.9	82	2.4	3	4.2	31	2.8	24	1.6	33	2.7	11	3.4
5. High elevation	71	3.9	71	1.9	3	3.4	25	2.1	31	1.6	24	2.3	10	2.1
6. Northern rain-fed	74	5.3	74	2.8	6	9.2	36	3.6	14	2.8	25	3.4	11	4.5
7. Southern rain-	73	6.7	73	3.2	1	6.4	19	3.4	23	2.1	34	4.9	17	5.3
F prob.	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	<0.0	0.4	0.0	<0.0	<0.0	<0.0
L.S.D. (P<0.05)	5.8	0.8	5.7	0.5	3.1	7.0	7.0	0.8	7.6	1.6	8.3	0.8	5.3	1.5
CV %	16.0	35.0	16.0	35.0	142.	264.	50.0	52.0	74.0	125	63.	48.0	79.0	76.0

Source: Analysis using data from the 2010 Census
Notes:

- Livestock data are average ownership (head) per HH.
- F probability and LSD are based on one-way ANOVA.

Table 7. Poverty level, household annual expenditure and income from a range of sources for the eight livelihood zones

	Below poverty line(%)	Annual expenditure ($)	Value of production and income ($)	Value of livestock sold + eaten	Value of non-coffee crops produced, less sold amount	Income from non-coffee crops sold	Income from employment	Value of food assistance	Income from coffee	Annual income from forestry	Annual income from animal by-products	Annual income from fishing
1. North coast irrigated areas	31%	$2,820	$1,238	$127	$770	$8	$68	$12	$0	$15	$0	$51
2. Inland irrigated areas	47%	$2,120	$718	$150	$470	$32	$22	$6	$11	$4	$0	$2
3. South coast irrigated areas	53%	$2,035	$985	$130	$708	$62	$15	$3	$0	$3	$3	$45
4. Mid-elevation uplands	54%	$1,884	$744	$147	$303	$60	$27	$3	$137	$9	$1	$5
5. High elevation uplands	66%	$1,600	$593	$72	$232	$75	$11	$2	$154	$2	$0	$0
6. Northern rain-fed areas	40%	$2,420	$836	$160	$401	$60	$32	$5	$28	$38	$3	$71
7. Southern rain-fed areas	35%	$2,548	$749	$175	$401	$34	$44	$7	$4	$5	$1	$2
8. Capital cities	33%	$2,460	$1,135	$118	$253	$48	$77	$3	$38	$2	$1	$73
Mean	43%	$2,259	854	139	484	475	42	6	43	10	2	21

Source: Timor-Leste Household Income and Expenditure Survey (2004)

2.6. Household income

HHs in the inland irrigated zone share many characteristics, but are also quite distinct from HH in other livelihood zones.

Based on the 2004 Household Income and Expenditure Survey (Table 7), 47% of HHs in this zone live under the poverty line. This is a little higher than the national average of 43%. Annual HH expenditure is similar to most other zones, at just over $2,100/HH per annum.

Total value of farm production plus non-farm income[5] for the inland irrigated zone (all sources) is $718/HH per annum. Of this, the value of crop production accounts for $502 (70%), livestock for $150 (21%), with the balance of 9% being made up from various sources including, forestry, fishing, employment, and food assistance.

Very little is sold. Total annual sales of crops and livestock amount to only $49 (9%). The major source is sale of surplus crop production.

Although this source of data is now 10 years old, it serves to demonstrate the generally low income levels, heavy reliance on agricultural and livestock production, and very limited cash sales. The situation will be re-analysed early in 2017 once the 2014 Household Income and Expenditure Survey data becomes available, but the overall conclusions are not expected to change markedly.

Another source of information on HH income comes from SoL. Over a 12-month period in 2007, SoL tracked income for 14 farming HHs that had no off-farm income. The most common agricultural items sold to raise cash were chickens, palm wine, cassava, leafy greens and pigs (Table 8).

Table 8. Types of agriculture produce and livestock sold by household over a 12 month period

Types of agriculture product and livestock sold	Percent of households selling
Chicken live	11
Palm wine & cassava (9% for each item)	9
Leafy greens	8
Pig, coffee, banana (7% for each item)	7
Sweet potato	8
Maize	5
Rice	4
Coconut	3
Dog, taro, mango (3 % for each item)	3
Pawpaw, bread, goat, salt & umbel (2% for each item)	2

Source: SoL 2007

[5] Excluding other social transfers and remittances.

3. Commodities

3.1. Cattle production

3.1.1. Introduction

Cattle production in Timor-Leste is based on the species *Bos javanicus*, also known as Banteng, or Bali cattle. The males are black and females buff in colour. Growth is sexually dimorphic; males grow faster and are larger than females. Females reach maximum size in three to four years, while males take five to six years. Males achieve sexual maturity at three to four years, and females at two to four years.

Timorese legends and myths often include stories about buffalo, but not cattle. This is because Timor-Leste has a short history of cattle production. Banteng were introduced from Indonesia in the late 1970s. Since that time, they have expanded in numbers in all municipalities. The total cattle population in Timor-Leste in 2010 was 161,654, owned by around 23% of HHs, with an average of 2 to 6 head/HH depending on municipality (

Table **9**).

Table 9. Total Bali cattle by municipality, 2010

Municipality	Total HH	HHs with cattle (%)	Average cattle/HH
Aileu	6,965	31%	2.2
Ainaro	9,664	17%	3.8
Baucau	21,255	7%	4.1
Bobonaro	16,883	43%	4.0
Covalima	11,105	49%	4.1
Dili	35,224	2%	4.6
Ermera	19,280	25%	2.4
Lautem	11,447	25%	5.9
Liquica	10,351	32%	2.4
Manatuto	6,925	23%	3.9
Manufahi	7,856	26%	3.7
Oecussi	13,890	44%	2.7
Viqueque	13,807	25%	6.6
Total	184,652	23 %	3.9

Source: 2010 Census

3.1.2. Cattle production systems

Cattle are usually raised in an extensive manner, grazing unimproved pasture, with an annual cycle of reproduction. Calving tends to peak during the dry season when feed is most limiting (August to October). The reproductive cycle commences after the start of the wet season, when females start to ovulate in response to improved nutrition.

Based on a study in Lautem and Ambeno, the overall annual calving rate is only 49% with first calving age at just over three years. Inter-calving intervals are between one and a half years to two years, with calf mortality around 30%.

Cattle are mainly owned by subsistence-oriented farming families. Most are open-grazed during the day, herded by one or two people, then tethered or shut into corrals at night. During the day, especially during the dry season once harvest has been completed, herders move cattle to forage on river banks and in rice fields.

Animals are seldom vaccinated or provided with other animal health treatments. This exposes them to a range of diseases and parasites. Vaccination of cattle under the prevailing extensive management systems is difficult as they are difficult to restrain for treatment.

3.1.3. Labour requirements

Tending of cattle is mostly done by men, and sometimes boys. The number of herders varies from one to 2 persons. Livestock farmers sometimes employ someone (mainly from family members) to take care of cattle. Wages are paid in the form of cattle (one to two yearlings per year). Payment can also be in cash ($50 to $65 per month).

3.1.4. Contribution to household income

Cattle (as well as pigs and other livestock) are used as a store of wealth that can be sold in times of emergency, or when cash is required.

In Dili there are two modern butchers (one in Comoro, managed by EDS company) and another one in Bemori (Talho Moris). These two companies buy bulls based on liveweight. Prices paid during the second half of 2014 and first half of 2015 were: >250kgs - $2.70/kg; 200 to 250kgs - $2.50/kg; <200kgs - $2.00/kg.

In Bobonaro and Viqueque, as in many other parts of Timor-Leste, cattle are sold not based on weight but on the number of siblings they have. The current price paid for bulls in surveyed municipalities is shown in Table 10.

Table 10. Cattle price (traditional pricing approach)

Local Naming	Age estimation (years)*	Price ($)		Municipality
		Minimum	Maximum	
Alin 1	1.5 - 2	170-175	200 – 250	Bobonaro
Alin 2	3 - 4	250 – 300	300 – 350	Bobonaro
Alin 3	4.5 – 6	300 – 360	500 – 700	Bobonaro
Alin 4	6 – 8	400 – 500	600 – 800	Bobonaro
Alin 5	6.5 – 10	700	800	Bobonaro
Alin 1	1.5 - 2	150- 180	225-250	Viqueque
Alin 2	3 - 4	250 – 275	300	Viqueque
Alin 3	4.5 – 6	400-450	500	Viqueque
Alin 4	6 – 8	500- 600	650	Viqueque
Alin 5	6.5 – 10	650-700	800	Viqueque

Source: Mission estimates

*Age estimation based on the calving interval of 1.5 to 2 years

From 2004, farmers in Bobonaro sold cattle to West Timor (Indonesia) through official channels. Cattle were weighed and price was calculated on the basis of $2.70/kg liveweight. The official export trade to West Timor has declined since 2011, when the Indonesian Government required all shipments to be approved by the Directorate General of Livestock in Jakarta. Complying with this process proved to be so lengthy and complicated that official exports have ceased. However, an illegal border trade continues. It is estimated that around 10,000 head /year are currently being sold from Timor-Leste to West Timor via Bobonaro and Covalima through unofficial channels, with total revenue of around $7.3 million/year.

The increased value of the US dollar has reduced this export trade in recent years. Indonesian traders prefer to fix prices in Rupiah, meaning Timor-Leste producers face a lower price in US dollars, as the Rupiah has reduced in value by 30%.

Forty-nine per cent of cattle traders consulted buy bulls directly from livestock farmers, 46% buy from both traders and livestock farmers and only 6% buy from other traders (middlemen).

3.1.5. Major production constraints

Diseases. There are several endemic diseases that seriously impact on cattle production in Timor-Leste. The most significant of these are *Septicemia Epizootic* (SE), *Brucellosis,* and intestinal worm infestations that cause diarrhoea. These diseases affect both mortality and morbidity.

Poor nutrition. Under traditional systems of raising cattle, animals are open-grazed on crop residues and unimproved pasture. During the wet season when grass is green and plentiful, nutrition is adequate, but during the dry season available feed is constrained in terms of both quantity and quality, and animals usually lose weight. Many animals die during the dry season due to lack of feed, and possibly water. As a result of poor nutrition, cattle take an extended period of time to reach slaughter weight (four to five years). Poor nutrition also leads to delays in first calving, reducing lifetime productivity.

Management. Cows and calves are usually grazed together, which can cause higher calf losses due to poor nutrition. It is preferable to separate (to wean) calves at a certain age, to allow cows and calves be separately managed with calves being given preferential treatment.

Invasion of noxious species. Two highly invasive weeds (*Lantana camara* and *Chromolaena ordorata***,** or siam weed)**,** continue to spread and smother native grasslands, and are toxic to cattle. This has resulted in reduced pasture available for grazing. *Lantana camara* was probably introduced to West Timor with the introduction of Bali cattle in 1912, arriving in Timor-Leste not much later. *Chromolaena* was introduced during Indonesian times, and was then spread by military traffic along the roads in Timor-Leste. It is still spreading in many rural areas.

3.1.6. Key opportunities for improvement

Diseases. Animal diseases are one of the major problems affecting cattle production in Timor-Leste. Most animal diseases are easily prevented using vaccines and/or treated with animal medicines. Currently, most farmers rely on free treatment and vaccination from MAF. Unfortunately, the free vaccination and treatment provided by government reaches relatively few farmers. Farmers need access to vaccines, drenches, antibiotics and B12 injections etc. Supply could be facilitated through public or private channels.

Nutrition. Improved animal nutrition could double live weight gains from 0.2 kg/head/day to 0.4 kg/head/day. Achieving this would require feeding improved forages, probably based on a cut-and-carry system whereby forage is produce in specialised areas, and carried to tethered or penned animals for feeding. Current cut-and-carry systems are mainly based on growing and feeding tree legumes. The most common trees used for this purpose are *Leucana leucocephala* (*Ai café*) and *Sesbania grandiflora* (*Ai turi*). Summaries of these systems are available from ACIAR reports on cattle systems in Indonesia. There is possibly also potential for producing other improved forages (e.g. green-feed maize, elephant grass) for use in cut-and-carry systems, or for grazing *in situ*.

Markets. There is potential for the value of the current illegal trade in live cattle to Indonesia to be increased by producing heavier cattle through improved feeding. However, the real potential for expanding this trade can only be realised once it is formalised through official channels. This is likely to demand improved disease control measures on the Timor-Leste side of the border.

Between 2009-2012, Timor-Leste imported approximately 100 Mt of beef per year from Australia and New Zealand at a value of around US$8 per kg, or US$800,000 per year. Besides Australia and New Zealand, frozen beef is also imported (278 tons from Malaysia and Singapore in 2013). There is some potential for local production to substitute for these imports, provided quality can be significantly improved.

3.1.7. Government policies

The current government policy is to provide free vaccination for endemic diseases including *Septicaemia Epizootica*. Government needs to be involved in promoting an environment where cattle producers can access vaccinations for the most important economic diseases. This can be done through private or public channels. MAF has chosen to buy and distribute these vaccines free of charge as a public service (until 2020). It currently spends >$100,000/year on vaccine purchase for three major livestock diseases (ND, Classical Swine Fever [CSF] and *Septicemia Epizootic* [SE]). Unfortunately, the vaccination rate for Bali cattle remains low (30.3%), well below the 75% rate needed to confer herd immunity.

3.1.8. Relevant projects and programs

Relevant projects include:

- Enhancing smallholder beef production in Timor-Leste (ACIAR: LPS/2009/036) (just completed)
- Smallholder Cattle Enterprise Development in Timor-Leste (ACIAR: LPS/2014/038) (just commenced). This is a five-year project, aimed at developing beef producer groups to test and extend new technology for increased beef production.
- The International Labour Organisation's Business Opportunities and Support Services Project (BOSS), a private sector development project aiming at developing a number of VCs, including cattle. The main intervention areas include:
  - Productivity: Animal health services and Good Animal Health Practices;
  - Processing: Improving slaughtering and processing to international standards;
  - Entrepreneurship: Promotion and development of entrepreneurship culture in the sector; and,
  - Legal support: Support to MAF to draft decree laws on animal and meat handling.

3.1.9. Review of livestock enterprise models

From 2002-2006, Co-operative Café Timor (CCT) assisted farmers to fatten and sell cattle, with the aim of diversifying and improving rural incomes with emphasis on low-technology approaches, and minimising the investment requirement and risk for smallholders.

The CCT model involved an arrangement whereby CCT supplied cattle to farmers for fattening, with the liveweight gain being shared between CCT and the farmers. Details of this arrangement included:

- 150 kg bulls were purchased as yearlings, at a price of $150-$170 per head.
- These were placed with qualifying HHs, who were responsible for feeding and watering. After 8-12 months, with bulls weighing a minimum of 280 kilograms, farmers were paid $1.10-1.14 per kg for the net liveweight gain (280-150 = 130 kgs x 1.10 = $143).
- After deducting expenses, and based on two cattle per family, farmers were able to earn approximately $215 a year. This represents more than 50% of the annual income of an average rural HH in Timor-Leste.
- About 1-3 hours per day of labour was required to look after the two animals; mainly related to cut-and-carry feeding.

Profit margins for CCT were reported to be low. The fattening model had more success in areas along the south coast, especially Suai. This was due to the longer wet season, easier access to fodder trees and easier access to the Indonesian market. The system failed to produce fat cattle along the most of the north coast (with the exception of Loes) due to low levels of fodder production, a much longer dry season and further distances to water springs/ water sources.

3.1.10. Gross margin analysis

A gross margin analysis was conducted to assess the financial returns for extensive and intensive cattle fattening systems in Timor-Leste. Note that the analysis is based solely on fattening and does not include the cost (or benefit) associated with the breeding herd.

The current extensive system is reasonably efficient in terms of labour. Under this system, one labourer manages a herd of around 12 head. The herd is taken out to graze each day, with animals being tethered or corralled at night.

The only marginal cost is the labour required to manage the cattle. For one day of labour, the total liveweight gain is 0.2 kg/head/day times the 12 cattle being managed, or 2.4 kg liveweight. At a sale price of $2.5/kg LW, this returns $6/day of labour (Table 11).

Intensive cattle fattening is most profitable in the period just prior to when cattle would normally be sold out of the extensive system. The most saleable weight for cattle is above 270 kg. Below that weight, the price ($/kg liveweight) is reduced. Investing in intensive fattening of cattle a long time prior to sale has significant risks. The major risk is that the intensive feeding cannot be maintained through to sale, the animal loses liveweight prior to sale and the value of the investment in intensive fattening is lost.

Research by ACIAR project LPS/2009/036 has produced much of the data for the following analysis, which includes the following assumptions: (i) animals are fed forage tree legumes produced by the farming family, consuming 2.5% of liveweight per day; (ii) daily liveweight gain is 0.4 kg/head/day; (iii) animals are sold for $2.50/kg liveweight; (iv) it takes 1 hr per day to feed/water and clean each animal being intensively fattened, i.e. half a day for four head. It is assumed that cattle would be 'finished' under this sort of system for one to two months prior to sale.

Using previous experience from the ACIAR project (ACIAR LPS-2014-034 Project), feed is costed at 75c/head/day, based on forage from tree legumes. Placing an appropriate cost on feed is the most difficult part of this exercise because the tree legumes need to be established for one year before they can be used for forage production.

Based on the analysis, the return to labour day for the finishing period is $2.0/day. This is within the range of $1.6 to $5/day estimated by the ACIAR cattle project. This return does not vary with the length of time an animal is fattened because the gross margin deals with a fixed amount of labour per animal and a fixed increase in liveweight per day.

The analysis is highly dependent on the cost of feed, and the amount of time it takes to care for the animals. It is unlikely that feed cheaper than 75c/day/head could be produced if the primary source is tree legumes. This cost could be reduced if there is a large natural resource of fodder trees (as in some areas on the south coast). It could also be reduced if specialised fodder crops are grown that are capable of producing large quantities of good quality dry matter per hectare. Examples include elephant grass and greedfeed sorghum or maize. These would probably need to be produced under irrigated or semi-irrigated conditions, and would therefore need to be able to compete financially with food crops that could be grown on the same land. Further assessment of the economics of producing specialised forages such as greenfeed maize and elephant grass is required. In relation to labour, one hour per head per day seems conservative for a cut-and-carry system, especially if the water source is some distance from the cattle.

Table 11. Gross margin analysis cattle fattening

System Item	Extensive One Month	Intensive One month
Scale of operation		
Number of head	12	12
Days on feed (days)	30	30
Cattle weight (kg/head)		
Live weight	200	200
Daily live weight gain (kg/head/day)	0.2	0.4
Weight gain over feeding period (kg)	6	12
Feed costs		
Cost of feed ($/head/day)	0	0.75
Cost of feed per day ($/day)	0	9
Cost of feed for whole period	0	270
Sale value		
Price ($/live weight)	2.5	2.5
Increase in value ($/head/day)	0.5	1
Increase in value for whole herd, full period	180	360
Labour		
Daily labour requirement (hr/head/day)		1
Labour days for the whole period	30	45
Gross Margin		
Gross margin ($)	180	90
Gross margin per labour day ($)	6	2

Source: Mission estimates

3.1.11. Recommendation

The current system of raising cattle, based on open grazing of unimproved pasture and crop residues, results in low growth rates, but produces a reasonable return to labour based on a herd size of 12 cattle. Intensive finishing using improved forages for a limited period prior to sale will result in cattle that are in better condition and therefore attract higher interest from buyers. Besides being heavier, this may also result in a small price premium ($/kg), especially if cattle can be finished ready for sale at a time of the year when market supply is limited. However, intensive cattle fattening requires significant labour for the duration of the fattening period, and the return to labour over this period (if viewed in isolation) is reasonably low. Profitability of finishing systems could possibly be improved through use of forages other than tree legumes, and through development of finishing systems based on *in situ* grazing of improved forages such as greenfeed maize or elephant grass, but more R&D is required.

Given that ACIAR has just started a new project (the Smallholder Cattle Enterprise Development in Timor-Leste) aimed at testing new technology for improved beef production, it is recommended that TOMAK defer support related to cattle finishing until such time as viable models have been better defined and tested, and are ready for scale-up.

3.2. Pig production

3.2.1. Introduction

Domestic pigs were introduced to the island of Timor about 5,000 years ago by Austronesian settlers from the west. They are often slaughtered for ceremonial and cultural purposes. At both weddings and funerals, wife-giving families (Tetun: *umane*) bring pigs to exchange for cattle or buffalo brought by the wife-taking families (Tetun: *feto san*). To supply the meat at weddings, pigs are supplied by both sides of the family. Pigs are also used as a store of wealth to be sold when families need money.

Ownership of pigs is common throughout the country, with more than 75% of HHs owning pigs in all municipalities with the exception of Dili. On average each HH has between 2-4 pigs. Households often view pigs as a mechanism for recycling kitchen and garden wastes.

Table 12. Pig population by municipality

Municipality	Total HH	% HH with pigs	Pigs/HH
Aileu	6,965	82%	2.2
Ainaro	9,664	73%	2.3
Baucau	21,255	77%	2.2
Bobonaro	16,883	78%	3.1
Covalima	11,105	79%	3.6
Dili	35,224	36%	2.3
Ermera	19,280	68%	2.1
Lautem	11,447	71%	3.1
Liquica	10,351	82%	2.6
Manatuto	6,925	74%	2.8
Manufahi	7,856	71%	2.9
Oecussi	13,890	72%	2.5
Viqueque	13,807	72%	3.5
Total	184,652		2.7

Source: Census 2010

Larger pig holdings are more common along the south coast than the north coast, and are more common in the far east and west of the country compared to the centre. Pig holdings are smaller and less common in the elevated areas such as Emera (Table 12).

3.2.2. Breeds and reproduction

The majority of pigs kept by Timorese farmers are a local breed which has a greater ability to survive on local feed types and under local environmental conditions. They are also less susceptible to common diseases and parasites compared to exotic breeds[6].

At birth, local piglets weigh about 800 g. Raised under extensive conditions they can reach a liveweight of 100 kg at around 10 months of age.

Male pigs start breeding at eight months, reaching maturity at one year of age. Female pigs start breeding a little earlier than boars (seven to eight months old). The recommended weaning age is seven weeks.

Litter size for local pigs varies from 4-10 piglets. Data available for Alieu shows an average litter size of 6.2, of which 1.4 die prior to weaning at 4 months age (Table 13).

Table 13. Local Timorese pigs performance in Aileu

Index	Unit	Mean
Litter size	Head	6.2
Weight	Kg	0.78
Weaning weight	Kg	6.15
Farrowing interval	Months	7.8
Age of weaning	Months	4.0
Piglets mortality rate per litter prior to weaning	Piglets	1.4

Source: Gomez 2015

[6] A description of smallholder pig production systems in eastern Indonesia.(GIZ pers com)

New pig breeds have recently been introduced to Timor-Leste. The most recent introductions are Duroc (and possibly Landrace) breeds, locally referred to as Macau pigs (Tetun: *fahi Macau*). *Fahi Macau* have large floppy ears, large litters and can grow to a large size in a reasonably short period of time (Table 14). However, as with most improved pig breeds, they also have less resistance to disease and parasites, and do not tolerate poor nutrition well.

Table 14. Type of pigs and their gestation, litter size and weights (FAO 2009).

Pigs breed	Litter size	Adults weight
Local	6.2	100-150 kg
Duroc/Landrace	9	Male 300 kg, female 250 kg

Source: Farmer's Hand Book on Pig Production, FAO, 2009

3.2.3. Pig management

Most pigs in Timor-Leste are raised extensively (estimated at more than 75%), but some are raised under semi-intensive conditions and a few are managed intensively (either penned or tethered). In major urban areas most pigs are penned to protect people's gardens. Government decree number 12/2014 on restriction of livestock in urban areas requires pigs to be penned, although this law is not yet applied at village level.

Pigs are usually fed twice a day, with a few HHs feeding three times a day. In addition to kitchen scraps they are fed with a wide range of local foods depending on availability, including corn, cassava, rice hulls, some vegetables, banana stalks, coconuts, sago and tamarin.

The optimal diet for pigs has a 15% protein level, which can be achieved on a ration comprising 80% maize and 20% soybeans[7]. The expected feed conversion ratio on this ration is 3.8:1. Timorese pigs are generally fed at a level far below this optimal diet. Growth rates are very slow due to restricted protein intake, often between five and 11 %[8]. Although a commercially formulated feed is available in Timor, very few pig growers use this due to the high cost ($1/kg).

3.2.4. Labour requirements

Most pigs are cared for using HH labour, mainly women and children. For local pigs, the time required is less than one hour a day, since they are fed mainly with kitchen scraps and garden waste; and with free-range systems there is no labour required for cleaning pens. In more intensive systems, the time spent varies from one to three hours a day (feeding and cleaning) for a pen that may contain several pigs.

3.2.5. Contribution to household income

As noted above, apart from being kept to fulfil cultural obligations, pigs are also used as a store of wealth to be sold when families need money. There are relatively few specialised pig producing HHs. Most production is small-scale, and carried out as a backyard activity.

Most pigs are sold at the point of production (i.e. traders come to the farmer's house to purchase). Some live pigs are sold in local markets, or in municipal and national markets. The price of live pigs varies from one place to another and depends on the size and breed of the animal (Table 15). Improved pigs command a much higher price. The minimum prices shown in Table 15 are for local breeds of pig, the maximum prices for improved breeds.

Table 15. Price of pigs in Timor-Leste at different ages

Age (months)	Minimum price ($)	Maximum price ($)	Approx weight (kg)	Municipality
2-4 (starter)	75	100	20	Baucau
5-8 (grower)	300	700 (Introduced breed)	75	Baucau
Over 9 (Finisher)	400	1000 - 1500 (Introduced breed)	100	Baucau, Loes (Liquicia)

Source: Mission estimates

[7] According to the FAO publication '*Nutrient Requirements of Swine'*

[8] Mission estimate.

Overall, the market price of pigs is estimated to average approximately $4/kg live weight. This is based on the observation that pigs dress-out at 65%, the butcher takes a margin of approximately $1.2/kg and pork is sold at $8 per kilo. The approximate live weights as shown in Table 15 are derived from this per kg price.

3.2.6. Major production constraints

Disease. Disease is one of the major constraints affecting pig production in Timor-Leste. The most common pig diseases include CSF, intestinal worms, and various other parasitic diseases.

Nutrition. The second major constraint is poor nutrition. This results in very low (or even negative) growth rates. In some cases, pigs die because of lack of feed, especially during the dry season. Most farmers respond to feed shortages by reducing the frequency of feeding, from three times a day to twice a day and in extreme cases to once a day. The low protein content of most rations also has a significant impact on growth rates.

Improved breeds. MAF, through the Directorate of Livestock, has recently distributed 920 Duroc pigs for breeding purposes across 10 municipalities. In Bobonaro, 67 pigs were distributed to six Administrative Posts. In Baucau 38 were distributed to Muia, Laga and Bahu. Many of these pigs are being kept under poor conditions (suboptimal feeding and disease control) and are not performing well. While there is undoubtedly good potential for productivity improvement based on improved breeds, these should be introduced only into situations where good feeding and improved disease control can be guaranteed.

3.2.7. Key opportunities for improvement

There are a number of opportunities for increasing pig production. The most significant of these include improving pig health care, and improving nutrition based on improved access to cheap sources of protein.

Vaccination. Vaccination against CSF is currently supplied by the government free of charge (until 2020). Unfortunately, coverage rates are very low (28%), and in many areas non-existent. Vaccination coverage needs to increase to over 70% to provide adequate levels of protection. Demonstrations could be implemented to show the effectiveness of vaccination, combined with efforts to then link farmers to commercial suppliers.

Other health treatment. Other common diseases affecting pigs can be easily treated. Treatment is seldom provided under extensive farming systems however. Some treatments are given under more intensive production systems, but these mainly rely on free government services, which are limited in coverage and quality. There is also scope to improve the capacity of the private sector to supply animal health inputs, combined with farmer training to improve recognition of common animal health problems, causes, treatments and benefits of treatment.

Nutrition. Good feeding plays a central role in achieving good growth rates. Feed conversion rates of around 2 to 2.5:1 for younger pigs increasing to more than 3.5 to 3.8:1 for older pigs are possible when quality feed is used.

Local rations typically use local carbohydrates such as cassava, sago, corn and papaya stems, with limited protein. To improve the pig ration, GIZ developed a local ration (Table 16) that produces a feed with 18% protein, costing approximately $1/kg. However, the sources of protein used for this ration (fish and mung beans, obtained from local sources) are relatively expensive, and once fed to pigs are removed from the human food chain.

Table 16 Itemised pig feed ration promoted by GIZ and used very occasionally in Timor-Leste

Item	Protein (%)	Amount (kg)	Approx price (c/kg)	Cost ($)
Corn	9	5	50	2.5
Rice hull	12.5	1.5	50	0.75
Cassava	2	0.5	25	0.125
Mung bean	24	1.3	1.5	1.95
Fish	49	1.7	3	5.1
Total		10		10.24

Source: GIZ

There are possibly alternative sources of cheaper protein that could be mixed with essential vitamins and minerals and sold as a pre-mix. Farmers using this pre-mix could then add their own source of local carbohydrate. One possible source of protein could be imported soybean meal or soybean cake.

Soybean meal is a by-product from the extraction of soybean oil, and is the most important protein source used to feed farm animals worldwide. It represents two-thirds of the total world output of protein feedstuffs and has been an accepted part of livestock and poultry diets in the United States since the mid-1930s.

Soybean meal is a highly palatable feedstuff, with a high protein content (from 43 to 53%) and low crude fibre (less than 3% for the de-hulled soybean meals). It has a very good amino acid balance and contains high amounts of lysine, tryptophane, threonine and isoleucine that are often lacking in cereal grains. However, the concentration of cystine and methionine are suboptimal for monogastric animals and methionine supplementation is necessary. Amino acid digestibility is also very high (more than 90% for lysine in pigs and poultry).

World prices for soybean meal over the last 10 years fluctuate from 20 to 60c/kg (Figure 1). Assuming a long term price of 40c/kg, soybean meal could be imported and sold in Timor-Leste at 80c/kg landed.

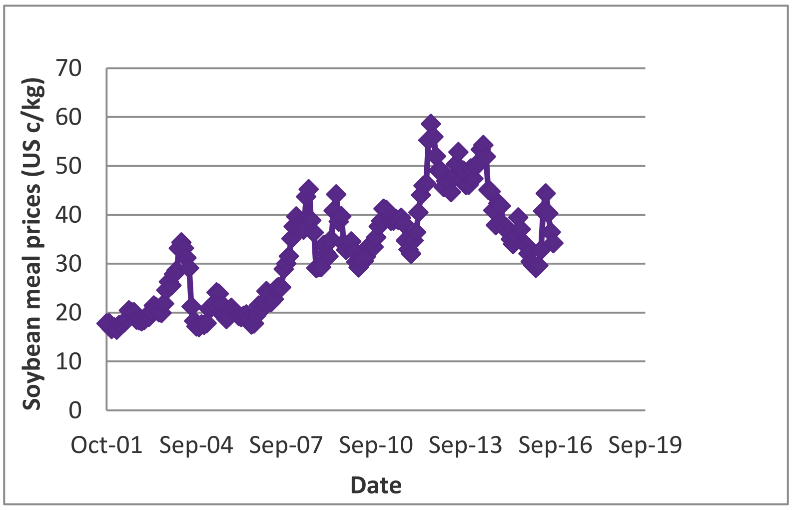

Figure 1. World soybean meal prices from 2001 to 2016[9]

Table **17** details the cost of a ration with 16% protein, with most of the protein coming from soybean meal. The price of $5.50 / 10 kg is about half the cost of the GIZ ration.

[9] https://ycharts.com/indicators/soybean_meal_price_any_origin

Table 17. Modified GIZ pig feed ration, utilising soybean meal as the protein source

Item	Protein (%)	Amount (kg)	Approx price (c/kg)	Cost ($)
Corn	9	7	50	3.50
Rice hull	12.5	0.5	50	0.25
Cassava	2	0.5	25	0.13
Soy meal	48	2	80	1.60
Total		10		5.5

3.2.8. Government policies

Government policy is to provide free vaccination for CSF across the country, until 2020. Government has also been recently involved in free distribution of improved pig breeds to selected farmers for breeding purposes.

3.2.9. Relevant projects and programs

GIZ's 'Support to Peaceful Development through the Innovative Employment Promotion' (IEP) Project supported a few pig producers in Suai and Baucau municipalities to improve feeding practices. Although the program claimed to follow a VC approach, little was done beyond production level.

ACIAR is also planning a project, commencing January 2017, which will investigate the effect of vaccination on reducing pig mortality (AH/2012/065)[10]. This project will be implemented in cooperation with the University of Sydney, MAF and Universidade Nacional Timor Lorsa'e (UNTL).

MAF has a program to develop groups of pig producers throughout the country.

3.2.10. Gross margin analysis

A gross margin analysis has been conducted to compare various production systems. The first is a semi-extensive system where a local-breed pig is tethered or penned, and fed locally available rations. The other two scenarios are based on more intensive feeding of pigs, one based on the local breed and the other on *Fahi Macau*.

All three scenarios aim to produce a 100kg live weight pig, with a sale price of $400. The required duration of feeding is different for the three scenarios: the local pig with local feed option would take 54 weeks to reach 100kg; (ii) the local pig with improved rations option would take 30 weeks to reach 100kg; and (iii) the improved pig with improved feed would take just 20 weeks to reach 100kg.

The local pig raised under local conditions has no housing costs, and has a small opportunity cost for food (20c/l=kg). This assumes a ration mainly comprising food scraps of no value, occasionally supplemented with edible food such as rice bran, mung bean etc. The net return generated by this model is a respectable $148/pig, or $6.25/day of labour. For a backyard activity that is carried out using part-time, surplus labour, this is likely to be reasonably attractive to HHs, particularly given that it provides a mechanism for adding value to kitchen and garden waste. However, this system can't be easily scaled-up, as the feed is based on a limited supply of kitchen scraps and garden waste. Improved access to vaccination and health care services could reduce death rates, leading to more frequent sales.

[10] Regional approach to enhance smallholder pig systems in Timor-Leste and eastern Indonesia.

The second two models involve intensive fattening of either local or *Fahi Macau* pigs using the GIZ ration, costed at $1/kg. Neither of these options is viable due to the high feeding costs. The net return generated is only $16-21/pig, or $0.6-1.2/day of labour.

If the cost of the ration could be halved to $0.50/kg through the import of soybean meal as suggested in

Table **17**, intensive pig production becomes far more attractive. The gross margin per pig (for both local and improved breeds) is estimated to be $160 dollars, based on 30 weeks feeding for a local pig and 20 weeks feeding for an improved pig. Return to labour day ranges from $6/day for a local pig to $9/day for an improved pig.

3.2.11. Recommendation

Pig fattening is an activity that is highly suited to TOMAK's target group, given that it is a backyard activity, investment costs are relatively low, it has a relatively short production cycle, and it is an activity that can generate particular benefits for women. The current extensive system of pig fattening (based on local breeds and a ration that is largely comprised of kitchen scraps and garden waste, occasionally supplemented with edible food such as rice bran and mung bean) produces a reasonable return to labour but is not scalable due to the low-cost feed resource being finite. A more intensive feeding system based on improved breeds and use of a formulated ration costing $1/kg has recently been trialled but is not profitable. Preliminary analysis suggests that the cost of formulated feed could be halved by using imported high-protein soybean meal mixed with locally-produced carbohydrate, rather than more expensive local sources of protein. With a feed cost of $0.50/kg intensive pig production becomes far more attractive, providing the basis for expanded HH production.

It is therefore recommended that TOMAK undertake additional assessment to confirm the proposed ration based on using imported soybean meal as a protein source, and to then design an appropriate smallholder pig production support activity if this is financially viable. Parallel activities would need to include: (i) improving the delivery of vaccination services especially for Classical Swine Fever, along with improving access for farmers to other pig-related animal health services; and (ii) together with the Market Development Facility, assisting the private sector to develop a small plant for mixing and bagging a pre-mix formulation that can be bought by farmers to add to a local source of carbohydrate at HH level.

Support for establishing specialised pig breeding households based on Duroc (*Fahi Macau*) sows should also be investigated, providing the basis for an expanded semi-intensive fattening industry.

3.3. Maize

3.3.1. Introduction

Maize (*Zea mays*) is the third most important crop internationally after wheat and rice). It is an important human food in many countries and is also grown for animal feed. In addition, maize is used to produce starch, bio-ethanol and corn syrup.

In Timor-Leste maize is cultivated by approximately 80% of small subsistence farming families, mainly under rainfed conditions to which it is well adapted. It is grown throughout the country as a low-input low-output crop. Average yields range from 1.5 to 2.0 t/ha, much lower than for many other countries.

The production of maize could be considerably increased through increased use of improved varieties such as *Sele* or *Noi Mutin*. The use of improved varieties along with other inputs and practices such as fertilizers, herbicides, and conservation agriculture could double or triple yields.

Small amounts of maize seed and grain are imported to Timor-Leste, mainly for production of the food supplement Timor Vita by Timor Global.

3.3.2. Current production system

Maize is normally grown once or twice a year depending on rainfall and environmental conditions. In most municipalities, it could be cultivated as a monocrop but is most often intercropped with sweet potato, cassava, taro, peanut, beans pumpkins, yams etc. Where intercropped, the other crops are usually planted either at the same time, or one or two weeks after the maize crop has been planted.

For land preparation, farmers in upland areas mostly practice slash and burn techniques. In lowland areas both slash and burn and mechanised cultivation practices are employed.

Planting is usually carried out using dibble sticks. Average plant density is approximately four plants/m^2. Planting distance is not fixed, ranging from 80cm by 50cm to 70cm by 30cm. Planting maize in lines tends to be practiced by farmers on flat land only. Two to three seeds are planted per hole. The crop is two to three times, depending on the weed burden.

The crop is harvested by hand when the grain is mature, at about 30% moisture. Cobs are left intact and dried on drying racks, before being stored as intact cobs.

All maize varieties, especially modern varieties, are prone to post-harvest damage by weevils (*Sitophilus zeamais*), therefore improved storage practices are essential. According to a study by the Universidade Nacional Timor Lorosa'e (UNTL) Faculty of Agriculture (commissions by IFAD, 2014), maize losses due to traditional methods of storage are estimated to be around 30%, with 3% of the stored grain destroyed by weevils every month. For this reason, the International Fund for Agricultural Development and others have assisted farmers to develop improved storage capacity.

Maize farmers often conduct cultural ceremonies around maize production. One of the most common ceremonies is *Sau Batar*. This ceremony marks the start of maize harvest in many parts of the country, and requires the sacrifice of animals, hence adding more cost for maize production.

3.3.3. Cropping seasons

Maize is planted in the early wet season after two to three days of rainfall, once the soil is sufficiently wet. It is sown earlier in elevated areas compared to low altitude areas, due to earlier rainfall.

In high altitude areas maize is planted from October until the middle of November and it is harvested from March to April for the first growing season. If a second season is possible, planting takes place in May or early June with harvest taking place from late August to September.

In coastal areas, the first cropping season is from November/December (planting) to March/April (harvest). The sowing time for the second season for plain areas is April/May, with harvest in July/August. Table 18 summarises growing seasons for selected municipalities.

Table 18. Growing seasons for the maize crop in selected locations across Timor-Leste

Municipality	Ad'trative Post	Village	First Season		Second Season	
			Plant	Harvest	Plant	Harvest
Baucau	Baucau vila	Buruma, Gariuai[1]	Nov	Mar-Apr	-	-
		Gareuai/ Wailili[1]	Nov-Dec	Mar-Apr	-	-
	Vemase	Ostico[2]	Nov	Mar-Apr	-	-
	Venilale	Badu-Ho'o[1]	Nov	Mar-Apr	July	Oct-Nov
		Watu-Haku[1]	Nov	March	May-Jun	Aug-Sep
	Vemasi	Loi-Lubo[1]	Nov	Mar-Apr	July	Nov
Bobonaro	Bobonaro		Nov	Mar-Apr		
	Maliana	Ritabou[2]	Nov-Dec	Mar	Mar/Apr	Jun/Jul
		Saburai, Memo[1]	Oct-Nov	Mar	-	-
	Cailaco	Atudara[1]	Nov	Mar	-	-
Viqueque	Ossu	Ossu de Cima,	Oct-Nov	Mar	-	-

		Loi-Hunu[1]				
	Lacluta	Dilor[2]	Nov-Dec	Mar-Ar	-	-
	Uatulari	Matahoi, Waitame[1]	Nov-Dec	Mar	-	-

Source; [1]MAF/SoL Agriculture Calendar, [2]community reports.

Maize varieties can be divided into short and long season varieties. Short season maize is known as *Batar Lais* meaning quick maize. Short maize can be harvested in ± 90 days. Normally the cultivated area for short maize is smaller than for long season maize. Iis used primarily as a quick source of food during the wet season while waiting for the long season crop to mature. Short season maize is often very hard, suitable for popcorn.

3.3.4. Use of inputs

Maize is mostly grown as a low input crop. The main inputs employed are seed, land and significant amounts of labour. Fertiliser and manure is rarely used even though on-farm trials have shown small amounts of phosphorus (P) and nitrogen (N) can increase yields by up to 30%.

In some places, farmers do not want to apply chemical fertilisers as they believe it will lead to dependency and cause the productivity of their land to decline. Timorese farmers are more willing to use organic fertilisers; however the logistics of sourcing and transporting sufficient raw material (minimum five Mt/ha of compost or manure) to small, scattered farms means that this option is available for very few farmers.

Insecticides and herbicides are also seldom used, especially in upland areas.

Farmers commonly retain their own seed for replanting the following year. By doing this, farmers have been able to select for tolerance to weevils. As a result, most local varieties have short cobs, with a long sheath protecting the cob. The grain is also very hard, similar to popcorn varieties.

About 20% farmers buy seeds every growing season. In general the price of seed ranges from $0.50/kg for community seed produced with minimum quality control to $1.50/kg for commercial seed of guaranteed quality.

According to MAF/ SoL3 End-of-Program Survey (2016), around 30% of rural farming families are growing improved maize varieties. There is considerable scope to improve average yields by increasing the adoption of high yielding varieties.

3.3.5. Labour requirements

Total labour requirement is around 80-90 days per ha for a typical low input crop. Of this, around 30 days is required for weeding, and another 30 days for harvest and post-harvest operations. Use of herbicides and mechanised shellers can considerably reduce labour inputs.

Farmers growing maize on larger farms usually hire labour (current rate of US$5/day plus meals). Smaller farms usually use unpaid family labour only, supplemented with mutual exchange labour (*Servisu Hamutuk*). *Servisu Hamutuk* involves a group of HHs pooling their labour resources to undertake particular activities such as land clearing or weeding. The activity is carried out for each HH in the group, in succession. Labour is unpaid, but the farm owner who hosts the activity on a particular day is required to feed all workers. This system of sharing labour is less common now compared to five years ago.

Traditionally, in almost all municipalities, men and women work together in maize cultivation. It is commonly accepted that men are responsible for clearing the land and doing the heavy work such as transporting farm inputs or outputs, whereas women are responsible for activities associated with reproduction, such as seed selection, sowing/planting, harvesting, as well as meal preparation whenever group activities are involved.

3.3.6. Yield and area harvested

The average yield recorded for maize in Timor-Leste over the last 15 years is 1.7 Mt/ha, with a range of 0.80 to 2.96 Mt/ha (Table 19). The sharp reduction in area in 2011 (21,700 ha) was due to the La Niña weather pattern that produced rain throughout the dry season of 2010. Then, in 2014, an El Niño event reduced the planted area due to late rains.

From 2011, the area planted to maize has remained below 39,000 ha, much lower than the 55-70,000 ha planted prior to 2011. This significant reduction in area has not been fully explained, but anecdotal evidence suggests that social welfare payments (old age and veteran payments) have reduced the incentive for many people to grow subsistence crops.

Table 19. Estimated planted area, yield and total production of maize in 2000 to 2015

Year	Area harvested (ha)	Yield (Mt/ha)	Total Production (Mt)
2000	55,000	1.61	88,449
2001	56,764	1.22	69,000
2002	53,396	1.76	93,714
2003	50,400	1.39	70,175
2004	52,000	1.58	82,209
2005	58,000	1.59	92,219
2006	71,000	1.68	118,984
2007	71,221	1.38	95,433
2008	72,483	0.80	71,526
2009	71,340	1.88	134,715
2010	70,255	2.12	148,891
2011	21,700	1.41	30,666
2012	35,304	1.78	62,839
2013	38,905	2.43	94,602
2014	10,950	2.96	32,420
2015	30,136	2.08	63,739
Average	**52,581**	**1.70**	**85,723**

Source: FAOSTAT, 2015 & MAF Timor-Leste crop data report, 2015.

Yields are generally higher in flat coastal areas (e.g. Covalima, Manufahi) compared to upland areas (e.g. Aileu and Emera) (Table 20). Yields could be significantly improved through adoption of improved practices. For example, applying small amounts of urea and triple superphosphate (TSP) (1 bag/ha each) could increase yields by 30-40%.

Table 20. Estimated planted area, yield and total production of maize in 2015, by municipality

Municipality	Estimated area (ha)	Estimated Yield (Mt/ha)	Production (Mt)
Aileu	1,617	1.55	2,502
Ainaro	331	1.57	519
Baucau	7,997	1.42	11,372
Bobonaro	2,488	2.26	5,624
Covalima	6,138	2.73	16,705
Dili	215	2.11	453
Ermera	1,895	1.68	3,180
Lautem	4,238	2.6	11,129
Liquiça	1,984	3.54	7,033
Manatuto	1,020	1.92	1,956
Manufahi	1,098	2.35	2,582
Oecussi			
Viqueque	1,093	1.55	1,690

Source: National directorate agriculture and horticulture September 2015

3.3.7. Crop utilisation

It is estimated that around 50% of production is used for family consumption (including retained seed); 10% for animal feed; 10% is sold; with storage losses (mainly due to weevils) accounting for the remaining 30%. Crop residues are only occasionally utilised. Green leaves of the harvested maize plants are sometimes used for livestock fodder.

Timor Global has recently started production of a nutritionally fortified product (known as Timor Vita), designed to help nourish young children and pregnant and lactating women. The basic ingredients are maize (65%), soybean (25 %) and oil (10%). More than 5,000 Mt/yr of maize grain is required for manufacturing the product. Currently, most of this is being imported due to problems of aggregating sufficient local product, combined with quality issues concerning aflatoxin. At a current farm-gate price for maize of $0.45/kg, small farming families in Timor-Leste are missing out on the opportunity to earn $ 2.3 million/year, or even more if the market can be expanded. In the last few months Timor Global has started using an ‘Aflatoxin quick test’ to identify maize with high levels of aflatoxin, potentially opening the door for local supplies of maize to be used.

3.3.8. Contribution to household income

While maize is a major crop in Timor-Leste, it is not considered as important in terms of household income[11]. It is currently grown mainly for family consumption and not for sale, except for those who have a contract with the Government to produce seed. Indirectly, maize contributes small amounts of income to HHs that use it for raising chickens or pigs, however as noted earlier this is usually through very low input/ outputs production systems.

3.3.9. Major production constraints

There are a number of important constraints affecting maize production. These include use of low yielding varieties, infertile soils combined with limited use of fertiliser, climate risk, insect pests and diseases, post-harvest losses, and limited use of labour-saving devices.

The perceived low price of grain and low return to labour provide little incentive for farmers to grow maize on a commercial basis. This is especially true for younger farmers.

The majority of farmers in Timor-Leste are small landholders with limited formal education and limited capital. These circumstances reduce their willingness and ability to use purchased inputs such as seed, fertilisers, chemicals and mechanised farming practices.

More recently, the identification of aflatoxins in a small number of maize samples has reduced the ability of farmers to sell maize to food processers.

3.3.10. Key opportunities for improvement

There are several options for improving maize production for smallholder farmers in Timor-Leste. Table 21 summarises these options.

[11] Of those farmers who were interviewed, most stated that the quickest way to make money is by selling vegetables or animals.

Table 21. Innovations investigated for growing maize in lowland areas

Innovation	Utilisation	Expenditure	Gross income	Labour
Plough with tractor		Tractor costs		Less clearing and wider cultivation area
New variety			Increase yield by 40%	Increase harvest and drying
Apply fertiliser		Fertiliser costs	Increase yield by 40%	Increase harvest and application costs.
Herbicides		Herbicide costs		Less weeding days
Conservation Agriculture		Reduced weeding time, fencing required	Increase yield by 90%	Increase harvest
Shelling use thresher		Thresher costs		Less shelling days
Drum/airtight container for storing corn	Reduce losses		Increase Income by 58%	

Due to the poor fertility of most cropping soils in Timor-Leste, small rates of fertiliser (15Kg N and 15 Kg P/ha) could increase maize yields by 40%.

Herbicides (such as glyphosate) are starting to be used by more progressive farmers in Maliana to reduce the cost of weeding.

Adoption of slash and mulch systems also known as conservation agriculture (CA) can lower labour inputs and improve yields. Under this system legumes are grown amongst the corn, and are then mulched on the surface for the following crop. The benefit is improved organic matter retention and soil structure, better soil water holding capacity, improved plant nutrition, less weeding and higher yields. Extra fencing to protect the out-of-season growth of the legume cover crop is required.

Hand powered shellers and drums for air-tight storage are excellent ways to reduce labour requirements and post-harvest losses.

3.3.11. Gross margin analysis

Gross margin analysis has been conducted to investigate the impact of new technology and improved agronomic practices on maize production including; (i) using improved varieties (e.g. *Sele*); (ii) using fertiliser; (iii) using herbicide; (iv) improved storage; and (v) use of tractors for cultivation and mechanised shellers (Table 22).

Total production, after losses, is valued at the current market price, whether consumed, given away, or sold.

Growing an unimproved variety with traditional production practices produces an estimated gross margin of $420/ha, for a return on labour of $4.20/day.

In comparison, if an improved variety such as *Sele* is used in combination with conservation agriculture, hand tools for threshing, and storage in a drum /airtight container to reduce losses, the gross margin increases to an estimated $1,277/ha, for a return on labour of $12.40/day.

Table 22. Gross margin analysis for maize production based different scenarios

Cropping system	Yield (kg/ha)	Gross Income ($/ha)	Expenditure ($/ha)	Labour/ day ($)	Gross margin /ha ($)
L. variety with tractor	1,500	480	140	4.22	340
L. variety hillside no tractor	1,200	384	24	4.35	360
Sele with tractor	2,100	672	134	5.85	538
Sele no tractor	1,680	538	24	5.59	513
L. variety with tractor & fertiliser	2,100	672	234	4.71	438
L. variety with fertiliser in hillside no tractor	1,680	538	124	4.45	413
Sele with tractor & fertiliser	2,940	941	234	6.49	706
Sele with fertiliser no tractor	2,352	753	124	5.95	628
Sele with CA no tractor	3,192	1021	24	9.01	997
Sele with CA, drum & thresher	3192	1277	41	12.36	1,235.
Sele with drum	1680	672	36	6.92	636
Sele with thresher	1680	538	29	5.89	508
Sele with herbicide	1680	538	74	7.37	463
Sele with drum & thresher	1680	672	41	7.31	631

Source: Mission estimates
L; Local, CA; Conservation Agriculture, Sele; improved variety
Details of gross margin calculation are shown for some options in Annex 1. A complete set of gross margin calculations for all cropping systems is in the excel spreadsheet GM_Maize_Nov2016.

3.3.12. Recommendation

Maize is one of the most commonly grown crops in Timor-Leste. At present, it is used overwhelmingly to meet HH subsistence needs – some estimates suggest as little as 7% is traded. In the absence of established markets of any size, infrastructure and services for aggregating, storing and quality assuring the product are poorly developed. Maize yields and productivity can be significantly improved through the introduction of a range of well-proven technologies and improved management practices. Increased production could provide the basis for a range of commercial value-added activities, such as using maize for manufacture of human food products (e.g. Timor Vita), or livestock feeds.

TOMAK's initial work with maize is likely to be under the food security and nutrition component the Program, focused on improving productivity and reducing storage losses. Once marketable surpluses have increased there is scope for extending this into a range of value chain development activities.

3.4. Peanut

3.4.1. Introduction

Peanuts are grown by smallholder farmers under rainfed conditions, with few inputs. They are often grown for sale, providing a source of cash income for rural households. They also are grown in small quantities in food gardens. Production is concentrated in Baucau, Bobonaro, Manufahi and Covalima plus some other municipalities.

3.4.2. Current production system

Peanuts are often planted as a wet season crop following two to three years of fallow to prevent soil-borne fungal disease build up, and to restore some soil fertility. The field is prepared by burning the grass and plant material before the opening rains, and if tractors are available, the land is ploughed.

Quality seed is important for good production and this can be obtained through a good seed selection process. Seed is generally selected for planting from the previous year's harvest. In most places, peanuts are planted directly into the soil without soaking, however in some places they are soaked in water overnight and then planted out.

Farmers weed peanuts between one and three times during the growing season. The first weeding requires more labour compared to the second and third weeding. Farmers prefer to harvest peanuts over several weeks therefore select different varieties with different maturities for planting.

Farmer's variety preferences are based on several characteristics. The most frequently mentioned by farmers include: saleability, yield, sweetness, early harvesting, snack food qualities, large-sized nut, and medicinal properties for skin problems associated with measles.

3.4.3. Cropping season

Peanuts are mainly grown as a monocrop. They are planted one to two weeks after maize, several weeks after the start of the wet season. By this time rain has saturated the soil. Farmers have their own signs for planting. For example in Viqueque (suku Matahoi) farmers report that the sign for planting peanuts is after rain has fallen and maize has been completely planted. In Bobonaro (suku Saburai) farmers plant after rain has fallen and maize is already tall while in Baucau (suku Vemasse tasi), farmers plant after heavy rain has saturated the soil. Table 23 summarises planting time for the three different municipalities.

Table 23. Planting time for peanuts in various locations

Municipality	Administrative Post	Suku/site	Season	
			Plant	Harvest
Baucau	Baucau villa,	Gariwai	Nov-Dec	May-June
	Venilale	Watuhaku	Nov-Dec	Mar-Apr
	Vemasse	Loi-Lubo	Nov-Dec	Mar-Apr
		Vemasse Tasi	Nov	April
Bobonaro	Cailaco	Atudara	Nov-Dec	Mar-Apr
	Maliana	Saburai	Dec	Mar
Viqueque	Ossu	Loihuno	Nov-Dec	Mar-April
		Ossu de Cima	Nov-Dec	Mar-April
	Uatulari	Matahoi	Dec	Mar
		Waitame	Dec	Mar

Source: MAF/SOL Agriculture Calendar

3.4.4. Use of inputs

The main inputs employed for peanut production are land, seed and labour. In some places the land is ploughed by tractor, otherwise it is prepared by slash and burn. There is almost no use of fertiliser, pesticides etc.

3.4.5. Labour requirement

Peanuts are a labour intensive crop, requiring 130-140 days per ha. Of this, around 30 days are required for weeding, and 35-40 for harvesting, and the same again for stripping, shelling and grading.

3.4.6. Current average yield

Yields in Timor-Leste are generally low due to poor soils and poor access to good quality seed. Table 24 presents information from SoL commercial seed production groups producing the *Utamua* variety in 2015. Average pod yield for these growers was 1.2 t/ha, with a range of 0 to 2.5 t/ha. This is almost certainly higher than average yields being achieved by farmers growing unimproved varieties.

Table 24. *Utamua* production by commercial seed producers in 2015

No	Name commercial seed producer	Municipal	Suku	Area grown (ha)	Total yield (Mt)	Seed (Mt) (60%)	Grain (Mt) (40%)	Yield Mt/ha
1	Faularan Furak	Liquiça	Leotela	2.5	2.7	1.6	1.1	1.1
2	Buras Hamutuk	Lautem	Fuiloro	1	0.3	0.2	0.1	0.3
3	Haburas	Dili	Beloi	1	2.5	1.5	1.0	2.5
4	Hadia Moris	Aileu	Bandudato	3	1.7	1.0	0.7	0.6
5	Ilimano Anan	Manatuto	Uma Kaduak	1.5	0.9	0.5	0.4	0.6
6	Matabean	Baucau	Uaitame	2	2.5	1.5	1.0	1.3
7	Meco Sicaloti	Oecussi	Nailueco	2	2.8	1.7	1.1	1.4
8	Mona Bulat	Baucau	Fatulia	2	2.5	1.5	1.0	1.3
9	Moris Foun	Baucau	Gariuai	2	5.0	3.0	2.0	2.5
10	Naroman	Liquiça	Fahilebo	1	0.8	0.5	0.3	0.8
11	Rai mean	Baucau	Gariuai	2	3.3	2.0	1.3	1.7
12	Remisto	Baucau	Gariuai	1	2.5	1.5	1.0	2.5
13	Unidade Samaklot	Bobonaro	Ritabou	2	1.7	1.0	0.7	0.8
14	Loliman	Bobonaro	Leolima	1.5	1.7	1.0	0.7	1.1
15	Weda	Manufahi	Mahaquidan	0.5	0.0	0.0	0.0	0.0
	Average							**1.2**

Source: SoL Annual Report (2015)

3.4.7. Contribution to household income

Peanuts are usually grown as a cash crop. An economic impact study carried out by SoL in 2009 indicated that the new variety *Utamua* was making a significant contribution to household incomes. Peanuts are generally sold by farmers in order to pay for other household needs (Table 25). Narrative stories of two farmers selling peanuts were recorded[12]:

> "*Domingos used the proceeds of this sale to send his children to Indonesia to study, while Jorge Concecao used his income to purchase a bicycle, and pants for his children. Both farmers like the variety [Utamua] for its large seed, soft texture of the nut, which possesses an oily fragrant smell, and the fact that they considered it produced a higher yield than their local variety. Neither farmer transferred significant amounts of seed to their family or neighbours* (SoL 2009).

[12] Sr. Domingos Sequire from Baucau and Sr. Jorge from Same.

Table 25. Peanut sales and selling method

Name	Municipality	Village	Peanuts Sold (kg)	Selling methods	Price(US$)	Income (US$)
Domingos Sequera	Baucau	Gariwai	650	$/sack[13]	12.00	600
Jorge Conceicao	Manufahi	Dotik	200	$/sack[14]	10.00	80

Source: SoL field interviews (2009)

3.4.8. Major production constraints

Common constraints affecting peanut production include: (i) seed quality; (ii) declining soil fertility; (iii) weeds; (iv) rats; (v) leaf disease; and (vi) labour constraints.

Low levels of soil P significantly reduce growth and yield. On the Baucau plateau, many farmers prefer to have two to three years of the weed *Chromolaena* grow before planting peanuts, as it is able to mobilise soil P and is therefore good for the following crop.

Labour availability, especially for weeding, harvest and post-harvest processing, limits the area that a household is able to plant. Mechanisation of weeding (or use of herbicide) and post-harvest processes could help alleviate this constraint.

Production is susceptible to a number of plant diseases. The diseases causing most economic impact are early leaf blight and late leaf blight. These diseases cause black spots on the leaf, and early death of the leaves. In an infected crop, the leaves die and drop to the ground before the pods mature. This reduces yield significantly. There is no experience in Timor-Leste of using fungicides as a control measure.

3.4.9. Key opportunities for improvement

High yielding varieties. Good quality seed is the foundation of productivity improvement. In 2007, MAF released the variety *Utamua* which produces up to 47% greater yield than local peanuts, with no extra inputs.

Fertiliser. Production in Timor-Leste tends to be constrained by low soil fertility, especially P. Fertilisers are commonly used for vegetable production, but very rarely used for peanuts. Very few agricultural input shops sell fertiliser, and even then only in small quantities. Availability and accessibility of fertiliser is a key limiting factor.

Labour saving devices. Peanuts require considerable processing post-harvest, especially for stripping, shelling and grading. Manual shelling of peanuts without tools is tedious and time consuming. Labour can be dramatically reduced with the use small hand-powered peanut shellers. Shellers can be manufactured locally for less than $200, and could be made available to grower groups by businesses that purchase shelled peanuts.

3.4.10. Gross margin analysis

Gross margin analysis has been conducted to investigate the impact of new technology and improved management practices on peanut production including; (i) using new high-yielding varieties; (ii) applying small rates of TSP as needed; and (iii) using threshers. Yields will likely increase by 47% with the use of new varieties; and applying fertiliser increases yields by 30%. The use of threshers significantly reduces labour costs.

[13] The size of the sack is 25 kg rice sack. One rice sack equivalent to 13 kg of peanuts (Sr. Domingos sold 50 sacks of peanuts)
[14] The size of the sack is 50 kg rice sack. One rice sack equivalent to 25 kg of peanuts (Sr. Jorge sold 8 sacks of peanuts)

Table 26. Innovations investigated for growing peanuts in the inland irrigated zone

Innovation	Utilisation	Expenditure	Gross income	Labour
New variety	-	-	Increase yield by 47%	-
Fertiliser	-	Added fertiliser cost	Increase yield (30%)	-
Thresher	-	Added thresher costs	-	Reduced labour costs

The gross margin per hectare increases from an estimated $790/ha ($5.8/day) to $1,263/ha ($6.50/day) by using a higher-yielding variety such as *Utamua*. With application of fertiliser this increases further to an estimated $1,660/ha ($7.30/day). The use of an improved variety, fertiliser and a mechanical thresher produces a gross margin of an estimated $1,645/ha, and $9.80/day (Table 27).

Table 27. Comparing gross margin from different scenarios of peanut production

Variety	Fertiliser	Machine	Yield (kg/ha)	Gross margin/ha/day ($)	Gross Income ($)	Expenditure ($)	Labour /day ($)	Gross margin/ ha ($)
Local	No	Nil	1,500	5.8	1,013	223	5.8	790
Improved	No	Nil	2,200	6.5	1,485	223	6.5	1,263
Improved	Yes	Nil	2,860	7.3	1,931	271	7.3	1,660
Improved	Yes	Yes	2,860	9.7	1,931	10	11.4	1,645

Source: Mission estimates

Details of gross margin calculation are shown for some options in Annex 1. A complete set of gross margin calculations for all cropping systems is in the excel spreadsheet GM_Peanut_Nov2016.

3.4.11. Recommendation

Peanut production and productivity could be considerably improved through the adoption of improved varieties, use of small quantities of fertiliser, and use of labour-saving devices for post-harvest operations. Given that peanuts are grown primarily as a cash crop, there is good potential for further developing the peanut VC under TOMAK, subject to available markets.

3.5. Black/red rice

Upland rice (generally black and red) was first introduced to Timor by Austronesians when they migrated to Timor about 3,500 years ago. White rice varieties (which are actually brown before the hulls are removed) have a much shorter history in Timor.

Even though white rice dominates rice production in Timor-Leste, there is some production of black and red rice both for consumption and for use in ceremonies. Locally-produced red rice is being produced under contract for ACELDA, for sale through Dili supermarkets. There is also imported red rice being sold in small consumer packs in Dili. Red rice is often required for cultural ceremonies that require a red rooster, red rice and the spilling of blood.

Black rice is generally grown as a rainfed upland crop. Red rice is grown both as an upland crop, and also as paddy rice in some areas.

3.5.1. Current production practices

The total area of black and red rice grown in Timor-Leste is not known, but is small. Upland black and red rice are commonly grown on the Baucau plateau during the main wet season. The varieties are quite old, tall and do not respond to higher levels of inputs. On the south coast, especially Viqueque, upland rice is grown during the second wet season, following a maize crop in the main wet season. Upland rice is grown in the same manner as maize. The fields are cleared, and the seeds are planted directly into the soil. Upland rice seedlings grow more slowly than maize seedlings, and require additional and careful weeding.

Red rice grown as paddy is produced in the same manner as white rice. There are no differences in production systems between normal irrigated white rice and red rice when grown as paddy.

3.5.2. Cropping seasons

Upland rice is grown during the main wet season on the north side of Timor-Leste, and during the second wet season on the south coast.

3.5.3. Use of inputs

The main inputs for growing upland rice are land, seed and labour. With the more recent availability of tractors, upland rice areas are often ploughed before planting. Production of upland rice is generally a low input system, with low yields.

Irrigated rice has much higher inputs, and often has higher outputs. Irrigated rice is grown in rice bays, which are generally flooded from transplanting to maturity. Farmers generally use traditional tall red rice varieties, although there are some short (higher yielding) red rice varieties becoming available. Occasionally rice crops are fertilised, and they are often sprayed with insecticide to control swarms of rice bugs at flowering time.

3.5.4. Labour requirements

Rice is a labour intensive crop, requiring 120-130 days per ha for both upland and paddy production systems.

3.5.5. Current average production

It is estimated average yield for upland black/red rice is 1.2 t/ha, and the irrigated red rice yield is 1.75 t/ha.

3.5.6. Contribution to household income

Current production of black and red rice is very low and it makes a very small contribution to household incomes. Most of what is produced is used for home consumption. With the exception of a few farmers supplying ACELDA, there are very few specialised producers.

3.5.7. Major production constraints

Production of upland and irrigated rice has many constraints. These include low yielding varieties, poor soils, insect pests (such as stem borer and rice bug), and losses to small birds (such as finches) at harvest. Although stem borer is a minor problem in irrigated rice, it can be a major problem in upland rice production.

3.5.8. Key opportunities for improvement

There are a number of opportunities for increasing farmer's income from growing red rice, as an irrigated crop. There are no known opportunities for increasing income from upland black/red rice. The opportunities for irrigated red rice production include: (i) use of improved varieties; (ii) application of fertiliser; and (iii) use of herbicides to reduce manual weeding requirements.

3.5.9. Gross margin analysis

The gross margin analysis is based on a 100% price premium for red rice over white i.e. 70c/kg vs. 35c/kg.

It is assumed that the local variety of irrigated red rice produces a yield that is 70% of the local white variety, and the improved variety of red rice is able to produce a yield that is 80% of the improved white variety *Nakroma*. It is also assumed that small amounts of fertiliser can increase yields by 30%.

The gross margin available from growing red rice as an irrigated crop using an improved variety, fertiliser and herbicide is estimated at $1,529/ha ($9.10/day). This compares with growing white rice under conventional practices (using a local variety), which demonstrates a return of $613/ha ($3.20/day), or $735/ha ($4.00/day) if an improved variety is grown (Table 28).

Table 28. Gross margin analysis for black and red rice production

Variety	Fertiliser	Herbicide	Yield (Mt/ha)	Dollars return per day ($)	Input costs ($/ha)	Income ($/ha)	Gross margin ($/ha)	Days of labour
Upland Black/red	No	No	1.2	4.4	30	588	558	126
Paddy Local variety	No	No	2.5	3.2	190	613	423	131
Paddy Nakroma	No	No	3.0	4.0	190	735	545	138
Paddy Local Red rice	No	No	1.8	5.5	190	858	668	121
Paddy Improved red rice	No	No	2.4	7.6	190	1176	986	130
Paddy Improved red rice	Yes	No	3.1	8.7	310	1529	1219	139
Paddy Improved red rice	Yes	Yes	3.1	9.1	390	1529	1139	124

Source: Mission estimates

Details of gross margin calculation are shown for some options in Annex 1. A complete set of gross margin calculations for all cropping systems is in the excel spreadsheet GM_Rice_Nov2016.

3.5.10. Recommendation

Production of red rice as an irrigated crop in paddy areas is financially viable for producers, particularly with the use of fertiliser and use of herbicides to minimise labour required for weeding. Subject to available markets, there is reasonable potential for developing the red rice VC under TOMAK as a substitute for white rice production, which is uneconomic. However, this is likely to remain a niche product.

Black rice can only be grown under rain-fed upland conditions. There are no known innovations that could increase farm level profitability. This option does not warrant further consideration.

3.6. Mung bean

Mung bean (*Vigna radiata)* is used for both human consumption and animal feed. It is high in protein, easy to digest, and particularly nutritious when combined with cereals. This is due to the ability of cereals to compensate for mung bean’s low levels of sulphur amino acid, while mung bean is able to compensate for a shortage of lysine in cereals. Worldwide annual production of mung beans is about 2.5 million Mt, concentrated in India and Pakistan. It is a popular food crop all over Asia. Mung bean contains 7% protein, and provide 440 KJ of energy per 100 grams. The relatively high level of protein and other nutrients makes it a highly nutritious food.

Mung bean can be grown with a low level of inputs and, because it is a legume, is able to produce its own N. It is a short growing-season crop that can be integrated into cereal-based crop rotations such as maize and rice.

Mung bean was mentioned in the Timor-Leste Strategic Development Plan 2011-2013. The plan notes that mung bean production is well below 1997 levels and that ‘much could be done to increase yields and area planted, if market access is provided’. The plan suggests that mung bean could be a potential export product. However, it remains a minor crop with a total area of just under 1,300 ha, concentrated in Covalima, on the south coast in Manatuto, and in Bobonaro (Table 29).

Table 29. Production of mung bean in Timor-Leste by municipality in 2006

Municipality	Area (ha)	Yield (Mt/ha)	Production (Mt)
Covalima	495	1.5	742
Manatuto	200	0.7	140
Bobonaro	170	0.7	119
Viqueque	97	0.8	78
Manufahi	85	0.8	68
Lautem	50	1	50
Oecussi	40	1.1	44
Baucau	22.5	1	23
Dili	16	0.9	14
Ermera	10	0.6	6
Ainaro	8	0.4	3.2
Aileu	7	0.9	6.3
Liquiça	4.5	0.3	1.5
Total	1205		1295

Source: MAF National Directorate of Agriculture, Horticulture and Extension

3.6.1. Current production practices

There are two main production systems for mung bean in Timor-Leste: (i) lowland (as a monocrop on cultivated level areas); and (ii) upland (planted among standing maize crops).

Lowland crops are generally planted as a monoculture second crop during May / June along the south coast, following a main season crop of rice (irrigated or rainfed) or maize. These second season crops are harvested from August to October (Viqueque and Covalima). Later crops can be grown in areas where there is irrigation and good fencing to control animals. In these more favourable locations (including parts of the Bobonaro plain) mung bean can be planted through to September. However, this currently occurs only in isolated situations.

In upland mixed farming areas, mung bean is usually planted into maize as an intercrop, just after the maize has flowered. Planting occurs in January–February in the upland area of Balibo, but is later (February) in upland areas of Covalima. Different planting dates in the northern and southern areas allow the pods to mature in a dry environment. Rain on a mature mung bean crop causes the seeds to sprout, reducing the marketable yield.

3.6.2. Seed supply

Farmers generally use seed saved from the previous harvest, or purchase seed. The lack of early and uniformly maturing, high yielding, disease resistant varieties has been a factor limiting production in Timor-Leste. Because of the difficulty of maintaining seed quality and viability from harvest through to planting season, many farmers buy seed each year from traders who store seed in air-tight drums.

Seeding rate should aim to establish 20-30 plants per m^2. There are many options for obtaining the required plant density, for example rows 40cm apart, and plants established every 10cm will give a plant stand of 25 plants/m^2. Narrow spacing between rows may increase yields. Sowing rates of 20-25 kg/ha would be adequate, given a seed size of 6g/100 seeds.

3.6.3. Labour requirements

The total labour requirement is around 76 days per ha, with 30 of these being required for weeding and 26 for harvest and post-harvest operations. Current local varieties are progressively harvested three times, which adds significantly to amount of labour required for harvesting. Recently released mung bean varieties have far more even maturity, and are only harvested once. However, these are not yet commonly available.

3.6.4. Use of inputs

Labour, land and seed are the main inputs currently used for mung bean production. There is virtually no use of chemical inputs (including fertiliser), and no use of irrigation.

3.6.5. Disposal of harvest

Mung bean is particularly prone to pest damage post-harvest. Bruchids (bean weevils) attack the grain once it is threshed. Just two bruchids per Mt can destroy stored grain within four to six months. Farmers often try and sell the crop soon after harvest so as minimise the risk of losses. Prices also reflect the seasonality of production and the storage risk, with low prices at harvest time, and high prices just prior to planting.

3.6.6. Contribution to household income

For those HHs growing mung bean, it can provide a substantial contribution to household income. There is significant opportunity for the area planted following maincrop rice to be significantly increased, provided animals can be controlled.

3.6.7. Major production constraints

Varieties. Most mung bean varieties grown by Timorese farmers are old varieties of unknown source. Chinese traders introduced mung bean to Timor, perhaps as early as 1255 AD. It is likely that only a small number of varieties/accessions were introduced, and there is probably relatively limited genetic variation among the mung bean population currently available to Timorese farmers.

Animals control. Mung bean is grown during the dry season. This means that in areas where animals are free range, it is vulnerable to damage from foraging animals. To enable extensive areas of mung bean to be grown, there must some community agreement to control animals while the crop is being grown, or alternatively crops will need to be fenced to keep animals out.

Wet harvest. Mung bean is very prone to large losses when rain falls on mature grain. Inappropriate time of planting and unseasonal rainfall will destroy the pods and grain inside.

Storage. Mung bean is also very prone to bruchid damage postharvest. With no treatment, mung bean stored in sacks will suffer 30% damage over the first two months, rapidly increasing to more than 80% damage over three months.

Low soil fertility. As a legume, mung bean requires good levels of soil P for good production. The vast majority of soils in Timor-Leste are low to very low in P. Small additions of P fertiliser can increase yields significantly.

3.6.8. Key opportunities for improvement

There are a number of technologies that can improve mung bean productivity. These include: (i) new varieties; (ii) direct sowing into rice stubble; (iii) good storage; (iv) use of small amounts of P fertiliser (Table 30).

Table 30. Innovations investigated for growing mung bean in the inland irrigated zone

Innovation	Utilisation	Expenditure	Gross income	Labour
New variety			Increase yield by 40%	Reduce harvest costs by 50%, Increase shelling/cleaning costs
Direct sown after rice		Less tractor cost, requires fencing		Reduced clearing and burning
Fertiliser		Added fertiliser cost	Increase yield (40%)	Increase harvest and shelling.
Direct sown prior to rice harvest		Less tractor costs,		Reduced clearing and burning. Reduced weeding costs
Fencing		Barbed wire		Labour
Storage	Reduce losses (from 20% to zero)	Drums	Higher price (20%),	

Varieties. In 2016 MAF released two improved mung bean varieties (*Kiukae* and *Lakateu*). These varieties have a 40% higher yield than local varieties. In addition to being higher yielding, the two new varieties are more synchronous in flowering, and mature in a shorter time. Having synchronous flowering means the new varieties need to be harvested only once. This represents a significant saving in the amount of labour that is required for harvesting.

Storage. Good storage prevents bruchid damage of mung bean and allows farmers to sell when the price is higher.

P fertiliser: TSP (triple superphosphate) is a common P-based fertiliser used in Timor-Leste. The addition of 15Kg P/ha is likely to increase yields by 40%.

3.6.9. Gross margin analysis

The gross margin available from growing mung bean using conventional practices is estimated at $301/ha ($4.0/day). With the introduction of new varieties, this increases to $480/ha ($6.4/day). If small amounts of fertiliser are applied, and if grown after paddy rice, the gross margin increases further to $825/ha ($10.7/day) (Table 31).

Table 31. Gross margin analysis of mung bean under current and improved production scenarios.

Variety	Land	Storage	Fertiliser	Yield (kg/ha)	Return on labour ($/day)	Gross Income ($/ha)	Expenditure ($/ha)	Gross margin/ha ($)	Days labour
Local	Flat land	Nil	Nil	800	4.0	448	148	301	76
New	Flat land	Nil	Nil	1,120	6.4	627	148	480	75
Local	Rice bay	Nil	Nil	800	6.5	448	88	361	56
Imp	Rice bay	Nil	Nil	1,120	9.8	627	88	540	55
Local	Sloping	Nil	Nil	600	3.9	336	38	299	76
New	Sloping	Nil	Nil	840	5.7	470	38	433	76
Local	Flat land	Yes	Nil	800	5.5	672	254	419	76
New	Flat land	Yes	Nil	1,120	9.1	941	254	687	75
New	Flat land	Nil	Yes	1,344	6.5	753	248	505	77
New	Flat land	Yes	Yes	1,344	10.7	1,129	304	825	77

Source: Mission estimates
Details of gross margin calculation are shown for some options in Annex 1. A complete set of gross margin calculations for all cropping systems is in the excel spreadsheet GM_Mung_Nov2016.

3.6.10. Recommendation

Mung bean production is financially viable for producers, with good opportunities for improving productivity and production through introduction of new varieties, use of fertiliser, and improved storage. There is also significant potential for expanding the area of mung bean by planting it as a second crop after rice, provided the crop can be protected from damage due to uncontrolled grazing. Subject to available markets, there is good potential for developing the mung bean VC under TOMAK.

3.7. Soybean

Soybean (*Glycine max)* is an important crop worldwide. It serves a variety of functions in the global food chain ranging from use as an edible oil to a source of protein for humans and livestock. Globally, soybean production is used mainly to produce soybean meal and oil for industrial products or use as animal feed. Less than 15% is used for direct human consumption. Major soybean producing countries are the USA, Brazil, Argentina, China and India (FAOSTAT 2015).

In Timor-Leste, soybean is considered an important crop. It is a versatile grain capable of fixing atmospheric nitrogen. It is an important source of protein and oils for those who eat it. Consumption of soybean products is increasingly popular in the form of tempe and tofu. There is strong domestic demand, and national production has not been able to meet this.

Soybean production has decreased substantially from 1,400 ha in 1997 to an average of around 900 ha over the last five years. Production is concentrated in Covalima, Bobonaro, Manatuto, Ainaro and Manufahi. Small areas are also grown in some others municipalities.

3.7.1. Current production practices

There are two common cropping systems for soybean. The first involves growing soybean as a rainfed crop during the wet season, at the same time as the main maize crop. Farmers grow soybean during the wet season both as a monocrop (at the same time as maize), or as an intercrop (usually with maize). The second system involves planting soybean into rice stubble as a second crop in paddy areas, after rice has been harvested.

3.7.2. Cropping season

Soybean is a hot weather crop that needs reasonable soil moisture during the first stage of life. It requires dry weather for the production of dry seed. It can withstand considerable drought, but does not tolerate waterlogged conditions.

Where soybean is grown as a rainfed monocrop during the wet season, planting commonly takes place between the end of October and early November, with harvest in January.

Where it is grown as a second crop following paddy rice, planting usually takes place in March, with harvest in May. If a second crop is possible, planting takes place in August with harvest in October. In Maliana, most soybean production follows this system i.e. it is grown as a monocrop following paddy.

3.7.3. Use of inputs

The main inputs used for soybean production are land, seed, labour and occasionally fertiliser and other agrichemicals. For seed, soybean growers need to source new seed each year (unless they grow twice a year) as soybean seed is difficult to store for more than three months. Good quality seed can be purchased for $1.50/kg. Fertiliser, herbicides, and pesticides are not widely used in upland areas, but are more commonly used in irrigated areas. The most common type of fertiliser applied by soybean growers in Maliana is TSP. Some farmers also use herbicides (e.g. Round-Up) for killing weeds prior to ploughing. Insecticides are sometimes used, particularly to control pod sucking bugs just after flowering.

For dry season production, fencing is required as most farmers in Timor-Leste free graze their animals once the main wet season crop has been harvested.

3.7.4. Labour requirements

Total labour requirement is around 120-130 days per ha. A significant portion of this is required for weeding (30 days); and for fencing to keep animals out (15 days). Weeding labour can be significantly reduced with the use of herbicides.

3.7.5. Harvesting and yields

Soybean is ready for harvest three to four months after planting, depending on the variety and location. Storage life is relatively short so pods need to be dried as much as possible in the field before harvest. Normally, pods are harvested manually, then further dried in the sun before threshing. Threshing is usually done manually by beating the pods, unless the farmer has access to a thresher. Seed is dried further if necessary, usually by spreading it out on a floor and turning it regularly. Once the seeds are dry, they are cleaned by sieving prior to being stored.

Yield and production data is summarised in Table 32. Yields have increased from around 0.7-0.8 Mt/ha to in excess of 1.5 Mt/ha over the last 10 years. Total production is currently around about 1,500 Mt from around 1000 ha.

Table 32. Harvested area, yield and total production of soybean in Timor-Leste from 2004-2014

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Area har. (ha)	879	977	882	790	892	1532	358	962	1000	1100	890
Yield (t/ha)	0.80	0.84	0.84	0.86	0.90	1.19	1.01	1.62	1.65	1.55	1.51
Prod. (Mt)	707	819	739	681	800	1,818	362	1,554	1,650	1,700	1,340

Source: FAOSTAT, 2015

3.7.6. Disposal of harvest

In Timor-Leste, soybean is mainly processed into tofu and tempe. Some HH also eat soybean boiled together with maize. Soybean, as well as waste from tofu and tempe production, is also fed to pigs and chickens. Domestic production is less than domestic demand, with the deficit being met from imports.

3.7.7. Contribution to household income

Soybean is in high demand and can serve as an important cash crop for producing HH's. However, many farmers are wary that the market is limited. This is likely to be related to difficulty in competing with cheaper imports. For example, farmers quoted instances of buyers in recent years offering farmgate prices of $0.75/kg which were subsequently decreased to $0.50/kg.

3.7.8. Major production constraints

Soybean yields in Timor-Leste are far below potential yields. The major constraints are poor seed, poor soils, water logging, and inappropriate soil and water management practice. Another significant constraint relating to production of soybean as a second crop following paddy rice is the need to fence off the cropped area to keep animals out.

3.7.9. Key opportunities for improvement

There are various technologies that could be applied to improve soybean productivity. The most important of these include: (i) adoption of improved varieties; (ii) use of fertiliser (Table 33).

Table 33. Innovations investigated for growing soybean in the inland irrigated zone.

Innovation	Utilisation	Expenditure	Gross income	Labour
Plough with tractor		Tractor costs		Less clearing
New variety			Increase yield by > 30%	Increase harvest and drying
Apply fertiliser		Fertiliser costs	Increase yield by 25%	Increase harvest and application costs.
No tractor, Plant after rice		Less cost and save time	Increase yield by	Less clearing costs

3.7.10. Gross margin analysis

The gross margin available from growing soybean using conventional practices is estimated at $400-510/ha ($3.6-4.2/day). With the introduction of new varieties and use of small amounts of fertiliser, this increases to $840/ha ($6.4-7.2/day) (Table 34).

Table 34. Gross margin analysis for soybean production based on different scenarios

Cropping system	Yield (kg)	Return on labour ($/day)	Gross Income ($)	Expen diture ($)	Gross margin/ ha ($)	Labour days
L. Variety with tractor	900	3.6	608	209	399	110
L. Variety no tractor	900	4.2	608	99	509	123
Anjasmoro with tractor	1,170	5.1	790	209	581	114
Anjasmoro no tractor	1,170	5.5	790	99	691	127
Anjasmoro with fertiliser & tractor	1,463	6.1	987	259	728	119
Anjasmoro with fertiliser no tractor	1,463	6.4	987	149	838	132
Anjasmoro with fertiliser, no tractor and after rice	1,463	7.2	987	149	838	117
Anjasmoro no fertiliser, no tractor and after rice	1,170	6.2	790	99	691	112

Source: Mission estimates
L; local and Anjesmoro; modern improved variety
Details of gross margin calculation are shown for some options in Annex 1. A complete set of gross margin calculations for all cropping systems is in the excel spreadsheet GM_Soy_Nov2016.

3.7.11. Recommendation

Soybean production is financially viable for producers, although less profitable than peanut and mung bean. There are good opportunities for improving productivity through introduction of new varieties and moderate use of fertiliser. There is also good potential for expanding the area of soybean planted as a second crop after rice. Subject to available markets, there is therefore potential for developing the soy bean VC under TOMAK. However, it is probably a higher risk crop given the difficulty of competing against cheap imports from major producers such as USA, Brazil, Argentina and China.

3.8. Cassava

Cassava is one of the most important crops for tropical regions in the world. It is grown mainly for its tubers. The biggest producers are Brazil, Thailand, Nigeria and Democratic Republic of Congo. In many of these countries it is produced as a major industrial crop.

In Timor-Leste, cassava is mainly a staple food crop that is grown in the farmer's backyard for family consumption. It is the third major crop in the country in terms of cultivated area and total production, after maize and rice. It is an important tuber crop for household food security. Aside from being used as food for human consumption, it is also widely used for animal feed. Some farmers also sell fresh cassava in local markets whenever they have excess production.

3.8.1. Current production practices

Cassava is propagated exclusively from cuttings (by planting a piece of stalk). It is either planted as a single crop (monocrop) or intercropped with other crops such as maize, pumpkins, sweet potato, legumes and other vegetables. Cassava is generally cultivated in the uplands with little or no fertiliser, and average yields are low. Cassava is always grown under rainfed conditions. The most important phase for cassava is establishment. The stakes need adequate soil moisture and freedom from insect pests such as termites during the initial three-week period in order to establish and produce good quality tubers.

3.8.2. Cropping seasons

Cassava is usually planted between the end of October and early November when the main rainfed crops (such as maize) are established. Under monocrop conditions, cassava is planted at the beginning of the rainy season. The cropping season is generally similar between regions, but changes from year to year depending on rainfall. It is normally planted at a spacing of approximately 80-100cm by 100cm, although the number of plants per hectare varies between region depending on variety and soil conditions.

3.8.3. Use of inputs

Growing cassava requires very low inputs. Being a highly extractive and deep rooted plant it grows reasonably well in poor soils and in areas with low or unpredictable rainfall. It is a popular crop for poor farmers because it requires few inputs besides land and labour to produce a reasonable yield. New higher-yielding varieties are available that have a significant (50% plus) yield advantage over traditional varieties. In terms of production and processing practices, cassava remains largely a small-scale (but common) subsistence crop for most farmers, rather than moving towards a more commercialised/ industrialised crop as has happened in many other countries.

3.8.4. Labour requirements

Total labour requirement is high at around 220 days per ha under current conditions. Harvesting and cartage of tubers from the field accounts for 118 days or over half of this, weeding for a further 40 days.

3.8.5. Harvesting and yields

Cassava is ready for harvest 9-12 months after planting depending on variety, rainfall and soils. Harvesting normally takes place August to September. Cassava tubers can be harvested over a long period of time, as they store well in the ground. On deep soils in areas with bimodal rainfall cassava can be grown throughout the year, and harvested on demand.

FAO statistics show the total area planted to cassava was 10-11,000 ha/yr between 2007-2009. This has reduced in recent years to 5-6,000 ha/yr. Total production has shown a corresponding decrease from a peak of over 41,000 Mt in 2007 to 20-25,000 Mt in recent years. On the basis of this data yields are in the range of 35-45 Mt/ha (Table 35).

Table 35. The total area harvested and production of cassava for the last 7 years in Timor-Leste

Element	2007	2008	2009	2010	2011	2012	2013	2014
Area harvested (ha)	11,200	10,006	10,757	6,120	5,784	6,000	6,500	6,620
Yield (t/ha)	36.2	36.0	34.7	45.5	38.4	41.7	40.8	39.9
Production (t)	41,212	35,533	37,302	27,857	22,197	25,000	26,500	26,370

Source: FAOSTAT 2015

The FAO estimates of average yield are high compared with data from SoL research plots and farmer demonstrations. These indicate yields of 17 Mt/ha (fresh tuber). Yields of up to 32 Mt/ha can be obtained, but require good establishment, and some fertiliser.

3.8.6. Use of cassava and contribution to household income

Cassava tubers, in either fresh or dried form, are used for both human food and for feeding animals (particularly pigs and chickens). To store cassava tubers after harvest, farmers usually peel the skin, chip the root, then sun-dry for several days. Once dried, the chips can be stored for several months providing a food reserve for both human and livestock feed. Some farmers also sell dried cassava with prices ranging from $7-10/25kg per sack ($ 0.28-0.40/kg). There are few industries available in Timor-Leste that buy dried cassava. In the past few years, CCT has been purchasing dried cassava, however the price paid ($ 0.16 c/kg at the farmgate) has not been sufficiently attractive to motivate farmers to produce for this market. Apart from the tuber, cassava leaves are also used as a vegetable in Timor-Leste. It is not known how much money cassava growers earn by selling fresh cassava leaves although it is not considered a significant source of income.

3.8.7. Major production constraints

The main production constraints include: (i) farmers are still using old/low yielding varieties); (ii) labour requirements and reliance on manual labour (ie lack of mechanisation); (iii) the need for protection from grazing animals (considering that cassava is a long duration crop); (iv) lack of inputs; and (v) low economic return.

As cassava has such a long season (approx. nine months), it needs protection from grazing animals for the full period. Fencing is therefore a major input for good cassava production.

Photo 1. Cassava growing well in fenced area with fencing (September 2016)

3.8.8. Key opportunities for improvement

There are several options that could be considered for enhancing cassava production, summarised in Table 36.

Table 36. Innovations investigated for growing cassava in the inland irrigated zone.

Innovation	Utilisation	Expenditure	Gross income	Labour
Plough with tractor		Tractor costs		Less clearing
New variety			Increase yield by 50%	Increase harvest and drying
Apply fertiliser		Fertiliser costs	Increase yield by 25%	Increase harvest and application costs.
Herbicides		Herbicide costs		Herbicide application , less weeding
Insecticide treatment of stems to control termites		Insecticide costs	Increase yield by 25%	Increase harvest and treatment costs

3.8.9. Gross margin analysis

The gross margin available from growing cassava using conventional practices is estimated at $870/ha ($4.4/day). With the introduction of various improvements, this would increase to $1,420-1,830/ha ($5.4-5.5/day) (Table 37).

The potential impact on HH incomes (if sold) or food security (if retained for consumption) is significant. For example, changing to improved varieties combined with insecticide treatment of stems to control termites would result in yields improving from 17 Mt/ha to 32 Mt/ha. HH income derived from cassava could more than double with adoption of recommended production practices, if product is sold rather than being retained for HH use.

Table 37. Gross margin analysis for cassava production based on different scenarios

Cropping system	Yield (kg)	Gross margin ($/ha/day)	Gross Income ($)	Expenditure ($)	Gross margin($/ha)	Labour days
Local variety with tractor	17,000	4.36	979	110	869	200
Ailuka 1 with tractor	25,500	5.14	1,469	110	1,359	264
Ailuka 1 no tractor	25,500	5.20	1,469	1,469	1,469	282
L.variety with tractor & fertiliser	21,250	4.33	1,224	210	1,014	234
Ailuka 1 with tractor & fertiliser	31,875	5.18	1,836	210	1,626	314
Ailuka 1 with herbicide	25,500	5.37	1,469	50	1,419	264
Ailuka 1 with Insecticide	31,875	5.50	1,836	8	1,828	332

Source: Mission estimates

Details of gross margin calculation are shown for some options in Annex 1. A complete set of gross margin calculations for all cropping systems is in the excel spreadsheet GM_Cassava_Nov2016.

The low increase in return to labour is primarily due to the high labour requirements at harvest time. As yields increase, the labour required for harvest also increases. The gross margin analysis is based on a labourer harvesting 200kg of fresh tuber per day, valued at $12.8 (c.f. daily wage rates of US$5.0+). Note that this does not include the labour required to skin, dry and chip the cassava. Due to the high harvest and post-harvest labour requirements, there is little scope for significantly increasing the return to labour by increasing yields of cassava, unless labour requirements can be reduced by mechanisation.

The harvest rate (200kg/day/person) is very low when compared to international levels, due to the heavy clay nature of Timor-Leste soils. The industrial cassava industries in Vietnam, Indonesia and other countries is based on much lighter soils that allow cassava tubers to be pulled from the soil. In most of Timor-Leste, the heavy clay soil means the plants need to dug individually.

A mechanised cassava puller was tested when harvesting a cassava crop at Betano research station in 2006. Unfortunately this failed due to the tubers breaking in the soil.

3.8.10. Recommendation

Adoption of new varieties, use of fencing for animal control, and small amounts of herbicide and fertiliser have good potential for increasing yields, food security and/or HH incomes.

However, the high labour requirements for harvesting, drying and cleaning tubers post-harvest mean that there is little scope for improving returns to labour. Given the current situation of a constrained (and possibly reducing) total rural labour supply, cassava should not be a priority VC for TOMAK, at least until such time as viable options for mechanised harvesting have been developed. This recommendation may change if TOMAK supports the development of intensive livestock production enterprises where cassava can be used as a feed resource.

3.9. Onions

3.9.1. Current production practices

Two types of onions (*Allium cepa*) are grown in Timor-Leste. The most common is the small red onion (Tetun: *Lis Mean*), and a bulb-less spring onion that is eaten for the green leaf. Red onions are grown in elevated areas (above 400m), and leafy spring onions close to the major fresh markets. Major red onion production areas are in Aileu and the Baucau/Viqueque corridor, especially in the higher altitude areas. Spring onions (or shallots) are grown in the Comoro river valley, just inland from Dili, for the Dili market.

National production of red onions in 2012 was 1,160 Mt from 356 ha, with an average yield 2.8 Mt/ha (Table 38). For onions, reproductive rates are as important as yields. Small seed bulbs are used to produce red onions, and on average a seed bulb produces 4-5 onions for sale.

Table 38. Red onion production per municipality for 2011 and 2012

Municipality	Red onion (*Lis mean*)					
	2011			2012		
	Area Cultivated (ha)	Yield (Mt/ha)	Production (Mt)	Area Cultivated (ha)	Yield (Mt/ha)	Production (Mt)
Aileu	80.5	3.53	284	82.1	3.59	295
Ainaro	75	3.40	255	75.3	3.40	256
Baucau	49.0	3.16	155	50.0	3.10	155
Bobonaro	18	3.44	62	20.9	3.00	62.7
Covalima	13.0	2.60	33.8	13.0	2.60	33.8
Dili	0	0.00	0	0	0.00	0
Ermera	8.0	3.20	25.6	8.0	3.20	25.6
Liquica	3.0	2.60	7.8	3.0	2.60	7.8
Lautem	13.0	2.68	34.8	12.0	2.90	34.8
Manatuto	11.2	2.79	31.2	10.2	3.00	30.6
Manufahi	8.0	3.00	24.0	8.0	3.00	24.0
Oecussi	6.0	2.90	17.4	6.0	2.90	17.4
Viqueque	68.2	3.20	218	68.2	3.20	218
Grand Total	**352.9**		**1148.6**	**356.7**		**1160.7**
Average		**2.81**			**2.81**	

Source: MAF Directorate of Agriculture, Horticulture and Extension

3.9.2. Cropping season

Red onions are generally grown in irrigated beds during the dry season. Planting commonly takes place in April/May, with harvest 70-90 days later. Some onions are sold fresh into the Baucau market and command a price premium, but the majority are dried and sold.

3.9.3. Use of inputs

Red onions are a high input crop, like most horticultural crops. They require irrigation, seed bulbs, good soil fertility, and sometimes fungicide to control fungal diseases. Seed bulbs are planted directly into the field, and then bulk-up to produce three to seven bulbs at time of harvest. The cost and availability of seed bulbs for planting is a significant production constraint. Seed onions are available in Atambua, which is where many Maliana growers source their seed requirements from.

3.9.4. Labour requirements

Production of red onions is a relatively labour intensive crop, with a total requirement of 183 days/ha. The main activities requiring significant manual labour include fencing (20 days); planting (20 days); irrigation (20 days); weeding (40 days); and harvest (40 days).

3.9.5. Current average production

Average yield is 2.5 Mt/ha, over a national area of 350 ha. The largest areas of production are Aileu, Viqueque and Baucau (

Table). This average yield is much less than achieved in Indonesia, which produces 1.1 million Mt from 120,000 ha, an average of 9.6 t/ha. Indonesian farmers generally employ more intensive production practices, many of which could be replicated in Timor-Leste.

3.9.6. Contribution to household income

Red onions are currently a minor crop, with relatively few specialist growers. As a result, this enterprise currently makes a minor contribution to HH incomes. Specialised growing HHs can, however, generate very substantial returns, as shown in the following gross margin analysis.

3.9.7. Major production constraints

The main production constraints include: (i) seed bulb quality and availability; (ii) soil nutrition; and (iii) fungal diseases. Quality seed bulbs are essential for good production, as well as ready access to organic and inorganic fertilisers and fungicides.

In Bobonaro, there are strong cultural taboos around the cultivation of red onions on the Maliana plain. If red onions are planted in this area, farmers believe that they will be struck dead by lightning.

3.9.8. Key opportunities for improvement

Red onion production could be considerably improved by facilitating the supply of quality inputs to farmers, including seed bulbs, fertilisers (organic and inorganic) and fungicides.

Another opportunity is to grow large Bombay onions (Tetun: *Lis Bombay*) from seed. Bombay onions are currently imported for sale throughout Timor-Leste. There is no local production. In the final year of USAID’s USAID's Developing Agricultural Communities (DAC) Project, seed was imported from overseas for trials. The project successfully grew crops of large onion from seed at Fatubossa (between Aileu and Maubisse). These trials were conducted during the dry season, producing yields of 5 to 10 Mt/ha. If a farm-gate price of $2.50/kg could be obtained this would be an excellent alternative to red onions, which have a much higher establishment cost due to reliance on vegetative propagation (i.e. seed bulbs) as opposed to seed.

3.9.9. Gross margin analysis

The estimated gross margin for red onion produced under current practices is $3,000/ha with an overall return to labour of $17/ day (Table 39). This is based on production of 2.5 Mt/ha at a sale price of $2.50/kg. One of the major costs is seed bulbs ($500/ha).

With better quality planting material and improved soil nutrition, yields could be increased by 30%. This would increase the gross margin to $3,600/ha, or $20/day.

Table 39. Gross margin analysis for red onion production based on current and improved scenarios

Cropping system	Yield (kg)	Gross margin ($/ha/day)	Gross Income ($)	Expenditure ($)	Gross margin($/ha)	Labour days
Improved variety and practices	2,530	17	4,744	1,665	3,079	17
Improved variety and practices	3,289	20	6,167	2,610	3,557	20

Source: Mission estimates

Details of gross margin calculation are shown for some options in Annex 1. A complete set of gross margin calculations for all cropping systems is in the excel spreadsheet GM_Onion_Nov2016.

3.9.10. Recommendation

Red onions is the most profitable activity assessed. Productivity could be further improved through the use of improved quality planting material, and increased use of fertilisers and fungicides. Subject to available markets, there is good potential for developing the red onion VC under TOMAK, although the size of the market – and therefore the number of farmers involved – will always be somewhat limited. Note also that due to the high production costs, red onion farming is an activity that will be better suited to HHs that are already reasonably well capitalised.

An additional recommendation is to further investigate the production of Bombay onions from seed, in the same locations where red-onions are currently being grown.

3.10. Potato

European potato is a common part of Timorese cuisine, although is only grown in cooler elevated areas. The main producing areas include Maubisse, Hatobuilico, Quelicai, and Bobonaro. Production is based on low input/ low output systems, usually producing low yields of very small tubers.

3.10.1. Major production constraints

Until 2005, potato growers made good money. Since 2006, production has been decimated by two new fungal diseases (*Phytophora infestans* and *Rhizoctonia solani*). These diseases cause a breakdown of leaf and stem tissue, leading to wilt and premature death of the plant. As the plants die from the infection, the partly formed tubers are not filled, resulting in very small potatoes.

P. infestans is also known as late blight or potato blight, and was a major cause of the European, the Irish and the Highland potato famines in the 1840s. In these famines, potato yields crashed, causing mass starvation and mass exodus of people out of the afflicted areas.

Fungal spores are transmitted via the planting material (potatoes) and through the soil. This means these diseases can be controlled by limiting the source of fungal spores. Only good-quality seed potatoes from disease free suppliers should be planted, as often discarded potatoes from the previous season and self-sown tubers can act as sources of inoculum. Similarly, crops should only be planted into clean ground that has been fallowed for a sufficient length of time between host crops.

3.10.2. Key opportunities for improvement

MAF has made various attempts to improve potato production following the disease outbreak in 2006. In 2008 research was conducted in collaboration with an Indonesian researcher that demonstrated high yields could be obtained with appropriate crop management, including high use of chemical inputs for crop protection.

MAF has also made various attempts to import clean Indonesian planting material into the country. Very little of this has made its way beyond the port[15]. The European Commission's Rural Development Program Phase III (RDP3) successfully imported the potato variety Granola, common in Indonesia. However, this variety proved highly susceptible to potato blight, and has had no impact on potato yields in Timor-Leste.

SoL conducted a series of potato variety trials in Timor-Leste, including in the TOMAK target area of Larigutu. Unfortunately no blight resistant varieties could be identified. The conclusion from this research was that increased potato yields can only be achieved with major investment in clean seed production, and considerable use of fungicides coupled with sound crop rotation.

3.10.3. Recommendation

Due to the cost and length of time required to address the potato blight issues, there is little potential for developing the European potato VC under TOMAK. It is recommended that this VC should not be considered further.

4. Major cross-cutting issues

4.1. Improved seed varieties

In many of the crop-based VCs, the use of improved varieties is the easiest way to increase production and profitability. On average, using an improved variety increases the gross margin per hectare from an estimated $4.6/day to $6.2/day. This is a 35% increase in profitability, fairly consistent across the different commodities (Table 40).

Table 40. Impact of improved variety on gross margin per labour day for six commodities.

Species	Variety	Yield (kg/ha)	Return on labour ($/day)
Maize	Local	1,500	4.2
Maize	Local	2,100	5.9
Cassava	Local	17,000	4.4
Cassava	Ai Luka 1	25,500	5.1
Mung bean	Local	800	4
Mung bean	Improved	1,120	6.4
Rice	Local red rice	1,800	5.6
Rice	Imp red rice	2,900	8.3
Soybean	Local	900	3.6
Soybean	Improved	1,170	5.1
Peanut	Local	1,500	5.8
Peanut	Improved	2,200	6.5
Mean	Local		4.6
Mean	Improved		6.2

Source: Mission estimates

From 2011 to 2016, SoL focused on developing a national seed system for a number of common food crops. By the end of SoL Phase 3, the highest adoption rates for any one improved variety were less than 30% (Table 41). There is obviously considerable scope for increasing farmer's income through further promotion of improved varieties, using seed produced in Timor-Leste.

[15] In the worst case, the smell of rotting potato seed at the port could be smelt at Parliament house.

Table 41. Adoption rates of improved varieties (% among crop growers) from 2011 to 2016.

Crop	Variety	2011	2013	2014	2016
Maize	Sele	13%	15%	20%	30%
Noi	Mutin	-	2%	10%	22%
Nai	-	-	0.30%	0.60%	
Rice	Nakroma	11%	15%	14%	21%
Peanut	Utamua	16%	11%	12%	6%
Cassava	Ai-luka	3%	3%	5%	5%
Sweet Potato	Hohrae	7%	7%	9%	10%

Source: SoL Final Report (2016)

There may be scope for TOMAK to further develop the role of the private sector in relation to the production, distribution and sale of improved varieties.

4.2. Access to agrichemical inputs

To make the move from subsistence to commercial farming requires improved access to a range of agrichemical inputs (including a range of herbicides for upland crops and rice, fungicides, insecticides and organic fertilisers) and associated training. Currently there is very limited access to farm inputs throughout Timor-Leste. In both Baucau and Maliana there is only one major supplier. Further away from the main centres availability is limited or non-existent.

Training in the appropriate selection and use of agrichemicals is also essential. There has been good progress in this area by the USAID-funded DAC program, and Mercy Corps. TOMAK could learn from these current and past projects and build on their successes to improve the supply of farm chemicals to Timorese farmers.

4.3. Access to appropriate labour saving devices and fencing

As discussed in earlier sections, significant improvements in labour efficiency can be achieved through adoption of labour saving devices. These devices are often quite low cost, but still well out of the range of the average subsistence farmer, if they are available at all (Table 42).

Table 42. Possible labour saving devices that should be available to farmers to increase profitability

Crop	Item	Approximate cost ($)
Maize	Storage drum	50
Maize	Hand sheller	50
Maize	Husking hook	5
Peanut	Peanut sheller	200
Soybean	Petrol powered thresher	500
Mung bean	Storage drum	50
Out of season crops	Barbed wire	$70/500m
All crops	Hand sprayer	35

It is recommended that TOMAK should investigate ways that these devices can be made more available to farmers.

4.4. Market information

There is a serious lack of market information available to farmers who are trying to produce commodities for sale. Many farmers never obtain independent information regarding the true value of the goods they are selling. In this information vacuum, sellers sometimes have unrealistic price expectations based on ill-founded rumours, and traders often have an unfair negotiation advantage.

It is recommended that TOMAK investigate ways of improving the supply of independent price information for farmers in Timor-Leste.

4.5. Soil testing

Most soils in Timor-Leste are low fertility. In 2014 soil samples were collected from 44 farms by SoL in major cropping areas. Of these, 73% had soil P levels in the low to very low range. Only 15% had soil P levels of optimal or high, mainly confined to coastal areas on the south coast, or where vegetables had been grown the previous year. With such universally low soil P values, a blanket recommendation would be appropriate.

The situation for soil nitrogen is likely to be worse. It is very likely that almost all of the cropped soils in Timor-Leste would benefit from applied nitrogen.

To move forward from a blanket approach, some soil testing will be required. Over the last few years the Australian Institute of Soil Scientists and the Crawford Fund have donated equipment and training to the MAF soils lab. The lab is established to measure soil electrical conductivity, pH and soil P. The lab has been under-utilised for a number of reasons, but could be brought into service relatively quickly.

As a cross-cutting issue that affects many of the VCs likely to be targeted by TOMAK, it is suggested that TOMAK investigate the feasibility of a private soil testing service in Timor-Leste, including the possibility of MAF providing commercial soil testing services through its lab.

Appendices

Appendix 1: Detailed Gross Margin Estimates

This Appendix presents a summary of the gross margin analyses for the various products/ enterprises assessed as part of this study. Due to space considerations, results are presented for a limited number of selected development options in relation to each enterprise. The full analysis is available as a separate excel file.

Peanut

Gross margin for Peanuts

Tractor		Tractor		Tractor		Tractor		Tractor	
Variety		Local		Utamua		Utamua		Utamua	
Fertiliser		Nil		Nil		Fertiliser		Fertiliser	
Thresher		Nil		Nil		Nil		Thresher	
Average yield (kg/ha)		1500		2200		2860		2860	
Consumption/Seed (kg)		200		150		150		150	
Animal feed (kg)		0		0		0		0	
Losses		150		220		286		286	
Cash sales		1150		1830		2424		2424	
Total utilization		1500		2200		2860		2860	
Area		1		1		1		1	
Gross income	**Unit price ($)**	**Unit**	**Total**	**Unit**	**Total**	**Unit**	**Total**	**Unit**	**Total**
Value of Production	0.75	1350	1012.5	1980	1485	2574	1930.5	2574	1930.5
Total income			1012.5		1485		1930.5		1930.5
Expenditure		**Unit**	**Total**	**Unit**	**Total**	**Unit**	**Total**	**Unit**	**Total**
Seed (kg)	0.75	150	112.5	150	112.5	150	112.5	150	112.5
Fertiliser (kg)	1	0	0	0	0	48	48	48	48
Grain bags	0.2	0	0	0	0	0	0	0	0
Tractor	110	1	110	110	110	1	110	1	110
Herbicide	2	0	0	0	0	0	0	0	0
Pesticide	15	0	0	0	0	0	0	0	0
Annual thresher cost	15	0	0	0	0	0	0	1	15
Rodenticide	5	0	0	0	0	0	0	0	0
Total gross expenditure			222.5		222.5		270.5		285.5
Net gross margin/ha			790		1262.5		1660		1645
Labour income/ha/labour day			5.81		6.54		7.35		9.75

Labour requirment for peanuts

Tractor	Tractor	Tractor	Tractor	Tractor
Variety	Local	Utamua	Utamua	Utamua
Fertiliser	Nil	Nil	Fertiliser	Fertiliser
Thresher	Nil	Nil	Nil	Thresher
Labour	Days	Days	Days	Days
Cleaning grass/burning	10	10	10	10
Fencing	0	0	0	0
Preparing nursery	0	0	0	0
Ploughing (tractor)	1	1	1	1
Harrow(Tractor)	1	1	1	1
Planting	15	20	20	20
Weeding	30	30	30	30
Spraying chemicals	1	0	0	0
Harvesting	37.5	55	71.5	71.5
Carrying to thresher/cleaning	0	6	6	6
Drying	0	3	3	3
Bunding/bagging	3	3	3	3
Shelling	37.5	55	71.5	14.3
Marketing	0	3	3	3
Transporting	0	3	3	3
Other crop management	0	3	3	3
Total labour	**136**	**193**	**226**	**168.8**

Mung Beans

Gross margin for Mung bean

System Agronomy				**Current**		**Post rice**		**Current**	
Variety				**Local**		**New Variety**		**New**	
Land					**Flat**		**Rice bay**		**Flat**
Storage									**Good storage**
Fertiliser									**Fertiliser**
	Area (ha)		1						
Utilisation									
	Average yield (kg/ha)			800		1120		1344	
	Consumption/Seed (kg)			40		56		67.2	
	Animal feed (kg)			0		0		0	
	Losses			160		224		0	
Price	0.7		$/kg	600		840		1277	
	Total utlisation			800		1120		1344	
	Area			1		1		1	

Gross income		**Unit price ($)**	**Unit**	**Total**	**Unit**	**Total**	**Unit**	**Total**
	Value of Production	0.7	640	448	896	627.2	1344	1129
	Total income			448		627.2		1129

Expenditure		**Unit price**	**Unit**	**total $**	**Unit**	**total $**	**Unit**	**total $**
	Seed (kg)	1.5	25	37.5	25	37.5	25	37.5
	Fertiliser (kg)	1	0	0	0	0	50	50
	Grain bags	0.2	0	0	0	0	0	0
	Tractor	110	1	110	0	0	1	110
	Barbed wire	50	0	0	1	50	1	50
	Storage drums	7	0	0	0	0	8	56
	Herbicide	2	0	0	0	0	0	0
	Pesticide	15	0	0	0	0	0	0
	Rodenticide	5	0	0	0	0	0	0
	Total gross expenditure			147.5		87.5		303.5
Net gross margin/ha				300.5		539.7		825.46
Labour income/ha/labour day				3.97		9.77		10.68

Labour requirement for Mung beans

System Agronomy	**Current**	**Post rice**	**Current**
Variety	**Local**	**New Variety**	**New**
Land	**Flat**	**Rice bay**	**Flat**
Storage			**Good storage**
Fertiliser			**Fertiliser**
Labour	Days	Days	Days
Cleaning grass/burning	5	0	5
Fencing	5	10	5
Preparing nursery	0	0	0
Ploughing (tractor)	1	0	1
Harrow(Tractor)	1	0	1
Planting	5	3	5
Weeding	30	10	30
Harvesting	7	5	6
Carrying to thresher/cleaning	3	3	3
Drying	3	3	3
Bunding/bagging	3	3	3
Shelling / cleaning	4	6	7
Marketing	3	3	3
Transporting	3	3	3
Other crop management	3	3	3
Total labour	**76**	**55**	**77**

Maize

Gross margin for maize				
Variety	**Local**	**Sele**	**Sele**	**Sele**
Fertiliser				**Fertiliser**
Conservation Ag.			**CA**	**Drum**
Drum			**Drum**	**Thresher**
Thresher			**Thresher**	**Herbicide**

Average yield (kg/ha)		1200	1680	3192	2730
Consumption/Seed (kg)		480	672	1276.8	1092
Animal feed (kg)		120	168	319.2	273
Losses (kg)		240	336	0	0
Cash sales		360	504	1596	1365
Total utlisation		1200	1680	3192	2730
Area (ha)	1				

Gross income	**Unit price ($)**	**Unit**	**Total**	**Unit**	**Total**	**Unit**	**Total**	**Unit**	**Total**
Value of Production	0.4	960	384	1344	537.6	3192	1276.8	2730	1092
Total income			384		537.6		1276.8		1092

Expenditure	**Unit price**								
Seed (kg)	1.5	16	24	16	24	16	24	16	24
Fertiliser (kg)	1	0	0	0	0	0	0	50	50
Grain bags	0.2	0	0	0	0	0	0	0	0
Tractor	110	0	0	0	0	0	0	1	110
Herbicide	10	0	0	0	0	0	0	5	50
Pesticide	15	0	0	0	0	0	0	0	0
Annual Barbed wire	37.5	0	0	0	0	1	37.5	0	0
Annual thresher cost	25	0	0	0	0	1	25	1	25
Annual drum cost	2	0	0	0	0	17.7	35.5	6	12
Rodenticide	5	0	0	0	0	0	0	0	0
Total gross expenditure			24		24		121.97		271

Net gross margin/ha	360	513.6	1154.8	821
Labour income/ha/labour day	4.35	5.59	11.73	10.84

Labour requirement for maize

Variety Fertiliser Conservation Ag. Drum Thresher	Local	Sele	Sele CA Drum Thresher	Sele Fertiliser Drum Thresher Herbicide
Labour	days	days	days	days
Cleaning grass/burning	10	10	2	5
Fencing	0	0	15	0
Ploughing (tractor)	0	0	0	0
Harrow(Tractor)	0	0	0	0
Pulling weeds & Bunding	0	0	0	0
Planting	5	5	8	5
Weeding	30	30	10	5
Spraying/applying chemicals	0	0	0	3
Harvesting	10	14	27	23
Carrying to thresher/cleaning	5	7	13	11
Drying	3	3	3	3
Bunding/bagging	3	3	3	3
Shelling	8	11	9	9
Marketing	3	3	3	3
Transporting	3	3	3	3
Other crop management	3	3	3	3
Total labour	**83**	**92**	**98**	**76**

Cassava

Gross margin for Cassava							
Tractor		**No tractor**		**No Tractor**		**Tractor**	
variety		**Local**		**Ailuka 1**		**Ailuka 1**	
Fertiliser		**Nil**		**Nil**		**Fertiliser**	
Herbicide		**Nil**		**Nil**			
Average yield (kg/ha)		17,000		25,500		31,875	
Consumption(kg)		6,800		10,200		12,750	
Animal feed (kg)		6,800		10,200		12,750	
Losses		1,700		2,550		3,188	
Cash sales		1,700		2,550		3,188	
Total utilisation		17,000		25,500		31,875	
Area (ha)	1						
Gross income	**Unit price ($)**	**Unit**	**Total**	**Unit**	**Total**	**Unit**	**Total**
Value of Production	0	6,120	979	9,180	1,469	11,475	1,836
Total income			979		1,469		1,836
Expenditure	**Unit price**						
Planting material	0	10000	0	10000	0	10000	0
Fertiliser (kg)	1	0	0	0	0	100	100
Grain bags	0.2	0	0	0	0	0	0
Tractor	110	0	0	0	0	1	110
Pesticide	8	0	0	0	0	0	0
Total gross expenditure			**0**		**0**		**210**
Net gross margin/ha			979.2		1469		1626
Labour income/ha/labour day			4.48		5.20		5.18

Labour requirements for Cassava

Tractor	No tractor	No Tractor	Tractor	No tractor
variety	**Local**	**Ailuka 1**	**Ailuka 1**	**Ailuka 1**
Fertiliser	**Nil**	**Nil**	**Fertiliser**	**Nil**
Herbicide	**Nil**	**Nil**		**Insecticide**
Labour	**Days**	**Days**	**Days**	**Days**
Cleaning grass/burning	15	15	5	15
Fencing	15	15	15	15
Harrow (Tractor)	0	0	1	0
Planting	5	5	5	5
Weeding	40	40	30	40
Spraying/applying chemicals	0	0	2	2
Harvesting	85	127.5	159.4	159.4
Carrying to house/cleaning	42.5	64	79.7	79.7
Peal Chip and Dry	7	7	7	7
Marketing	3	3	3	3
Transporting	3	3	3	3
Other crop management	3	3	3	3
Total labour	**218**	**282**	**314**	**332**

Soybean

Gross margin for soybean

Variety		Local		New		New	
Fertiliser		**Nil**		**Nil**		**Fertiliser**	
After rice		**Nil**		**Nil**		**Nil**	
Average yield (kg/ha)		900		1,170		1,463	
Consumption/Seed (kg)		22		22		22	
Animal feed (kg)		0		0		0	
Losses		90		117		146	
Cash sales		788		1,031		1,294	
Total utlisation		900		1,170		1,463	
Area		1		1		1	

Gross income	Unit price ($)	Unit	Total	Unit	Total	Unit	Total
Value of Production	0.75	810	608	1,053	790	1,316	987
Total income			608		790		987

Expenditure	Unit price						
Seed (kg)	1.5	16	24	16	24	16	24
Fertiliser (kg)	1	0	0	0	0	50	50
Grain bags	0.2	0	0	0	0	0	0
Tractor	110	0	0	0	0	0	0
Herbicide	2	0	0	0	0	0	0
Pesticide	15	0	0	0	0	0	0
Threshing machine	75	1	75	1	75	1	75
Rodenticide	5	0	0	0	0	0	0
Total gross expenditure			**99**		**99**		**149**

Net gross margin/ha			508.5		690.8		838.2
Labour income/ha/labour day			4.1		5.5		6.4

Labour requirements for Soybean

Variety	Local	New	New
Fertiliser	Nil	Nil	Fertiliser
After rice	Nil	Nil	Nil
Labour	**Days**	**Days**	**Days**
Cleaning grass/burning	20	20	20
Fencing	15	15	15
Planting	5	5	5
Irrigating crops	18	18	18
Weeding	30	30	30
Spraying/applying chemicals	0	0	1
Harvesting	7.5	9.75	12.1
Carrying to thresher/cleaning	6	6	6
Drying	3	3	3
Bunding/bagging	3	3	3
Mechanized Shelling	6	7.8	9.75
Marketing	3	3	3
Transporting	3	3	3
Other crop management	3	3	3
Total labour	**123**	**127**	**132**

Rice

Gross margin for paddy rice

Variety		Local Red rice		Imp red rice		Imp red rice		Imp red rice	
Fertiliser						Fertiliser		Fertiliser	
Herbicide								Herbicide	
Average yield (kg/ha)		1750		2400		3120		3120	
Consumption/Seed (kg)		875		1200		1560		1560	
Animal feed (kg)		175		240		312		312	
Losses (kg)		525		720		936		936	
Cash sales		175		240		312		312	
Total utlisation		1750		2400		3120		3120	
Area (ha)	1								

Gross income	Unit price ($)	Unit	Total	Unit	Total	Unit	Total	Unit	Total
Value of Production	0.7	1225	858	1680	1176	2184	1529	2184	1529
Total income			858		1176		1529		1529

Expenditure									
Seed (kg)	1.5	20	30	20	30	20	30	20	30
Fertiliser (kg)	1	0	0	0	0	120	120	120	120
Grain bags	0.2	0	0	0	0	0	0	0	0
Tractor	110	1	110	1	110	1	110	1	110
Herbicide	10	0	0	0	0	0	0	8	80
Pesticide	15	0	0	0	0	0	0	0	0
Annual thresher cost	50	1	50	1	50	1	50	1	50
Annual drum cost	2	0	0	0	0	0	0	0	0
Annual fencing cost	37	0	0	0	0	0	0	0	0
Rodenticide	5	0	0	0	0	0	0	0	0
Total gross expenditure			**190**		**190**		**310**		**390**
Net gross margin/ha			667.5		986		1219		1138.8
Labour income/ha/labour day			5.52		7.60		8.74		9.15

Labour requirement for paddy rice

Variety Fertiliser Herbicide Labour	Local Red rice Days	Imp red rice Days	Imp red rice Fertiliser Days	Imp red rice Fertiliser Herbicide Days
Cleaning grass/burning	5	5	5	5
Fencing	5	5	5	5
Preparing nursery	5	5	5	5
Ploughing (tractor)	1	1	1	1
Harrow(Tractor)	1	1	1	1
Pulling weeds & bunding	5	5	5	5
Planting	10	10	10	10
Maintaining borders	5	5	5	5
Irrigating crops	10	10	10	10
Maintaining irrigation system	10	10	10	10
Weeding	20	20	20	5
Spraying/applying chemicals	5	5	5	5
Bird scaring				
Harvesting	19.444	26.667	34.667	34.667
Carrying to thresher/cleaning	6	6	6	6
Drying	2.1875	3	3.9	3.9
Bunding/bagging	2.1875	3	3.9	3.9
Shelling	0	0	0	0
Marketing	3	3	3	3
Transporting	3	3	3	3
Other crop management	3	3	3	3
Total labour	**121**	**130**	**139**	**124**

Onions

Gross margin for red onion					
Variety		**Local**		**Improved**	
Average yield (kg/ha)		2530		3289	
Consumption/Seed (kg)		506	0.200	658	0.200
Animal feed (kg)		0	0	0	0
Losses (kg)		126.5	0.05	164.45	0.05
Cash sales (kg)		1898	0.75	2467	0.75
Total utlisation (kg)		2530	1.0	3289	1.0
Area		1		1	

Gross income	**Unit price ($)**	**Unit**	**Total**	**Unit**	**Total**
Value of Production	2.5	1898	4744	2467	6167
Total income			4744		6167

Expenditure	**Unit price**				
Seed (kg)	2	340	680	340	680
Fertiliser (kg)	3.5	250	875	500	1750
Grain bags	0.2	0	0	0	0
Tractor	110	1	110	1	110
Herbicide	0	0	0	0	0
Pesticide	10	0	0	7	70
Rodenticide	0	0	0	0	0
Total gross expenditure			**1665**		**2610**
Net gross margin/ha			3079		3557
Labour income/ha/labour day			17		20

Labour requirement for red onion

Labour	Days	Days
Cleaning grass/burning	10	10
Fencing	20	20
Planting	20	20
Maintaining borders	0	0
Irrigating crops	28.33333	28.33333
Weeding	40	40
Spraying chemicals	2	2
Harvesting	40	40
Carrying to thresher/cleaning	6	6
Marketing	10	10
Transporting	3	3
Other crop management	3	3
Total labour	**182.3**	**182.3**

PIG FATTENING

Gross margin for pig fattening (GIZ ration, $1/Kg)		Local pig Local feed		Local Pig Ration feed		Macau pig Ration feed	
Gross income	**Unit price ($)**	**Unit**	**Total ($)**	**Unit**	**Total**	**Unit**	**Total**
Value of Production	4	100	400	100	400	100	400
Total income			400		400		400
Expenditure							
Weaner	60	1	60	1	60	1	60
Feed ration (1 kg)	1	0	0	318	318	315	315
Local feed (Opportunity cost)	0.2	962	192.4	0	0		
Housing Annual cost	10	0	0	1	5.8	1	3.8
Total gross expenditure			252.4		383.77		379
Net gross margin/weaner			147.6		16.2		21.1
Labour income/weaner/labour day			**6.25**		**0.62**		**1.20**

Labour	**Hrs / day / pig**	**Total days**	**Hrs / day / pig**	**Total days**	**Hrs / day / pig**	**Total days**
Preparing local feed (hr/week)	0.5	23.625	0	0	0	0
Preparing ration (hr/week)	0	0	0.5	13.1	0.5	8.7
Cleaning house (hr/week)	0	0	0.5	13.1	0.5	8.7
Total labour (days)	**24**			**26**		**16**

PIG FATTENING REVISED ANALYSIS

Gross margin for pig fattening Revised ration ($0.5/kg)		Local pig		Local Pig		Macau pig	
		Local feed		Ration feed		Ration feed	
		54	Weeks	30	weeks	20	weeks
Gross income	**Unit price ($)**	**Unit**	**Total ($)**	**Unit**	**Total**	**Unit**	**Total**
Value of Production	4	100	400	100	400	100	400
Total income			400		400		400
Expenditure	**Unit price ($)**						
Weaner	60	1	60.0	1	60.0	1	60.0
Feed ration (1 kg)	0.55	0	0.0	318	174.9	315	173.3
Local feed (Opportunity cost)	0.2	962	192.4	0	0.0		
Housing Annual cost	10	0	0.0	1	5.8	1	3.8
Total gross expenditure			**252.4**		**240.7**		**237.1**
Net gross margin/weaner			147.6		159.3		162.9
Labour income/labour day			6.2		6.1		9.3

Labour	**Hr. / day / pig**	**Total days**	**Hr. / day / pig**	**Total days**	**Hr / day / pig**	**Total days**
Preparing local feed (hr/week)	0.5	23.6	0	0.0	0	0.0
Preparing ration (hr/week)	0	0.0	0.5	13.1	0.5	8.8
Cleaning house (hr/week)	0	0.0	0.5	13.1	0.5	8.8
Total labour (days)		**23.6**		**26.3**		**17.5**

Actor	Soybean oil industry	Importer	Farmer	Farmer	Butcher
Product	Soybean meal	Premix	Pig feed ration	Fat pigs	Pork
Price	40c/kg	80c/kg	55c/kg	$4/kg LW (from 4kg feed)	$8/kg
Notes	Soybean meal is a by-product of the soybean oil industry.	Meal is imported, and mixed with additives (e.g. phosphate) to make a pre-mix. Premix is very high (48%) protein, and mixed with local feeds at household level to make the pig diet.	Add low cost grain and cassava to pre-mix to make a feed ration.	At a feed conversion rate of 3.8/grain per kg pig, , $2 of feed converts to $4 of live weight.	At a 65% dressing out percentage , butcher makes a margin of $1.25/kg