The Democratic Republic of Timor-Leste
Ministry of Agriculture and Fisheries

Seeds of Life

Fini ba Moris

Annual Research Report 2014

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2014

Seeds of Life
Fini ba Moris

‘Improved food security through increased productivity of major food crops’

Seeds of Life (Fini ba Moris) is a program within the Timor-Leste (East Timor) Ministry of Agriculture and Fisheries (MAF). The Governments of Timor-Leste and Australia collaboratively fund the program. Australian funding is through the Australian Department of Foreign Affairs and Trade (DFAT) plus the Australian Centre for International Agricultural Research (ACIAR) and is managed by ACIAR. The Centre for Plant Genetics and Breeding (PGB) within The University of Western Australia (UWA) coordinates the Australian funded activities.

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Foreword

This past year, 2014, was very productive in the development of the National Seed System for Released Varieties (NSSRV). On 23 May a bitter cassava variety KU50 (Ca109) was released with the name Ai Luka 1. This variety has been promoted by the Cooperativa Café Timor (CCT) as a second cash crop for coffee farmers. In addition, new varieties of cassava, mung beans, red beans, rice, sweet potato, velvet beans and winged beans were evaluated on farmers' fields for release over the next year or so. The research stations were also busy conducting replicated trials on these species plus pro vitamin A enriched maize germplasm from the International Institute of Tropical Agriculture (IITA) in Nigeria. Other activities occupying researchers' time included agronomic research on plant spacing fertilizer rates and the use of green manures to improve crop productivity. The results of these studies are summarized in this report.

As in previous years, most of the research described in this report was conducted in the Districts of Aileu, Ainaro, Baucau, Bobonaro, Liquiça, Manufahi, and Viqueque. These Districts possess one or more of the six recognized Agro Ecological Zones (AEZ) in Timor-Leste. The six Ministry of Agriculture and Fisheries (MAF) research centres and stations are also located within them. These are at Loes (Liquiça, AEZ1), Betano (Manufahi, AEZ6), Quintal Portugal (Aileu, AEZ3), Urulefa (Ainaro, AEZ3), Darasula (Baucau, AEZ2) and Raimaten (Bobonaro, AEZ2). All stations are well equipped and have undergone extensive renovations. Meanwhile, in the area of capacity building, MAF staff members continued to receive short term training, conduct comparative studies, have access to national and international conferences and, in some cases, researchers are enabled to attend MSc training in Australia and Indonesia.

The MAF oversees the multiplication of seed of released varieties both for certified and commercial purposes. We have a network of seed inspection services and quality control laboratories to ensure the seed remains pure and of high quality. The bulk of seed utilized by farmers is, however, grown by farmers both as community seed production groups and as individuals.

The National Directorate for Research and Special Services (NDRSS) within the Ministry of Agriculture and Fisheries (MAF) received extra funding for agronomic research activities in 2014 and there are plans to increase funding even further in 2015. However, the Australian Government through the Australian Centre for International Agricultural Research (ACIAR) and the Australian Department of Foreign Affairs and Trade (DFAT) who have made financial support available for the implementation of the research and seed multiplication program is gratefully acknowledged. My high appreciation also, to all parties who have collaborated in the development of agriculture in Timor-Leste to eradicate hunger, food insecurity, and poverty.

July, 2015

Estanislau da Conceição Aleixo Maria da Silva
Minister of Agriculture and Fisheries
Republic Democratic of Timor-Leste

Acronyms and Abbreviations

ACIAR	Australian Centre for International Agricultural Research
ALGIS	Agricultural Land Geographical Information System
AEZ	Agricultural Ecological Zone
ANOVA	Analysis of variance
ATCFC	Australian Tropical Crop and Forages Collection
CCT	Cooperative Café Timor
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Centre for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Centre
CIP	International Potato Centre
CSPG	Community Seed Production Group
DFAT	Australian Department of Foreign Affairs and Trade
FAO	Food and Agriculture Organization
GIS	Geographic Information Systems
ICRISAT	International Centre for Research in the Semi-Arid Tropics
ILETRI	Indonesian Legumes and Tuber Crops Research Institute
IRRI	International Rice Research Institute
M&E	Monitoring and Evaluation
MAF	Ministry of Agriculture and Fisheries
masl	Metres above sea level
NDA&H	National Directorate for Agriculture and Horticulture (MAF)
NDR&SS	National Directorate of Research and Special Services (MAF)
NDP&P	National Directorate of Policy and Planning (MAF)
NDACD	National Directorate of Agricultural Community Development (MAF)
NGOs	Non-Government Organizations
OFDTs	On-Farm Demonstrations and Trials
PDD	Program Design Document
PGB	Centre for Plant Genetics and Breeding
PSC	Program Steering Committee
QPM	Quality Protein Maize
SEOs	Suco Extension Officer (MAF extension officer)
SoL	Seeds of Life
SoL3	Seeds of Life 3
SOSEK	Social Science and Economics (Sosial Ekonami)
TAG	Technical Advisory Group
TL	Timor-Leste
TLMSP	Timor-Leste Maize Storage Project
UNTL	University of Timor Lorosae
UWA	University of Western Australia

Personnel

Ministry of Agriculture and Fisheries

H.E Mariano ASSANAMI Sabino	Minister of Agriculture and Fisheries (Until Feb 2015)
H.E Estanislao Aleixo da Silva	Minister of Agriculture and Fisheries (Start Feb 2015)
H.EMarços da Cruz	Vice Minister of Agriculture and Fisheries
H.E Valentino Varela	Secretary of State for Livestock (Until Feb 2015)
H.E Rafael Pereira Gonçalves	Secretary of State for Fisheries (Until Feb 2015)
H.E João Cardoso Fernandes	Secretary of State for Forestry and Natural Conservation (Until Feb 2015)
Mr. Lourenço Borges Fontes	Director General and SoL Co-Leader
Mr. Gil Rangel da Cruz	National Director of Agriculture and Horticulture (Until Oct 2014)
Mr. Amaro Ximenes	National Director of Agriculture and Horticulture (Start Oct 2014)
Mr. Adalfredo do Rosario Ferreira	National Director of Research and Special Services
Mr. Octávio da Costa Monteiro	National Director of Policy and Planning (Until Oct 2014)
Mr. Januário Marçal de Araujo	National Director of Agriculture Community Development (Until Oct 2014)
Mr. Fernando Soares	National Director of Agriculture Community Development (Start Oct 2014)
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Mr. Rafael Feliciano	Research Manager, Betano
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Mr. Tobias Monis Vicente L. Agm	Research Manager, Bobonaro

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Mr. Albino Ribeiro	Dili	
Ms. Virginia Soares	Dili	
Mr. Atanazio Caiero Barreto	Dili	
Ms. Anita Ximenes	Dili	
Ms. Octaviana Ferreira Agostinho	Dili	
Mr. Abril Fatima Soares	Dili	
Mr. Marcelino de Jesus da Costa	Dili	
Ms. Dorilanda da Costa Lopes	Bobonaro	Maliana
Ms. Maria Fernandes	Dili	
Mr. Cipriano Martins	Aileu	Aileu Villa
Mr. Salvador de Jesus	Aileu	Remexio, Liquidoe, Laulara
Ms. Odete Ximenes	Dili	
Ms. Juliana de Jesus Maia	Manufahi	Same
Mr. Antonio Pereira do Rego	Baucau	Venilale
Mr. Rojino Da Cunha	Baucau	Baucau Villa
Mr. João Bosco Pedro C.R. Belo	Baucau	Baucau Villa
Mr. Basilio da Silva Pires	Baucau	Baucau Villa, Laga, Venilale, Vemasse

Mr. Marços Vidal Corréia	Manufahi	Same
Mr. Felisberto Amaral Soares	Manufahi	Same
Mr. Jose da Costa Freygen	Liquiça	Maubara
Mr. Jorge Amaral	Manufahi	Alas
Mr. Armindo Moises	Ainaro	Maubisse
Mr. Mario Tavares Gonçalves	Liquiça	Liquiça Villa
Mr. Luis da Costa Patrocinio	Bobonaro	Balibo
Mr. Paulo Soares	Liquiça	Liquiça Villa
Mr. Mario da Costa	Viqueque	Uatolari
Ms. Maria Martins	Aileu	Aileu Villa
Ms. Isabel Soares Pereira	Dili	
Ms. Julieta Lidia	Dili	
Mr. Luis Fernandes	Baucau	Baucau Villa
Mr. Amandio da Costa Ximenes	Viqueque	Ossu
Mr. Inácio Sávio Pereira	Viqueque	Viqueque Villa
Mr. Apolinário Ximenes	Ainaro	Maubisse
Mr. Modesto Lopes	Dili	
Mr. Luis de Almeida	Dili	
Mr. Simão Margono Belo	Dili	
Mr. Agostinho Alves	Manufahi	Same, Alas
Mr. Laurentino Ximenes	Dili	
Mr. Sabilio dos Santos	Dili	
Mr. Fernando Soares	Liquiça	Maubara (Until Oct 2014)
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Mr. Marçal Ximenes	Baucau	
Mr. Angelo do Rosario	Oecusse	
Mr. Fernando da Silva	Covalima	
Mrs. Natalia de Amaral	Ainaro	
Mr. Leão Mauleto	Bobonaro	Maliana
Mr. Julio Filipe	Baucau	Vemasse (Until Oct 2014)
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Mr. Moises Sarmento	Viqueque	
Mr. Constantino da Costa	Baucau	
Mr. Luis Siki	Bobonaro	
Ms. Nelia Aniceto	Liquiça	
Mr. Andre Alves	Manufahi	
Mr. Feliciano Soares	Viqueque	
Mr. Antonio de Jesus	Aileu	
Mr. Pedro da Costa de Jesus	Baucau	
Mr. Orlando dos Santos da Lux	Ainaro	
Mr. Floriano de Fatima dos Santos	Manufahi	
Mr. Marcelino Santos Lopes	Bobonaro	
Mr. Silvester Sarmento	Liquiça	
Mr. Felisberto Soares	Manatuto	
Mr. Bernardino da Costa Nunes	Oecusse	
Mr. Anibal dos Santos	Lautem	
Mr. Mario Cardoso	Ermera	
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Ms. Yessy Betty	Communications Coordinator
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Mrs. Carla Da Silva	Office Manager
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Ms. Cecilia da Silva Pires	Finance Officer
Mr. Aquiles T. Maia Barros	Translator / Interpreter
Ms. Miguelina Ribeiro Garcia	Admin Finance Officer Eastern Region
Ms. Alexandra Araujo	Administrative Officer
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Mr. Jeronimo Ribeiro	Logistics Officer (Until January 2015)
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Ms. Elisabeth Belo	Administrative Officer
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Mr. Egas Vong	Finance Assistant
Mrs. Chona P. Binuya	English Teacher
Ms. Yane Andriana	Admin Finance Officer Central Region
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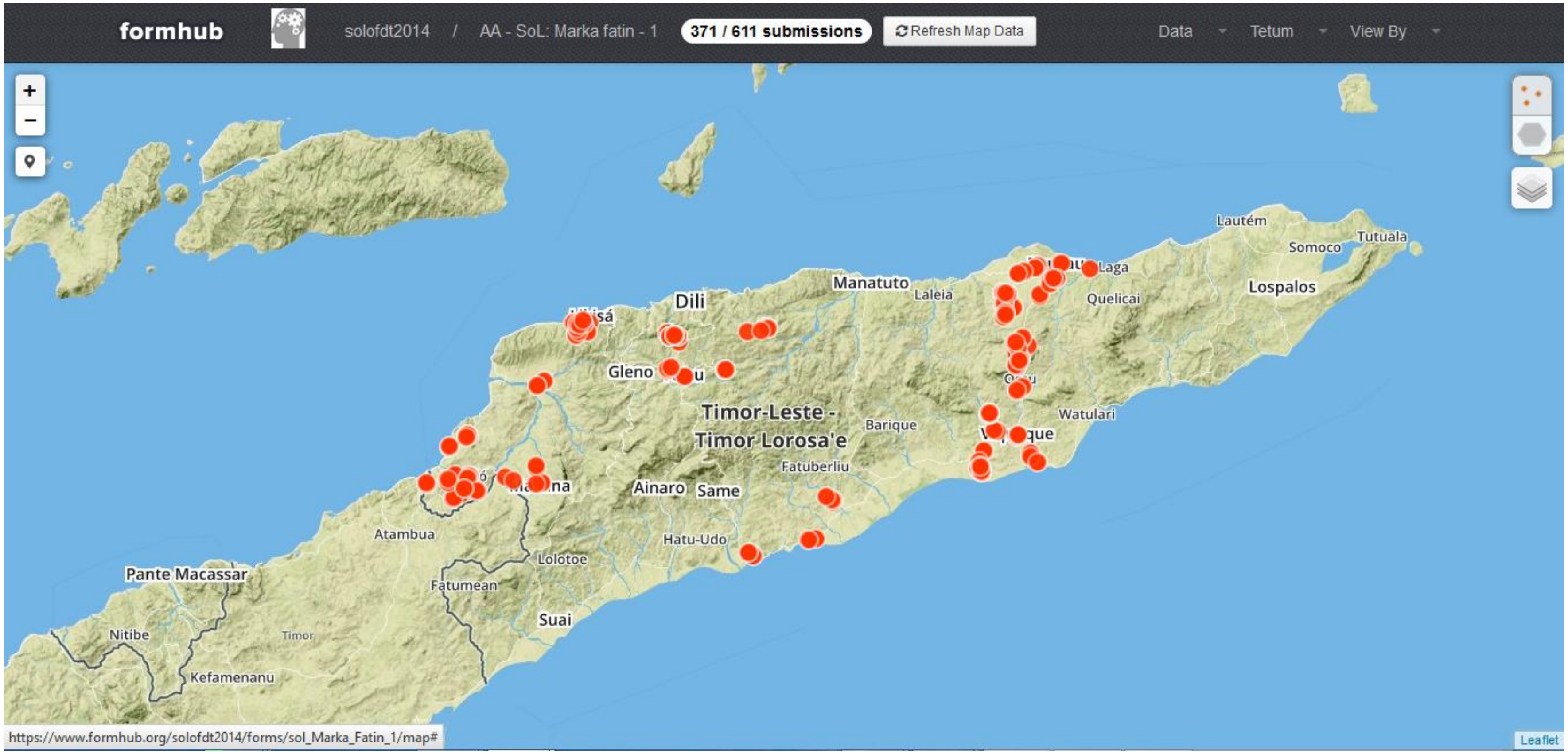


Figure 1. Map of 371 OFDT locationsof conducted in 2013-2014.

This map was generated automatically from the formhub.io web site, once data was submitted by a smart phone in the field.

1. Overview of the Seeds of Life program

1.1 Introduction

Seeds of Life (SoL) is a program within the Ministry of Agriculture and Fisheries (MAF) which assists the identification of productive varieties suited to local conditions, the development of a seed system, multiplication of planting material of improved varieties to feed into the system and strengthening of the institutional capacity for the seed system to become self-sustaining in the future. The vision of the program is to “have the foundations of a national seed system for Timor-Leste established, capable of providing a high level of access to seed of improved varieties to farmers throughout the country”. The focus crops for the program have, to date, been maize, rice, sweat potato, cassava and peanuts. The crop diversity has expanded in recent years and in 2014 there were on-farm trials on (apart from sweet potato and rice) climbing red beans, mung beans and winged beans. Some of these varieties may be released in 2015 or 2016 if they prove to be superior to those currently being cultivated in Timor-Leste.

This report details research conducted in the 2013-2014 wet season, months which straddle the second and third years of Phase 3 of SoL. Phase 3 builds on gains made in SoL1 (2000-2005) and SoL 2 (2005-2010) plus the SoL2 extension (September 2010 to January, 2011). SoL 3 commenced on 01 February, 2011 and will run to 30 June, 2016. Apart from maintaining a core focus on the seed system, support is forthcoming to analyse and develop strategies to overcome climate variability and change; to improve agronomic practices to reduce weed burdens and increase soil fertility; to reduce post-harvest storage losses and improve input supply arrangements for seed. There was also research into the level of aflatoxins in maize and peanuts.

SoL3 was being implemented in all districts in 2014. However, research activities were concentrated in the Districts of Aileu, Baucau, Viqueque, Bobonaro, Manufahi, Ainaro and Liquiça.

This is the ninth Annual Research Report prepared by Seeds of Life. The report details the results of the research conducted by the research component trials completed after August, 2013, including trials conducted in the dry season of 2013 and the 2013-2014 wet season. The achievements and activities of the source seed (Component 2 of SoL 3) and community seed production (Component 3 of SoL 3) and plus management activities (Component 4) for the September, 2013 to August, 2014 period are also included. Training and communications activities are reported for the 2013 calendar year.

1.2 Program summary

This summary follows the outline of the Seeds of Life Program Design Document (PDD) which is designed with four components possessing specific activities for each. These are 1) Crop identification and development, 2) Source seed and quality control, 3) Community and commercial seed development and 4) Seed system management. Capacity building is an integral part of the program and is part of each component but a summary of the year’s training activities is presented separately.

The activities and progress of each component for 2013-2014 are presented below:

1.2.1 Component 1: Crop identification and development

Component objective: Improved varieties of food crops evaluated and released.

Activities in this component include:

- National agricultural research centres and research stations established
- Genetic material of potential improved varieties identified and sourced
- Potential new varieties evaluated on-station
- Potential new varieties evaluated on-farm
- Selected new varieties officially released

A key part of the agricultural research is conducted on two research centres (Loes and Betano), four research stations (Quintal Portugal, Urulefa, Darasula and Corluli) and two other upland locations where land is rented from farmers on an as-needs basis (Venilale, Larigutu). Table 1 shows some main characteristics of these research locations. Personnel characteristics on these stations are presented in Table 2.

Table 1. MAF/SoL supported research centres and research stations

Research centres and stations [District]	*Location characteristics*	*Crops grown in 2013-2014*
RC Loes [Liquiça]	Elevation: 10 masl Soil: Alluvial AEZ: 1	Maize, peanut, sweet potato, winged bean, cassava
RC Betano [Manufahi]	Elevation: 3 masl Soil: Alluvial AEZ: 6 Area: 20 ha, of which 5 in use	Cassava, sweet potato, wing bean, maize, mung bean, velvet bean
RS Quintal Portugal [Aileu]	Elevation: 900 masl Soil: Heavy red clay AEZ: 3 Area: 0.8 ha, of which 0.8 in use	Peanut, wing bean, sword bean, maize, sweet potato, cassava
RS Urulefa [Ainaro]	Elevation: 1200 masl Soil: Heavy clay, limestone origin AEZ: 3 Area: 1.5 ha, of which 1.5 in use	Maize, sweet potato, wheat, barley, potato, climbing bean
RS Darasula [Baucau]	Elevation: 400 masl Soil: Heavy red clay AEZ: 2 Area: 8 ha, of which 2 in use	Maize, cassava, sweet potato, peanut, upland rice, mung bean
Raimaten [Bobonaro]	Elevation: 300 masl Soil: heavy clay AEZ: 2 Area: 1.7 ha, of which 1.7 in use	Rice

Table 2. Staffing at the research centres and research stations

Research centres and stations	*Researchers*		*Permanent labourers*		*Others*	
	Male	*Female*	*Male*	*Female*	*Male*	*Female*
RC Loes	2		9	1		
RC Betano	3		15	2	4	
RS Quintal Portugal		1	3		4	1
RS Urulefa	1		3			
RS Darasula	3		5		12	4
RS Raimaten	1		3			
Total	*10*	*1*	*38*	*3*	*20*	*5*
	11		*41*		*25*	

Most of the upgrading of these stations and centres was done in earlier years of the program and additional substantial improvements were not made to them during 2013-2014. In addition to these centres and stations, laboratory, administration and seed processing are also located on Triloca research station, Baucau. During 2014, major refurbishment was made to the Triloca administration building and the seed laboratory, including the construction of a drying pad and construction of a new access track.

In March 2014, MAF imported 19 vitamin A enriched maize varieties from the International Institute of Tropical Agriculture (IITA) in Nigeria for evaluation under Timor-Leste conditions. In addition, the MAF developed a good relationship with the Indonesian Legumes and Tuber Crops Research Institute (ILETRI) for future importation of material suitable for the agro-ecosystems of Timor-Leste. The collaborative relationship was being formalized at the end of 2014.

Forty wet season on-station trials were conducted during 2013 - 2014 (Table 3) and 11 trials during the dry season. The dry season trials included maize (Loes and Betano), peanut (Betano), mung bean (Betano and Loes), rice (Maliana), wheat (Maubisse) and climbing bean (Maubisse).

Table 3. Wet season on-station field trials, 2013-2014

Species	*Aileu*	*Baucau*	*Betano*	*Darasula*	*Fleisha*	*Hatolia*	*Lariguta*	*Loes*	*Maliana*	*Maubisse*	*Viqueque*	*# of trials for species*
Cassava	1		1	1				1				4
Maize	1		1	1				1		1		5
Peanut	1		1	1				1				4
Rice, irrigated	1	2						1	2			6
Rice, upland				2								2
Rice, Irrig. + fertilizer									1			1
Sweet potato	1		1	1				1		1	1	6
Potato							1			1		2
Wing bean	1		1	1				1				4
Velvet bean			1	1								2
Climbing bean					1	1	1			1		4
Total	*6*	*2*	*6*	*8*	*1*	*1*	*2*	*6*	*3*	*4*	*1*	*40*

Winged bean on-farm demonstration trials (OFDTs) were installed across a range of agro-ecosystems in seven core districts during 2013-2014. Sixty-five of these trials were harvested. Fifteen additional sites were also planted to velvet bean to evaluate the capacity of the crop to produce biomass. Seventy-four sweet potato on-farm trials were also installed and harvested as were twenty-five mungbean trials.

On May 23, 2014, the bitter cassava variety KU50 (Ca109) was released with the name Ai-Luka 1. This cassava variety has been promoted by the Cooperativa Café Timor (CCT) as a second cash crop for coffee farmers. This variety has been promoted by CCT since 2010 and by 2013-2014 was being grown by 2,306 farmers over 1703 ha. Prior to its release, the Variety Release Committee had met and indicated its support for the release of the variety by the Ministry.

1.2.2 Component 2. Source seed and quality control

Component objective: Sufficient high quality seed being produced to maintain the genetic quality of released varieties.

Activities in this component include:

- Sufficient foundation seed produced for the national seed system
- Sufficient certified seed produced by contract growers
- Quality assurance systems established
- Technical extension support provided to contracted seed producers
- Seed grading, packing and storage facilities established
- Formal seed distributed through preferred distribution channels

A large quantity of the breeder and foundation seed of Sele died from drought during 2014 and needed to be regenerated from 2013 stocks. Breeder seed of Noi Mutin was also lost and will need to be regenerated from foundation seed (Table 4). Sufficient stock of Nakroma rice seed and Noi Mutin breeder seed was, however, multiplied.

Table 4. Breeder and foundation seed availability at MAF warehouses, October 2014

Variety	*Production year*	*Breeder seed (kg)*	*Foundation seed (kg)*	*Seed warehouse*
Sele (maize)	2013	15	322	Betano RC
	2014	0	0	
Noi Mutin (maize)	2013	150	10	Loes RC
	2014	217	0	
Nakroma (rice)	2014	20	80	Triloca Baucau

Certified seed distributed to thirty seven commercial seed producers for the 2014-2015 crop included 2,450 kg of Sele and 920 kg of Noi Mutin. In addition, 3,150 kg of Utamua peanut was provided to 13 commercial seed producers for multiplication. It is estimated that this will be sufficient to plant 168.5 ha of maize and 21 ha of peanut. This area should produce at least 170 t of maize and 17 t of peanut. More than 200,000 sweet potato and 125,000 cassava cuttings were grown in 2013-2014. The cuttings will be distributed for 2014-2015 season. The cuttings were grown on the research stations.

By the end of 2014, six seed warehouses and three laboratories were established and fully equipped by the MAF to regulate seed quality in Timor-Leste. Warehouses were operating in the Districts of Bobonaro, Liquiça, Manufahi, Baucau, Viqueque and Aileu. Seed laboratories were established and operational in Baucau, Manufahi and Dili. Most of the tested commercial seed met the required standards.

The seed quality assurance system is implemented by the MAF Seed Department, which consisted of 24 persons during most of 2014 with an extra District seed officer added at the end of the year. During the year they provided training on harvest and post-harvest technology to commercial maize seed producers. The one-day trainings were conducted in Bobonaro, Baucau and at the Betano Research Center, with the training being provided by Seed Department staff. The participants at the training were members of maize CSPs (three members per group), District Community Seed Production Coordinators and SEOs. Apart from the technical skills training, these meetings also helped to build better relationships between the seed producers, extension staff and Seed Department staff.

A seed crop can be rejected during field inspection if other varieties are found to be growing within the seed plot, or if the occurrence of off-types is above standard. During seed processing it may also be rejected if for some reason germination rates are low. On average, there is a 20% seed loss for each crop.

Seed and other planting material distributed during the year includes 25 t of maize, 12 t of rice and 7.7 t of peanuts. In addition, 494,000 sweet potato cuttings and nearly 93,000 cassava cuttings were disbursed from the centres to both CSPs, research and NGOs for seed multiplication.

1.2.3 Component 3. Community and commercial seed dev't

Component objective: Mechanisms for the production and distribution of seed through community and market channels strengthened.

Activities in the component include:

- Community Seed Production Groups (CSPGs) established
- Commercial seed producers supported
- Focal seed merchants in local markets established
- Improved access to seed for vulnerable groups
- Systems linking informal seed producers with potential buyers developed

By the end of the 2013-2014 cropping season 1018 community seed production groups (CSPGs) were active in all 13 districts in 61 of the 65 sub-districts, and in 349 of the 397 rural sucos. As several CSPGs grow more than one crop, the sum of the CSPGs by crop is often larger than the number of CSPGs in a district. The 72 CSPGs that associated themselves to become registered CSPs are not included in this list. The total membership of the supported CSPGs is 12,703 persons, of whom 32% are women.

A key element of the NSSRV is the production of commercial seed by registered Commercial Seed Producers (CSPs). The majority of the CSPs were formerly CSPGs that established Farmers Associations, but there are also contract growers – both individuals and groups who previously cultivated formal seed that applied for, and were registered as CSPs. In 2014, 57 CSPs were registered with the MAF Seed Department with at least one in every District. These included 45 Farmers Associations of CSPGs, and 12 groups that had previous experience as contract growers.

The program provided 1747 packets with 750 gram and 1 kg of maize and paddy seed to the Agriculture Shops in 13 Districts during 2014, to test whether the customers there were interested to purchase small packs of cereal seeds. By mid-December 2014, 75% of maize seed packets were sold to farmers at $1.50 per kg. Until 2014, these shops were selling only small packs of vegetable seeds (mostly hybrid seeds) imported from abroad. Of the 26 agriculture shops, 16 were established with support from MAF/SoL in 11 Districts and 10 agriculture shops were established with support from Mercy Corps.

As of December 2014, MAF/SoL supported CSPGs were able to assist 4,870 vulnerable households (29% women) with seeds of MAF varieties of maize, paddy, peanut and sweet potato cuttings in all Districts of Timor-Leste except Lautem where surplus seed was not available for distribution from CSPGs. Twenty seven Sub-Districts, 47 sucos and 145 aldeias in the country were serviced.

All CSPs are developing relationships with agricultural shops, CSPGs, NGOs and other organizations for sale of their product. In preparation for the 2014-2015 season, MAF also prepared forward contracts with the registered CSPs to produce 200 t (100 t of maize and 100t of rice) of quality commercial seed in 2015.

1.2.4 Component 4. Seed system management

Component objective: MAF capacity to manage the national seed system strengthened

Activities in this component include:

- Seed planning and management systems established
- Monitoring and evaluation processes strengthened
- Seed system gender strategy implemented
- Improved-variety technical and promotional materials developed
- Awareness of improved varieties increased through use of mass media
- Environmental and climate change impacts addressed
- Capacity of MAF staff to manage the national seed system enhanced

The national seed system was strengthened during the year with the formation of a National Seed Council (NSC), a body representing stakeholders in the national seed sector to advise the Minister on implementation of the National Seed Policy. By the end of 2014, at least one commercial seed producing group (CSP) was formed in each District and operating according to the national seed policy formulated by Government and Non-Government organizations. MAF staff involved in the system include the national Directorates for research and special services (NDR&SS), agriculture and horticulture (NDAH) and extension under the National Directorate of Agricultural Community Development (NDACD). At the District level, the District Director (DD) ensures there is a good understanding of the seed balance in the District. This is done through the Chief of Extension (CE), Chief of Technical (CT), Community Seed Coordinator (CSC), District Seed Officer (DSO), Crop Officer (CO), Database Keeper (DBK), Sub District Extension Coordinator (SDEC) and the Suco Extension Officer (SEO).

The SoL M&E/ Sosek unit focused mostly on SoL-specific activities during 2014. This included eight case studies one of which was a mid-term survey. These studies are summarized in Section 6 of this report.

A gender action plan for 2013-2014 was prepared, and implemented by each of the components, in line with the activities that are relevant for that component. The gender awareness group (with one Australian volunteer) promoted equal access for women to all sectors of the seed industry. During the year, total membership of the supported CSPGs was 12,703 or whom 32% were women. Women held key positions in 26% of the 840 CSPGs measured. CSPs also maintained a 31% membership and approximately 30% of women were involved in source seed production. Three of the five postgraduate students supported by SoL were women.

During 2014 some 52 technical and promotional materials were designed in Tetun and English. These were distributed to key stakeholders including ministry staff, development partners, local and international NGOs, and farmers, and for display in MAF and SoL offices (both in Dili and in the districts). Many of the brochures, posters and banners continue to be distributed and used at MAF/SoL events to promote the varieties.

MAF-SoL received 64 mentions in 2014 in local media (51) and international media (13). Mentions were typically positive (19) or neutral (39), with six negative mentions. Seeds of Life signed a one-year sponsorship agreement with local NGO Cinema Lorosa'e for the screening SoL's short films including a film on gender and on the NSSRV with animation. This partnership provides an affordable and effective way to share key messages with rural communities in an engaging manner.

The training activities are summarized in Section 9.

The four outputs of the climate change activities during the year were a) Promoting understanding of climate change, climate variability and farmer adaptation strategies by facilitating access to maps, climate and soil data; b) The development of information sheets at the suco level, c) The establishment of a good database of weather through the establishment and management of a set of 24 automatic weather stations and d) Strengthening the capacity of MAF staff to manage the weather stations and analyze weather and crop related data. These activities are summarized in Section 7 of this report.

1.3 Rainfall

Introduction

Rainfall data has been collected at 21 sites where automatic weather stations are located as well as a number of other sites in the proximity of On-Farm Demonstration Trials (OFDTs) during 2013-2014. These sites cover all Agro-Ecological Zones (AEZs). However, due to the mountainous terrain and tropical monsoon climate there is still great variation from one site to another within an AEZ when considering one year of rainfall. Attention should be paid to the actual location of the rain gauge and, in particular, its altitude when using the data for other locations within an AEZ. The location of the eight sites by latitude and longitude with altitude are presented in Table 5.

Table 5. Location, altitude and agro-ecological zones of weather stations

AEZ	*District*	*Station Name*	*Latitude (ºS)*	*Longitude (ºE)*	*Alt (masl)*	*Portuguese annual rainfall (mm)*	*Rainfall 2013-14 (mm)*	*Temp. average max (ºC)*	*Temp. average min (ºC.)*
1	Liquiça	Loes	-8.737	125.140	22	937	1182.0	29.7	20.2
2	Bobonaro	Ritabou	-8.947	125.205	163	2053	2250.0	32.9	21.9
3	Aileu	Quintal Portugal	-8.704	125.565	980	1725	1570.0	27.8	15.5
3	Baucau	Darasula	-8.535	126.346	690	1119	1414.0	28.6	18.5
4	Ainaro	Urulefa	-8.837	125.612	1316	1414	1870.4	24.0	12.7
5	Lautem	Fuiloro	-8.496	127.027	358	1906	1704.4	30.0	19.8
6	Manufahi	Betano	-9.163	125.718	9	1328	1008.0	31.3	22.5
6	Viqueque	Bahalara-Uain	-8.950	126.273	21	1617	1427.8	31.0	21.7

Weather station data are shown for each AEZ with AEZ 3 and 6 having data for two locations. During 2013-14, some areas such as Liquiça, Bobonaro, Baucau, and Ainaro received above average rainfall whereas other areas such as Aileu, Lautem, Betano and Viqueque received lower rainfall when compared to the long term average during the Portuguese era. The mean annual rainfall for these eight sites (1553 mm) was close to the long term average (1512 mm) however the distribution of this rainfall throughout the year was quite different. Notably, there were decreases in rainfall experienced during January. This led to wilting of some maize crops at various locations. Above average rainfall occurred during December, April and June (Figure 2).

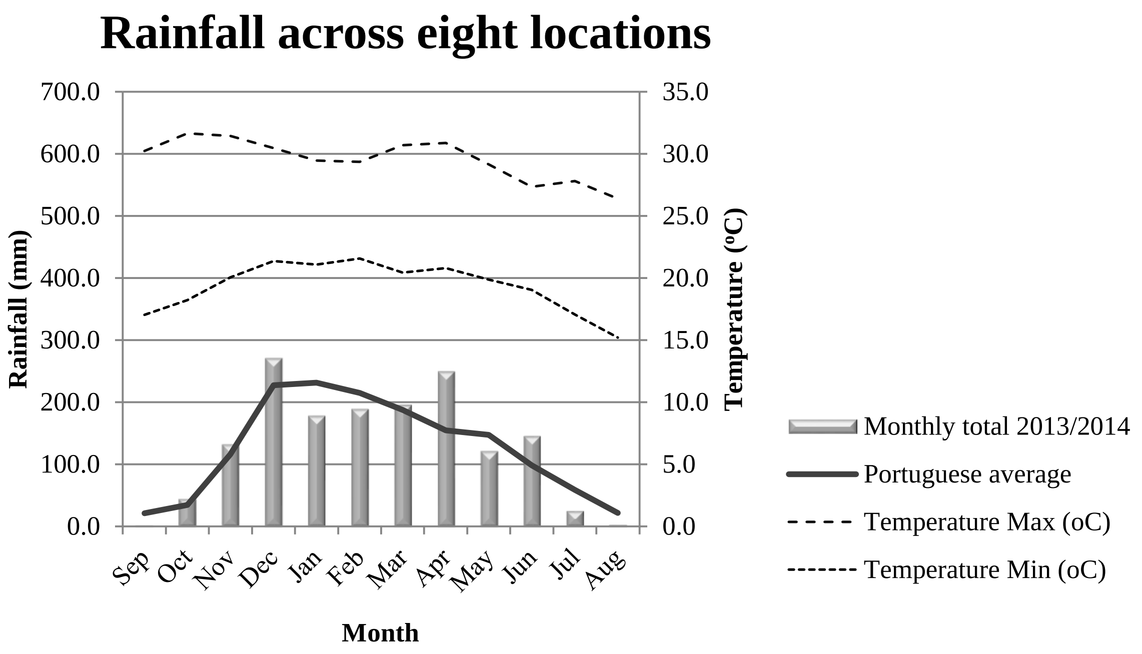


Figure 2. Monthly average rainfall across 8 sites and long-term average.

Rainfall data at select sites

At the north coast research station of Loes, the wet season started strongly but then experienced slightly drier conditions than normal during January. Good rains continued after January with an unusually high peak in April (Figure 3).

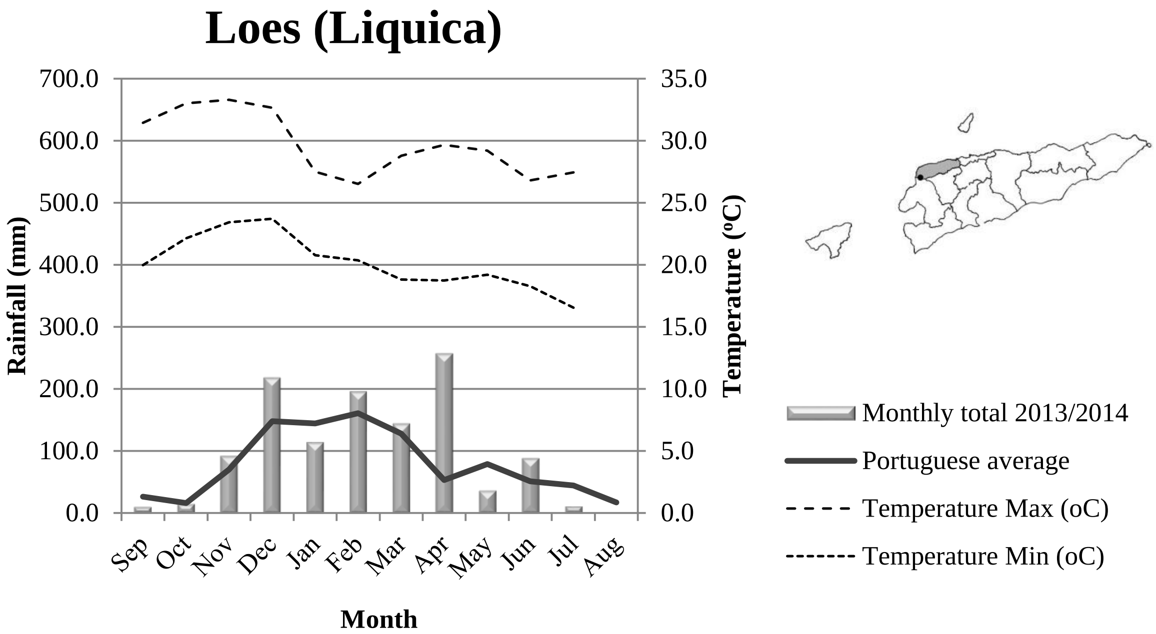


Figure 3. Monthly rainfall (mm) and temperature (ºC) at Loes, Liquiça, 2013-2014.

Further up the Loes River in the Maliana Basin, farmers experienced a strong, early start to the wet season (Figure 4). There was very high rainfall during December and January. A comparison of the rainfall in Ritabou with Loes demonstrates just how variable conditions can be in Timor-Leste. Ritabou is just 24 kms from Loes and a difference of 120 m in altitude. After some reduction in rainfall in February and March there was a second peak in April followed by an abrupt end to the wet season.

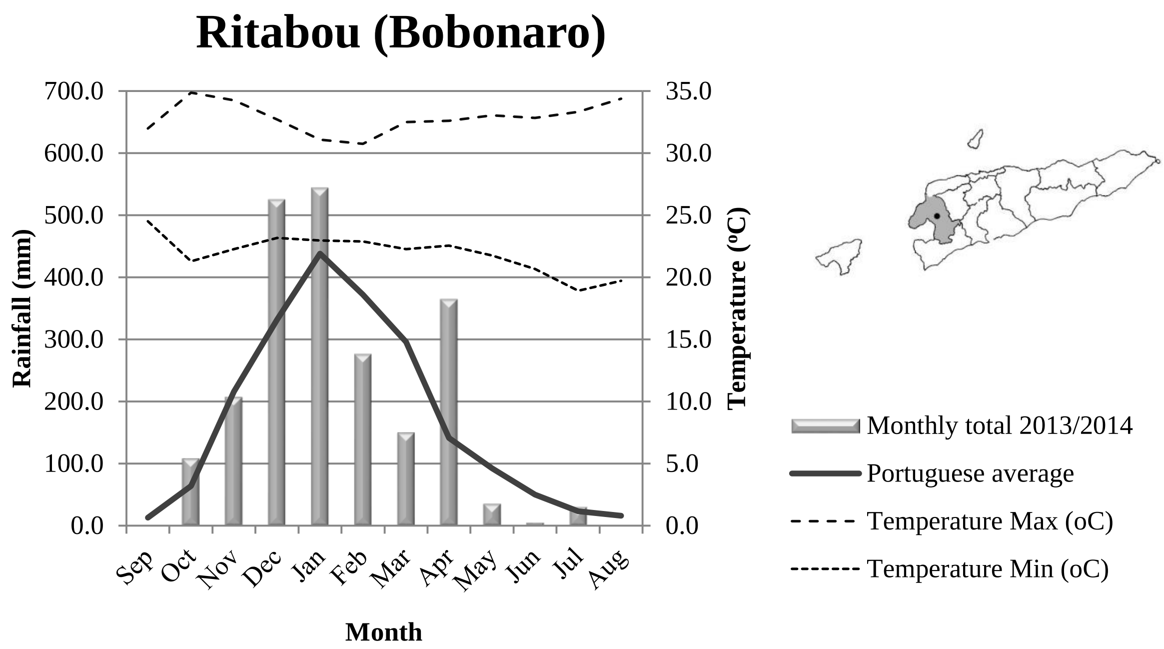


Figure 4. Monthly rainfall (mm) and temperature (ºC) at Ritabou, Bobonaro, 2013-2014.

In the mountains of Aileu there was a slower start to the wet season with good rainfalls in December (Figure 5). During January the rainfall was much lower than average. Above average rainfall fell throughout February to April.

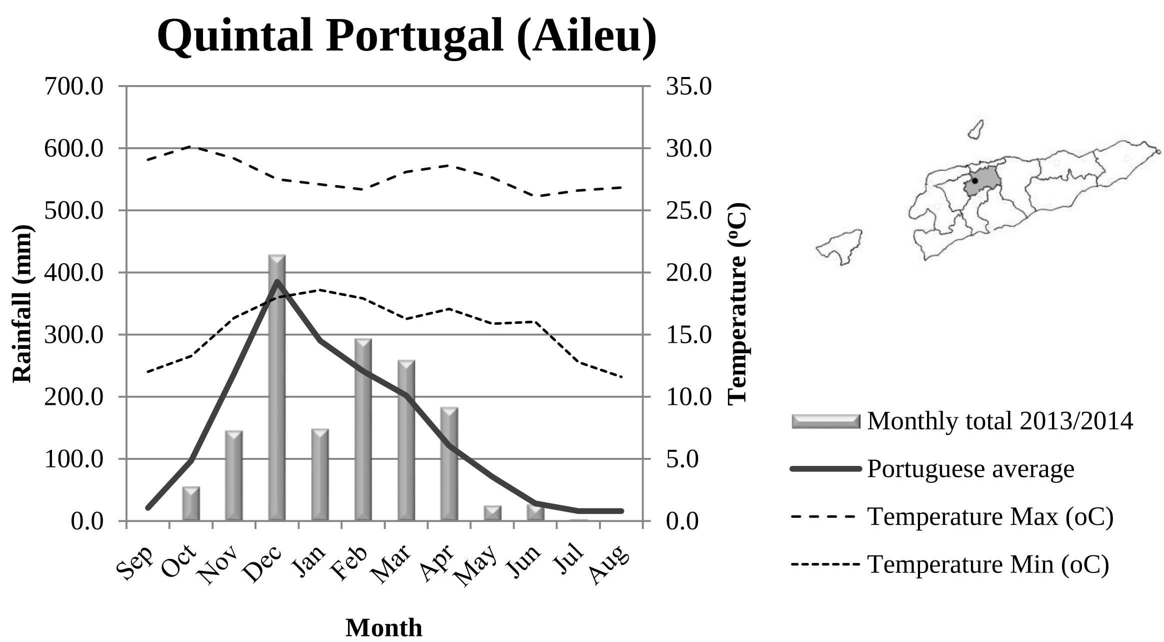


Figure 5. Monthly rainfall (mm) and temperature (ºC), Quintal Portugal, Aileu, 2013-2014.

In Darasula, on the Baucau plateau, there was a very strong start to the wet season (Figure 6). Despite lower than average rainfall in January, the growing season continued to receive adequate rainfall.

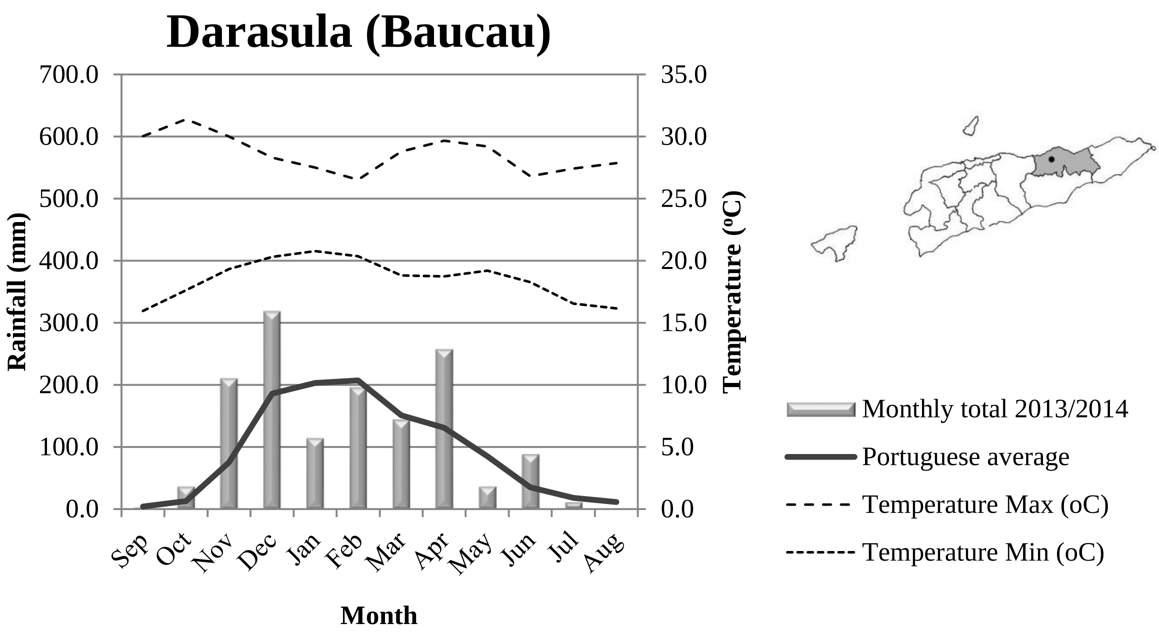


Figure 6. Monthly rainfall (mm) and temperature (^{0}C), Darasula, Baucau, 2013-2014.

At the high altitude sight of Urulefa, there was a strong and early start to the wet season followed by significantly lower rainfall during January and February (Figure 7). Rainfall increased again during March and April. As at Darasula, there was another peak in rainfall during June.

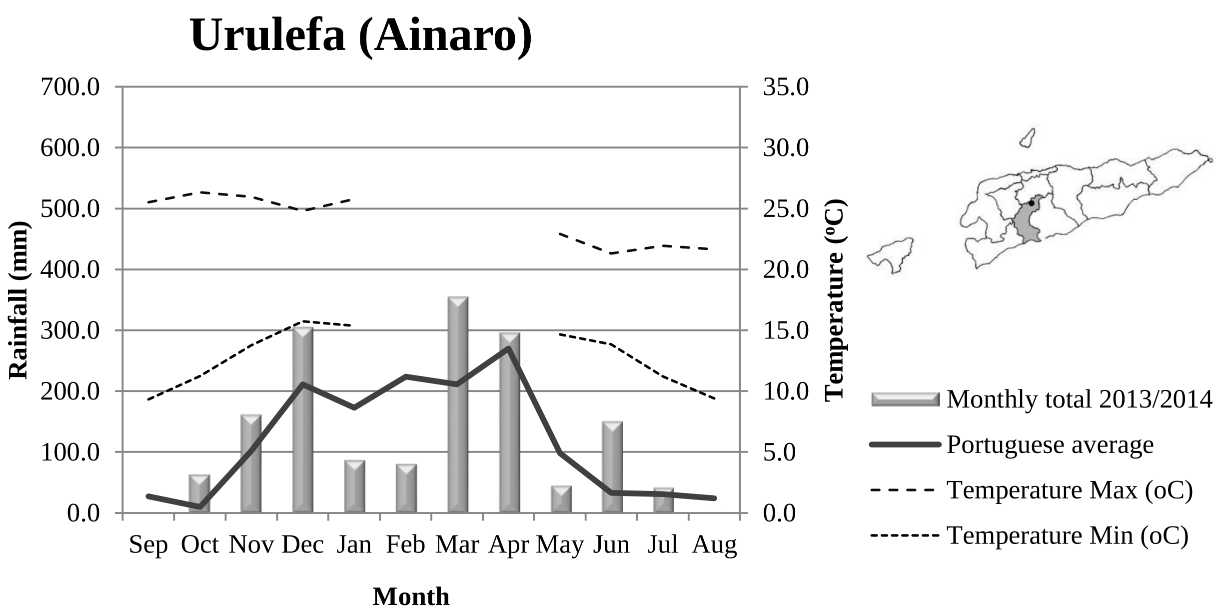


Figure 7. Monthly rainfall (mm) and temperature (ºC) at Urulefa, Ainaro, 2013-2014.

On the eastern Los Palos basin there was a slow start to the wet season with conditions being quite dry (Figure 8). Rainfall increased to above average during March and April making it difficult for maize crops to dry off. There was a strong peak in rainfall for the second phase of the bi-modal wet season with very high rainfall in June. Many farmers will grow two crops of maize on the plateau but the reduced rains in November and December may have led to late planting of the first crop.

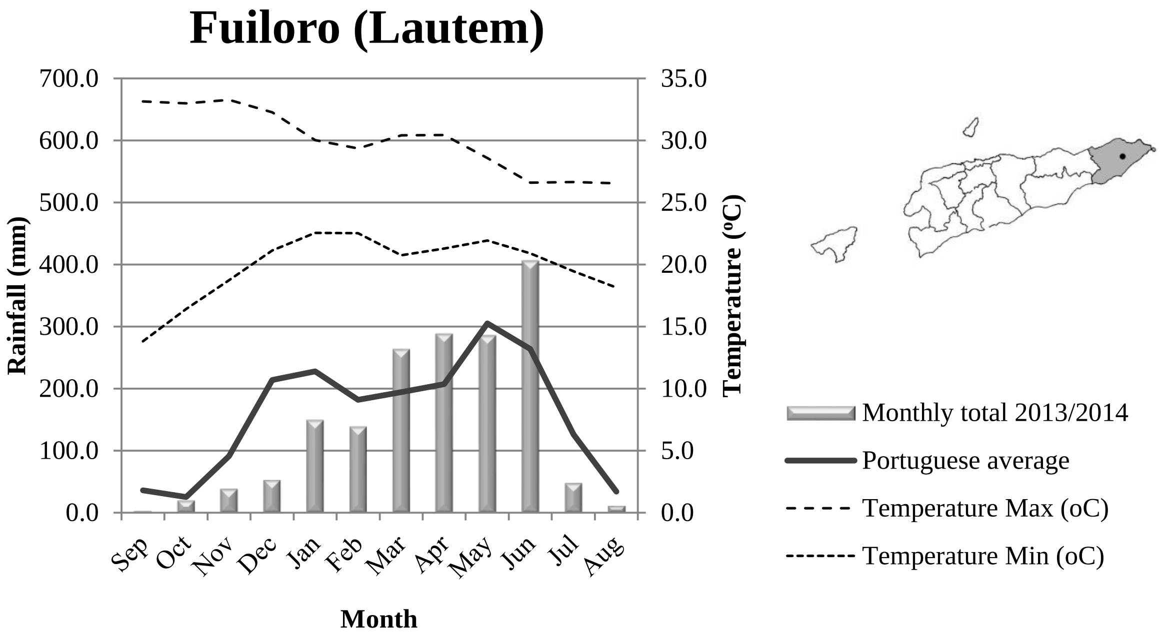


Figure 8. Monthly rainfall (mm) and temperature (ºC) at Fuiloro, Lautem, 2013-2014.

At the research station on the south coast at Betano, farmers experienced an average start to the wet season (Figure 9). Below average rainfall from January to March was followed by good rains during the second phase of the bi-modal wet season. Finally, there was an early finish to the wet season in July.

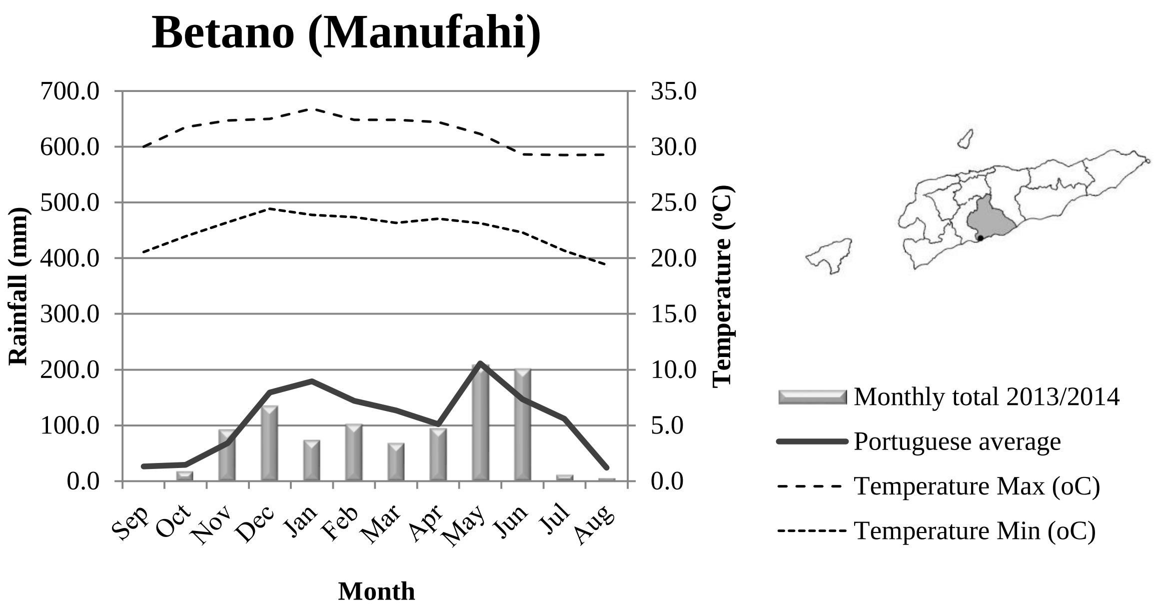


Figure 9. Monthly rainfall (mm) and temperature (ºC) at Betano, Manufahi, 2013-2014.

Further east along the south coast, Bahalara-Uain in Viqueque there was a good start to the wet season (Figure 10). This continued through until March when very low rain was received allowing the first crop to dry. During the second phase the rainfall increased again allowing a second crop to be planted.

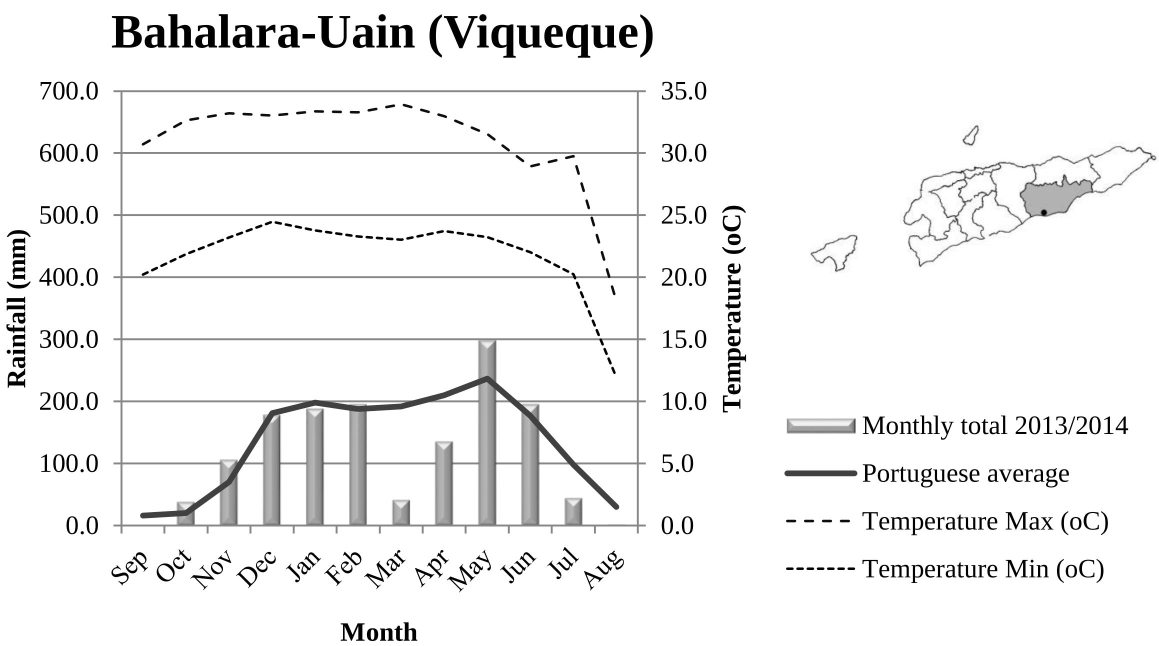


Figure 10. Rainfall (mm) and temperature (ºC) at Bahalara-UIain, Viqueque, 2013-2014.

2. Evaluation of new germplasm

2.1 Maize

2.1.1 Replicated maize trials, 2014

In March 2014, MAF imported 19 maize (*Zea mays* L.) varieties from the International Institute of Tropical Agriculture (IITA) in Nigeria for evaluation under Timor-Leste conditions. These varieties were selected by IITA plant breeders for their suitability to be cultivated under conditions in Timor-Leste and their high pro-vitamin A content. All 19 maize varieties are yellow in colour. They were compared with two yellow maize controls (Sele and SW5) and three local white coloured controls. These were the MAF released Noi Mutin and two locals, L. Fatulurik and L. Kakatua. Trials were conducted at research centers at Betano (Manufahi) and Loes (Liquiça).

Methods and materials

The trials were arranged as a randomized complete block with 3 replicates composed of 25 m^2 (5 m x 5 m). The plots were planted with 1 seed/hill, 25 cm between hills and 75 cm between rows. After 2 weeks, plant numbers were counted and missing hills replanted. The crop was observed for pests and diseases. At harvest, plant density, plant height, cob number/plant and yield were measured. After weighing the fresh cob weight/plot, the cobs were dried in the sun and re-weighed. The cobs were then threshed and seed weight/plot and 100 seed weight measured. The final process was the taste test of higher yielding varieties.

Data collected were entered into an MS Excel spreadsheet database before being transferred for further analysis to GenStat and ANOVA.

Results

Both maize variety trials were planted during the dry season of 2014. Betano recieved a large amount of rain during the growing period thereby extending the harvest period to 166 days. At Loes, the crop was able to grow on residual soil moisture (Table 6).

Table 6. Location and period of dry season maize variety trials, 2014

Location		*Harvest date*	*Maturity (days)*	*Rainfall recorded during trial*	*Yield (t/ha)*
Betano (Same)	03-05-14	16-10-14	166	445	1.83
Loes (Maubara)	30-04-14	09-09-14	131	0	2.35

Maize yield components of the trial at Loes is presented in Table 7. Yield differences between varieties were noticeable in this trial, possibly due to larger seed size, although it may also have been related to different plant density in the plots. Plant density was included in the analysis or covariance.

Table 7. Maize yield components, dry season, Loes, 2014

Variety	*Plant density (m^2)*	*Cobs/plant*	*Cob weight (g)*	*Seeds/cob*	*100 seed weight (g)*	*Prod. (t/ha)*	*Covariate (t/ha)*
AFLATOXIN SYN-Y2	3.4	1.1	92.1	306	30	3.6	3.4
PVA SYN-6 F2	4.1	1.0	90.3	310	29	3.6	3.1
PVA SYN11	3.5	1.2	81.3	280	29	3.3	3.1
PVA SYN 19	4.7	1.0	72.0	248	29	3.3	2.9
PVA SYN-2 F2	3.6	1.1	78.6	251	31	3.0	2.8
Acr.91.Suwan 1-SR C1	2.9	1.2	85.0	267	32	2.9	2.8
PVASYN4 F2	3.1	1.1	83.0	270	31	2.8	2.7
PVA SYN 18	4.3	1.0	67.5	256	27	2.8	2.6
AFLATOXIN R Syn 2-Y	3.7	1.0	74.9	267	28	2.7	2.6
PVA SYN-7 F2	3.7	1.0	69.3	228	30	2.7	2.6
L.Fatulurik	*2.5*	*1.2*	*91.5*	*301*	*30*	*2.7*	*2.5*
PVA SYN 17	3.4	1.2	64.8	223	29	2.6	2.4
SW5	2.6	1.2	80.0	286	28	2.5	2.4
PVA SYN 21	3.4	1.1	64.7	231	28	2.5	2.3
PVA SYN 22	3.6	1.2	61.3	221	28	2.5	2.3
Sele	2.2	1.3	89.7	310	29	2.4	2.2
PVA SYN 20	2.7	1.3	58.9	198	30	1.9	2.1
L.Kakatua	*2.2*	*1.3*	*63.3*	*208*	*31*	*1.9*	*1.9*
PVA SYN-10 F2	2.4	1.1	54.7	176	31	1.5	1.9
PVA SYN-9 F2	1.7	1.2	70.1	239	29	1.5	1.8
PVA SYN-3 F2	1.5	1.3	66.5	222	30	1.3	1.6
PVASYN1 F2	1.1	1.3	70.3	234	30	1.0	1.6
PVA SYN13	0.8	1.6	63.5	213	30	0.9	1.6
Noi Mutin	0.9	1.3	72.0	229	31	0.8	1.5
F.prob	*<.001*	*0.209*	*0.05*	*0.07*	*<.001*	*<.001*	*0.029*
LSD (P<0.05)	*0.93*	*ns*	*ns*	*ns*	*1.8*	*1.0*	*1.1*
% CV	*20*	*17.8*	*19.5*	*20*	*3.8*	*25.7*	*24.6*

Farmers were invited to a field day at Loes to evaluate the taste preferences of all varieties. Thirty two farmers attended. The results of whether the farmers considered the varieties easy to pound or were tasty or not are presented in Table 8. The varieties considered to be the tastiest were AFLATOXIN SYN-Y2, Noi Mutin, PVA SYN-6 F2 and PVA SYN11 and most of the group would chose these varieties to grow. Choice and taste were highly correlated ($R^2 = 0.85$). There were no gender differences for choice.

At Betano there were significant differences in yield but not for yield components (Table 9).

Table 8. Taste test, Loes Research Station

Variety	Soft to pound (%)	Hard to pound (%)	Tasty (%)	Persons choice (%)	Gender Women chose (%)	Gender Men Chose (%)
AFLATOXIN SYN-Y2	16	84	84	59	67	58
Noi Mutin	44	48	53	38	67	31
PVA SYN11	47	44	44	28	50	23
PVA SYN-6 F2	78	6	63	22	0	27
PVA SYN 19	75	13	32	9	17	8
Acr.91.Suwan 1-SR C1	13	72	22	9	0	12
PVA SYN 18	13	75	34	6	0	8
PVA SYN-7 F2	53	32	22	6	0	8
L.Fatulurik	*59*	*16*	*28*	*6*	*0*	*8*
PVA SYN 17	55	25	28	6	0	8
Sele	69	16	19	6	0	8
AFLATOXIN R Syn 2-Y	19	66	13	3	0	4
PVA SYN-2 F2	31	45	10	0	0	0
L.Kakatua	*19*	*66*	*6*	*0*	*0*	*0*
F.prob	*<.001*	*<.001*	*<.001*	*<.001*	*0.225*	
LSD (P<0.05)	*0.22*	*0.21*	*0.21*	*0.15*	*ns*	
% CV	*105.6*	*100.2*	*130.4*	*220.2*	*219.5*	

Table 9. Maize yield components, dry season, Betano, 2014

Variety	Plant density ($/m^2$)	Cobs/plant	Grains/cob	Seeds/cob	100 seed weight (g)	Yield (t/ha)
Noi Mutin	2.87	0.87	95.2	304	31	2.71
PVA SYN-10 F2	3.62	0.87	89.8	297	30	2.63
PVA SYN-6 F2	4.24	0.72	93.3	326	29	2.48
PVA SYN 20	4.29	0.81	75.5	291	26	2.36
PVA SYN13	2.42	0.86	73.4	248	30	2.06
PVA SYN-9 F2	3.56	0.70	82.0	284	29	2.05
Acr.91.Suwan 1-SR C1	3.18	0.86	73.9	267	28	2.05
SW5	3.02	0.82	71.5	241	29	1.97
PVA SYN 17	3.98	0.74	78.0	282	27	1.97
PVASYN4 F2	3.49	0.79	76.3	245	30	1.93
L.Fatulurik	*3.44*	*0.79*	*70.6*	*249*	*28*	*1.90*
L.Kakatua	*2.91*	*0.88*	*74.5*	*226*	*32*	*1.83*
PVA SYN-3 F2	2.71	0.78	65.1	245	27	1.77
AFLATOXIN SYN-Y2	4.42	0.69	69.7	284	25	1.66
PVA SYN-7 F2	4.00	0.81	57.5	203	28	1.63
PVA SYN 18	3.24	0.77	63.7	234	27	1.62
PVA SYN 22	4.24	0.71	61.7	233	26	1.58
PVA SYN 21	2.98	0.79	68.6	260	26	1.56
Sele	3.31	0.71	64.0	217	29	1.54
AFLATOXIN R Syn 2-Y	3.69	0.68	64.7	214	30	1.52
PVASYN1 F2	2.00	0.72	64.5	214	30	1.47
PVA SYN 19	3.36	0.82	61.1	215	29	1.44
PVA SYN-2 F2	3.93	0.67	52.3	193	27	1.20
PVA SYN11	3.58	0.58	46.1	172	27	1.13
F prob	*0.38*	*0.41*	*0.28*	*0.25*	*0.12*	*<.001*
LSD (P<0.05)	*ns*	*ns*	*ns*	*ns*	*ns*	*1.09*
% CV	*29.6*	*16.8*	*26.5*	*23.9*	*9.2*	*35.8*

As with Loes, farmers were invited to Betano to evaluate the new varieties. The varieties were pounded, cooked and eaten. The results at Betano were quite different to those at Loes, there being a significant difference between the preferences of women and men (Table 10). Most of the 52 farmers at the field day selected their preferred variety on the taste test rather than yield or pounding characteristics ($R^2 = 0.62$). People chose more than one variety with about 40% making PVA SYN 17 their first choice followed by PVA SYN-10-10F2 at 33%.

Table 10. Taste test conducted at Betano Research Station, 2014.

Variety	*Soft to pound (%)*	*Hard to pound (%)*	*Tasty (%)*	*People's choice (%)*	*Gender* Women chose (%)	*Gender* Men chose (%)
PVA SYN 17	87	14	54	40	8	38
PVA SYN-10 F2	15	83	44	33	13	41
Noi Mutin	75	23	67	31	20	35
SW5	83	17	35	29	53	19
PVA SYN 20	60	40	35	27	27	27
PVASYN4 F2	44	58	42	21	33	16
PVA SYN-6 F2	8	92	23	10	7	11
PVA SYN13	27	73	35	6	0	47
PVA SYN-9 F2	85	15	19	4	0	5
Acr.91.Suwan 1-SR C1	12	89	21	0	0	0
F pr.	*<.001*	*<.001*	*<.001*	*<.001*	0.021	
LSD (P<0.05)	*15.39*	*15.39*	*17.99*	*14.67*	226	
% CV	*80.8*	*79.3*	*124.5*	*190.3*	188.5	

This trial will be repeated in the wet season of 2014-2015.

2.1.2 Maize On-Farm Demonstration Trials (OFDTs) 2013-2014

No maize OFDTs were installed in 2013-2014.

2.2 Sweet potato

2.2.1 Sweet potato replicated trials, 2013-2014

Sweet potato *(Ipomoea batatas* (L.) Lamb *)* is cultivated in most places of Timor Leste and is generally consumed at breakfast or snack in the afternoon. Young leaves of the plant are also often eaten as a vegetable. The trials presented here examine a set of varieties initially imported from the International Potato Centre (CIP) office in Indonesia and compared with local varieties. The trials conducted at Betano (Manufahi), Loes (Liquiça), Darasula (Baucau), Quintal Portugal (Aileu) and Urulefa (Maubisse) were neither fertilized nor irrigated. The trials were planted between December, 2013 and January 2014 and harvested between May and August 2014. One dry season trial was planted in May and harvested in October 2014 (Betano).

Methods and materials

Each trial consisted of a randomized complete block design with 15 variety treatments and three replicates. The plot size was 5 m x 5 m (at Urulefa station it was 3 m x 3 m because of a lack of cuttings), and the planting distance was 1 m x 0.50 m (50 plants/plot and at Urulefa station 18 plants/plot). Data collected were entered into an excel spreat sheet then analyzed with Genstat 16th edition.

Field days were held at Betano (41 participants in the wet season, 14% of whom were women and 41 participants in the dry season, 17% of whom were women), Loes (41 participants in the wet season, 31% of whom were women) and at Urulefa 16 participants in the wet season, 1% of whom were women) allowing farmers to assess the varieties first hand. Tubers were boiled provided with a code name, and farmers were requested to fill in questionaire relating to tuber taste and texture (tasty, dry, crumbly, and soapy) characteristics.

Results

Sweet potato yields and yield advantages

Yields from test varieties and local checks are presented in Table 11. At all locations apart from Urulefa, varietal differences were significant. The new varieties, CIP 78, CIP 77 and CIP 83 were the highest yielding varieties.

Table 11. Sweet potato yields, 2014

	Yields (t/ha)								
Variety	*Betano*	*Betano**	*Loes*	*Darasula*	*Urulefa*	*Aileu*	*st. dev*	*Mean yield (t/ha)*	*Yield adv. (%)*
CIP78	20.0	21.6	24.8	0.91	5.5	5.1	9.39	12.98	358
CIP77	16.8	12.3	15.5	1.24	6.1	4.9	5.74	9.45	234
CIP83	13.8	13.3	15.3	0.97	6.8	3.0	5.58	8.86	213
L. Urulefa					8.8		0.00	8.77	
L. Baucau	8.5	16.1	5.87	0.66	7.4		4.99	7.70	172
Hohrae1	3.2	8.3	5.13	1.58	9.0	16.3	4.81	7.25	156
Hohrae3	7.8	5.9	13.0	1.19	5.4	4.7	3.56	6.33	123
CIP71	7.2	2.3	16.0	0.77	4.9	6.6	4.89	6.30	122
L. Mutin	14.1	4.7	3.63	1.18	4.8		4.40	5.67	100
CIP72	5.9	0	12.6	1.05	5.6	7.2	4.16	5.41	91
Hohrae2	2.1	6.5	12.5	0.77	7.5	2.2	4.07	5.27	86
CIP73	7.5	9.9	2.56	0.87	2.9	5.1	3.10	4.81	70
CIP68	5.3	6.7	0.80			1.8	2.41	3.64	28
L. Foun						3.4	0.00	3.36	
CIP70	2.4	0.3	5.73	1.15	2.5	4.8	1.91	2.81	-1
CIP76	2	0.5	3.67	1.29	3.2	3.3	1.15	2.33	-18
CIP65	0	3.7	0.57	0.97	4.1	2.6	1.56	1.99	-30
L. Atabae				1.16		1.2	0.04	1.20	-58
F.prob	*<.001*	*0.082*	*<.001*	*<.001*	*0.531*	*0.029*			
LSD (P<0.05)	*3.83*	*0.37*	*7.21*	*8.90*	*ns*	*6.90*			
% CV	*30*	*14*	*58*	*59*	*43*	*86*			
Mean site	*8.32*	*7.75*	*9.79*	*1.05*	*5.64*	*5.25*	*3.76*	*6.31*	
Mean locals	*2.20*	*0.40*	*4.70*	*1.22*	*3.27*	*1.24*	*1.02*	*2.83*	

* Dry season

Tuber weight and the number of tubers per plant tended to be the main determinant of tuber yields at Loes, Urulefa, Aileu, Darasula and Betano (Figure 11). At four sites (Aileu, Loes, Urulefa and Betano wet season) yield was correlated to plant density indicating plant density varied across the sites and at three sites Aileu, Betano and Loes, yield was correlated to the number of tubers per plant.

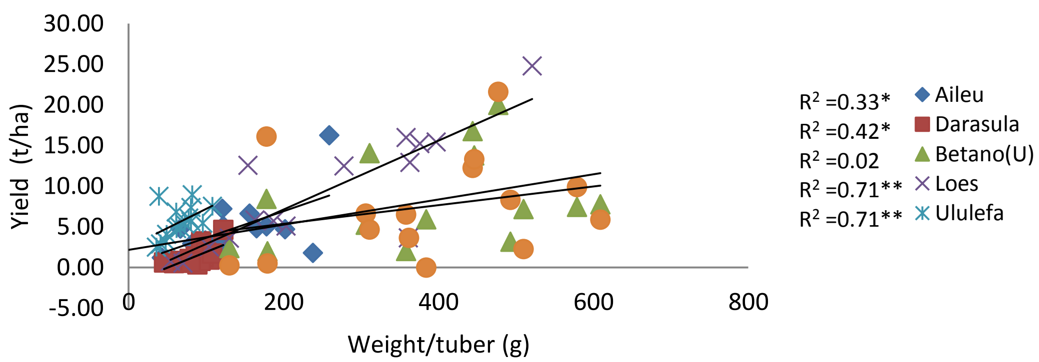


Figure 11. Correlation between yield and tuber weight, 2014

Farmers' preferences for varieties

Field days held to evaluate farmer's preference revealed that farmers tended to chose varieties based on taste rather than on yield or potential yield. At all sites, they judged the cooked tuber on whether it was tasty, dry, crumbly or soapy. They then made a choice based on those criteria. At Betano, farmers preferred CIP 73 and CIP 83 which were considered to be tasty but dry and reasonably crumbly (Table 12). In the dry season at the same station, the farmers preferred the taste of two locals indicating that cooking methods may be affecting their choices. Similar taste tests at Loes research centre and Darasula (Baucau) indicated that farmers preferences were for CIP 71 and Hohrae 2 in Loes and Hohrae 1 and a local from Baucau in Darasula. No single variety was selected to be of preference over others on all four occasions.

Table 12. Farmers' preferences and sweet potato yields at Betano (wet season)

Variety	*No. of tests (stations)*	*No. of respondents*	*Tasty (%)*	*Not tasty (%)*	*Dry (%)*	*Crumbly (%)*	*Soapy (%)*	*Farmers' choices (%)*	*Average Yield (t/ha)*
CIP68	5	3	42	59	7	17	93	7	6.67
CIP73	5	22	88	10	83	63	7	68	9.93
CIP77	5	7	51	49	32	29	61	17	12.3
CIP78	5	9	51	49	39	44	59	22	21.6
CIP83	5	26	88	10	78	66	10	63	13.3
Hohrae1	5	10	56	42	34	34	59	24	8.33
Hohrae2	5	11	61	39	73	54	17	27	6.53
Hohrae3	5	3	27	73	7	24	85	7	5.92
L.Bcu	*5*	*10*	*37*	*61*	*51*	*29*	*54*	*24*	*16.1*
L.Mut	*5*	*16*	*49*	*51*	*27*	*37*	*66*	*39*	*4.67*
F pr.			*<.001*	*<.001*	*<.001*	*<.001*	*<.001*	*<.001*	
LSD (P< 0.05)			*0.37*	*0.370*	*0.350*	*0.372*	*0.342*	*0.339*	
% CV			*83.3*	*102.7*	*99.5*	*114.7*	*82.3*	*138.4*	

2.2.2 Sweet potato multi-year, multi-location trial analysis

Thirty three successful sweet potato variety trials were implemented by SoL over the period from 2005 to 2013 at different sites (Aileu, Betano, Baucau, Loes, and Maubisse) in both the dry and wet seasons. The data of 28 varieties (including eight local varieties as controls) were included in a yield comparison. Some varieties were not included in all trials and some trials were not conducted at every site every year.

Results and discussion

The average yield of the entire dataset (40 environments, 512 data points) was 7.6 t/ha (st.dev = 6.8). Yield averages from trial to trial varied from a minimum 4.1 t/ha to a maximum of 11.3 t/ha. Wet season yields at Betano research station reached 12 t/ha during three years of trials.

As shown in Table 11, the local variety from Urulefa gave a high yield but it was only planted at Urulefa research station. The released varieties Hohrae (1, 2 and 3) consistently showed mean yields above 12 t/ha during some years. Varieties CIP71 and CIP78 was also obtained consistently good yields and performed particularly well in Betano and Loes in 2013 - 2014.

When 19 varieties from 12 environments for the trials harvested in both 2013 and 2014 are graphed using a biplot analysis (Figure 12), showed that CIP71, CIP78 and CIP 83, Hohrae

2 and the Local from Baucau were well adapted for cultivation in the lowland and upland (Betano, Loes, Baucau Maubisse and Aileu) ecosystems. Hohrae 1 performed particularly well in high land areas (Aileu).

CIP 83 is a yellow colour which as shown in Williams *et al* (2013) indicates an enrichment in vitamin A and the local selected from Baucau (L. Baucau) possessed a deep purple colour which is thought to possess anti-oxidant qualities. These two varieties plus 71 and CIP 78 may be included in OFDTs in 2014-2015.

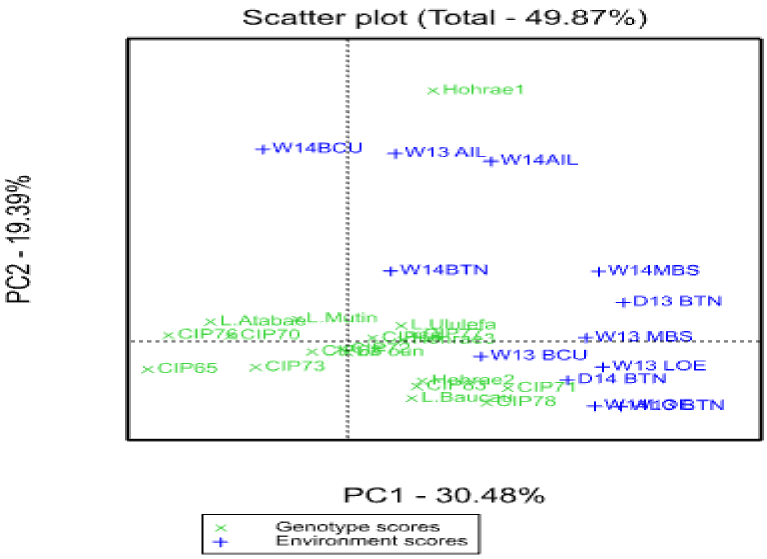


Figure 12. Biplot analysis, 15 sweet potato varieties and 12 environments 2013-14

2.2.3 Sweet potato OFDTs 2013-2014

Introduction

In 2013-2014, two improved varieties shown to have good performance in replicated trials conducted over the past three years were compared with the released Hohrae 3, a purple coloured variety popular in Baucau and a local variety on farmers fields. Each farmer had his own local variety.

Methods and materials

The varieties under evaluation were the released Hohrae 3, CIP 83 and CIP 72 (all from CIP sources in Indonesia) and a local purple coloured variety popular in the District of Baucau. These were compared with the farmer's local variety.

The latitude, longitude, and elevation were recorded at all sites using a 12 channel GPS receiver (Garmin ETrex) to an accuracy of ± 4 m. In addition, the slope of the land was defined at each site as was the orientation of the test location. Based on elevation and location, each site was allocated to a particular Agro-Ecological Zone (AEZ) (ARPAPET 1996). AEZs are numbered from 1 to 6, starting with 1 in the lowlands of the north coast to 6 in for the lowlands of the south coast.

Table 13. Agro-ecosystems of Timor-Leste

AEZ	*Area*	*Elevation*
1	Northern coast	0-100 m
2	Northern slopes	100-500 m
3	Northern uplands	>500 m
4	Southern uplands	>500 m
5	Southern slopes	>500 m
6	Southern coast	0-100m

All sites were tested for soil pH using the commercially available "Manutec" test kits. The test kits are designed for in-field use. Composite samples of soil were collected from each plot and sieved through a 2 mm sieve to remove stones, large clods etc. A small amount of soil was placed on a white slide and indicator fluid added. After thorough mixing, a white powder was added to the surface of the soil/indicator mixture. The white powder assumed the colour of the indicator, and pH value identified by comparing that colour with a standard colour sheet.

Soil texture was estimated using a field based ribbon test method. Prior to testing, a handful of surface soil was sieved and water added to make a malleable bolus. This wet soil was formed into a round ball, and then attempts made to form a ribbon with the wet soil. The length of the ribbon (in cm) was measured and compared to a reference table which staff carried with them in the field, and the ability to form a U shape and a donut shape with the ribbon was used as a further indicator to describe soil texture.

Data from protocols were first entered into MS Excel spreadsheet and then analyzed using Genstat Discovery 16 ed. In addition to the main yield analysis, the total number of roots per plant, root weight, and plant density were examined.

Sweet potato on-farm trials were installed on 74 farmer fields in 15 sub-districts within 7 districts during 2013-2014 under a range of environmental conditions. The Districts were Aileu (Aileu Villa, Laulara, Lequidoe and Remexio), Ainaro (Maubisse), Baucau (Baucau Villa, Vemasse and Venilale), Bobonaro (Balibo and Maliana), Liquiça (Liquiça Villa), Manufahi (Alas and Same) and Viqueque (Ossu and Viqueque Villa).

Elevation

Sweet potato OFDTs were conducted at elevations ranging from sea level to over 1200 masl (Table 14).

Table 14. Distribution of sweet potato OFDT sites by elevation, 2013-2014

Elevation (masl)	*Number of sites*	*Locations (%)*
0 - 100	16	22
100 - 200	12	16
200 - 300	2	3
300 - 400	3	4
400 -500	2	3
500 - 600	10	14
600 -700	1	1
700 - 800	4	5
800 - 900	7	9
900 - 1000	5	7
1000 - 1100	7	9
1100 - 1200	2	3
1200 - 1300	3	4
Total	*74*	*100*

Results

The released Hohrae 3 variety proved to be the highest yielding variety across all 79 sites (Table 15). CIP 83, CIP 72 and the purple Baucau variety also signifcantly outyielded the local variety selected by individual farmers. Although the plant density was higher for the local, yields were more related to the number of roots per plant and root weight.

Table 15. Sweet potato yields and yield components, OFDTs 2013-2014

Variety	*Yield (t/ha)*	*Plant density ($/m^2$)*	*Roots /plant*	*Root weight (g)*
CIP 72	6.7	1.7	3.0	156.1
CIP 83	10.4	1.8	3.1	196.8
Hohrae 3	12.0	1.8	3.2	217.3
L.BCU	8.6	1.8	3.5	160.9
Local	*5.1*	*2.0*	*2.4*	*134.8*
F. prob	*<.001*	*0.006*	*0.009*	*0.001*
LSD(P<0.05)	*2.58*	*0.15*	*0.60*	*43.44*
% CV	*92.9*	*25.5*	*61.4*	*77.63*

Factors affecting sweet potato OFDT yields.

Significant yield differences were noticeable between varieties (Table 16). In addition, yields were affected by the District and Sub-District they were located in, the AEZ, slope of land and soil texture on which the trial was conducted. However, there were no significant interactions between the variety and these factors. Some interactions are examined in more detail below.

Table 16. Factors affecting sweet potato OFDT yields, 2013-2014

Factor	*F prob. 2013-2014*	*Significant*
Variety	<.001	✓
District	<.001	✓
Variety-District	<.001	ns
Sub-District	<.001	✓
Variety-Sub-District	<.001	ns
AEZ	<.001	✓
Variety-AEZ	<.001	ns
Slope of land	0.003	✓
Variety-Slope of land	0.772	ns
Soil colour	0.239	ns
Variety-Soil colour	0.996	ns
Soil texture	<.001	✓
Variety-Soil texture	0.56	ns
Topography	0.004	✓
Variety-Topography	0.225	ns
pH	<.001	✓
Variety-pH	0.933	ns

Agro-ecological zone

Although there was no interaction between variety and agro-ecological zone on yield, most varieties tended to yield lower in AEZ 4, possibly due to its high elevation and lower temperatures inhibiting plant growth (Figure 13). Two varieties (CIP 83 and CIP 72) produced high yields in AEZ 6.

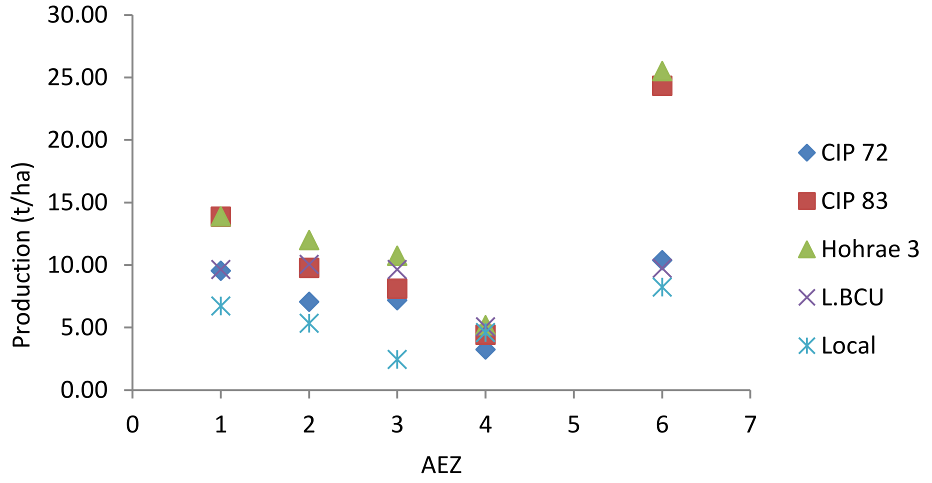


Figure 13. The impact of Agro-ecological Zone on sweet potato yield, OFDTs 2013-2014

Variety, land slope and soil texture

There was no interaction between variety and land slope and the overall relationship between yield and slope, although significant, was highly variable. This small correlation between root yield and soil slope may have been more to do with soil texture on the slopes than the slope itself. Sweet potato yields tended to be higher in the heavier soils than the loams and silty loams (Table 17)

Table 17. The impact of soil texture on sweet potato yield, OFDT 2013-2014.

Soil texture	*Yield (t/ha)*
Loam	5.41
Fine clay	7.84
Clay loam	8.12
Sandy loam	9.74
Silty loam	10.56
Heavy clay	16.24
F.prob	*<.001*
LSD(P<0.05)	*3.24*
%CV	*91.06*

Although the interaction between variety and soil pH was non-signifcant, most varieties tended to yield best in the 6.5-7.5 pH range (Table 18).

Table 18. The impact of soil pH on sweet potato yield, OFDTs 2013-2014

	pH							
Variety	*5.0*	*5.5*	*6.0*	*6.5*	*7.0*	*7.5*	*8.0*	*8.5*
CIP 72	6.43	9.72	5.31	4.67	7.80	9.45	6.37	3.44
CIP 83	7.73	8.96	8.57	7.28	8.35	16.38	15.00	4.94
Hohrae 3	11.77	15.62	10.21	7.61	13.01	17.15	14.10	4.13
L.BCU	12.14	12.10	7.78	5.27	8.94	11.11	10.21	4.67
Local	*1.38*	*3.19*	*2.98*	*4.18*	*5.36*	*8.55*	*5.98*	*4.92*
F.Prob					*0.978*			
LSD (P<0.05)					*ns*			
% CV					*90.8*			

Farmers opinions

All farmers who planted new sweet potato cuttings for evaluation were interviewed for their opinions of the varieties. All wanted to continue growing Hohrae 3 and CIP 83 along with some local varieties. Farmers in Vemasse, Maubisse, Baucau and Viqueque Sub-Districts liked the fact that the new varieties had good growth, large tubers, nice colour and were crumbly and sweet.

One farmer, from Sub-District Baucau Villa, Mrs. Brigida Ximenes Guterres, stated that she wants to continue planting variety Hohrae 3 and CIP 83 because they had large roots which she was able to sell at $1 per kg.

In the Sub District of Viqueque two farmers declared that they like to plant variety Hohrae 3 and CIP 83 even though these varieties were not resistant to insect pests when the roots were harvested late. Farmers who received cuttings in the Sub-District of Aileu Villa said that they liked to plant the Baucau red variety because it has a nice colour and high yields.

Researcher's opinions

The researchers considered that the release of CIP 83 and local Baucau (purple) requires another year of on-farm trials, CIP 83 and Hohrae 3 should be planted at an elevation of less than 1000 meters and the purple Baucau variety can be planted at elevations above 500 meters.

2.3 Cassava

Cassava (*Manihot esculenta* Crantz) is grown as a staple food crop in most areas of Timor-Leste. It is eaten in a variety of ways with fresh roots either boiled or fried, dried roots soaked and then boiled, or leaves boiled and eaten as a vegetable. Most rural households maintain a small crop of cassava throughout the year to be harvested as needed for reserve or supplemental food. It is often intercropped or planted in marginal areas, though large monoculture crops are found in some Districts. Cassava is typically harvested by farmers after approximately one year of growth.

2.3.1 Replicated cassava trials 2013

Replicated trials for the 2012-2013 season are presented in this report as the 2014 trials were harvested too late for inclusion. Trials were conducted at the MAF research centres and stations in Betano, Darasula, Loes, and Aileu. The trials included a similar set of clones as in previous years, allowing for a multiyear analysis.

Methods and materials

Each trial utilized a randomized complete block design with three replicates. They were planted in November/December and harvested 10 to 12 months later. The timing of the 2013 harvest trials are presented in Table 19.

Table 19. Cassava planting and harvest details, 2012-2013.

Location	*Number of entries*	*Planting date*	*Harvest date*	*Mean yield (t/ha)*
Darasula	15	18/12/2012	03/10/2013	10.2
Loes	15	18/12/2012	18/11/2013	64.3
Betano	15	29/12/2012	~Dec 2013	54.4
Aileu	15	29/11/2012	13/11/2013	15.9

Twelve to fifteen of the most promising clones were selected from the original imported 25 selections. As in previous years, five of the best performing local varieties (Mantega, Merah, Etu Hare, Local Manatuto and Local Liquiça) were included for comparison.

Plots at all sites were 5 m x 5 m with a walkway between each plot. Plant spacing was 1 m x 1 m resulting in 25 plants per plot. Yields were determined from 20 plants per plot with the remaining 5 plants used for field day observations and fresh stem production. At harvest, data were collected immediately on the fresh weight of tubers and their starch content. At some sites, HCN was also measured on a sample from each plot in the laboratory.

At most sites, field days were conducted in which farmers could inspect the remaining 5 plants and harvested tubers. Taste tests were also included in the field days during which both cooked and uncooked tubers could be sampled. In both instances, farmers were asked to choose which varieties they would be interested in planting on their own farms.

Data collected from the trials were entered into an Excel spreadsheet and then analysed with GenStat Discovery Edition 15 and GenStat 16 via one way ANOVA in randomized blocks. For the multi-year analysis, a REML Linear Mixed Model in GenStat 15 was used. A principal component analysis (PCA) was used to describe the variation of yields across locations and years. PCA is one way to summarize variation in a large matrix of data (ie. variety by experiment) into a smaller number of components. When the data are summarised into 2 components (PC1 and PC2) they can be displayed as an xy graph. However some of the variation is lost from the full matrix to just 2 components. The amount of variation retained from the full matrix in the 2 components depends on the data set. The principal component analysis was conducted using the GGE Biplot routine in Genstat 15.

Results

Cassava root yield comparison, 2013

Root yields of the trials conducted at Betano, Aileu, Loes and Baucau during 2013 are summarized in Table 20. As in the past, Ai-Luka 2 performed very well. The yield of the other released varieties Ai-Luka 1 (Ca 109 or Ku 50) also performed well and more than Ai-Luka 4.

Table 20. Cassava root yields at four sites, 2013

Code	*Variety name*	*Betano*	*Aileu*	*Loes*	*Baucau*	*Mean (of 4 sites)*
		Root yield (t/ha)				
Ca 015	Ai-Luka 2	54.4	19.6	57.5	1.4	33.2
Ca 107	Rayong 72	19.4	19.2	62.4	7.6	27.2
Ca 102	Rayong 1	40.1	14.9	43.7	8.3	26.8
Ca 013	CMM 96-25-25	15.9	14.9	64.3	7.2	25.6
Ca 109	KU 50	20.5	15.9	63.7	1.8	25.5
Ca 036	CMM 97-02-36	22.5	19.8	47.1	2.9	23.1
Ca 042	CMM 97-02-181	21.1	19.2	44.1	2.9	21.8
Ca 108	Rayong 90	21.2	16.0	44.7	3.2	21.3
Ca 026	Ai-Luka 4	21.2	19.5	33.7	5.4	20.0
Ca 101	Hanatee	18.5	14.7	38	6.4	19.4
Ca 106	Rayong 60	19.0	13.5	35.3	5.3	18.3
Ca 016	Mantega-Aileu	14.7	12.2	25.9	10.2	15.8
Ca 060	Local Etu Hare	17.5	10.8	29.2	3	15.1
Ca 62	Local Liquiça			55.5		na
Ca 007	CMM 96-36-224	23.3				na
Ca 103	Rayong 2				4.8	na
F pr.		<.001	<.001	<.001	0.03	
LSD(P<0.05)		6.84	4.3	16.3	4.9	
% CV		18.1	16.2	21.1	59.4	

Starch production, 2013

There was considerable variation for starch production between varieties when tested at the four locations over one year (

Table **21**). Ca 107 (Rayong 72) performed the best when compared with the mean of the local varieties. The released Ca109 (Ai-Luka 1) and Ai-Luka 2 performed poorly due to an extremely low result in Darasula (Baucau).

Table 21. Cassava multi-site starch yield advantages (%), 2013

Variety	*Aileu*	*Darasula*	*Betano*	*Loes*	*Mean*
Ca 107	38.2	71.1	17.2	3.1	32.4
Ca 036	35.0	49.8	0.3	-1.5	20.9
Local Mantega	*16.9*	*61.9*	*0.3*	*-2.1*	*19.2*
Ca 102	30.8	40.1	-11.0	10.7	17.7
Ca 042	33.7	48.8	-11.0	-6.5	16.3
Ca 106	16.9	40.6	5.4	-5.4	14.4
Ca 103	31.3	24.2		-12.8	14.2
Ai-Luka 4	24.5	27.4	-6.6	-1.8	10.9
Local Liquiça				*8.1*	*8.1*
Ca 101	-3.6	48.0	0.4	-15.9	7.2
Ca 013	2.4	46.7	-10.6	-22.5	4.0
Local Merah	-11.7		14.0		1.1
Ca 108	26.5	-43.8	11.0	3.2	-0.8
Local Etuhare	*-5.1*	*-1.7*	*-14.3*	*-6.0*	*-6.8*
Ai-Luka 1	7.2	-51.3	4.3	5.6	-8.5
Ai-Luka 2	-2.6	-100.0	4.0	10.5	-22.0
Ca 007			-26.6		-26.6
Local Manatuto		*-60.2*			*-60.2*

Farmer field day results, 2013

Field days were held at Loes (Liquiça), Betano (Manufahi) and Darasula (Baucau) to evaluate farmers' personal reactions to each of the tested varieties. They were shown the yield results and roots of the best yielding ten which were also cooked for consumption evaluations. The results of the taste tests at Betano and Darasula are presented in Table 22 and Table 23. Ai-Luka 2 was considered to be the sweetest variety at Betano and most people wished to plant it. Most people at Darasula considered Ai-Luka 4 to be the sweetest. These results indicate the wide personal differences when eating acceptability is concerned.

Table 22. Farmer field day result, taste test, Betano, 2013

Variety	*Like (%)*	*Sweet (%)*	*Crumbly (%)*	*Fiber (%)*	*Soggy (%)*	*Soggy (%)*	*Bitter (%)*	*Wish to plant (%)*
Ai-Luka 2	41	63	33	11	15	7	4	59
Ca 017	44	44	26	7	19	0	0	56
Ca 016	37	44	19	11	19	15	7	44
Ai-Luka 4	41	59	37	4	7	11	4	30
Ca 013	37	48	19	4	30	11	7	30
Ai-Luka 1	11	11	4	11	26	11	37	26
Ca 060	44	33	19	11	19	4	7	19
Ca 108	30	41	22	11	26	4	19	15
Ca 036	19	30	7	7	0	11	19	7
Ca 102	15	7	7	15	26	67	0	4

Farmer field day results at the Darasula Research Centre showed many farmers are selected the local variety Etu Hare due to the good taste. The MAF released variety, Ai-Luka 2 was also selected by many farmers because it showed consistent yield.

Table 23. Farmer field day result, taste test in Darasula research centre, 2013

Variety	*Sweet (%)*	*Like (%)*	*Tasty (%)*	*Dry (%)*	*Bitter (%)*	*Soggy (%)*	*Crumbly (%)*	*Wish to plant (%)*
Ca 060	67	61	78	36	8	6	50	72
Ca 16	53	61	72	58	22	19	25	69
Ca 042	50	39	47	28	42	8	42	33
Ai-Luka 2	67	50	42	39	25	33	22	28
Ai-Luka 4	78	56	53	25	8	19	42	28
Ca 36	36	31	25	36	44	28	14	17
Ca 13	67	53	47	28	19	44	14	11
L Man	*33*	*33*	*39*	*47*	*44*	*8*	*31*	*11*
Ca 12	56	50	28	28	36	56	11	8
Ca 19	11	6	14	36	78	28	19	8

2.3.2 Cassava performance across sites (2010 to 2013)

A multi-year analysis was performed on all trials at the four sites for the years from 2010 to 2013. The results of this analysis are presented in Table 24. Ai Luka 2 and Ai Luka 4 continued to yield well compared with the other varieties. These varieties have been tested in 15 replicated trials between 2010 and 2013, and have consistently maintained a high yield advantage over local varieties. The overall average yield for cassava for all sites and years was 23.7 t/ha.

When analysed across all years, Baucau proved to be the lowest producing and Loes the highest.

Table 24. Multi-year cassava replicated trial yields by variety and location, 2010-2013

	Average yield by location 2010- 2013 (t/ha)				*Mean yield*
Variety	*Aileu*	*Baucau*	*Betano*	*Loes*	*(t/ha)*
Ai-Luka 2	23.0	9.4	36.3	50.4	29.8
Ai-Luka 4	24.4	7.4	33.9	46.3	28.0
Ca 013	20.2	8.3	25.0	57.4	27.7
Ca 036	23.8	7.5	28.0	48.5	27.0
Ca 107	25.5	8.2	29.2	44.5	26.8
Ai-Luka 1	20.7	7.6	29.6	48.6	26.6
Ca 102	15.0	9.8	26.2	52.3	25.8
Ca 042	21.4	9.1	28.1	44.4	25.7
Ca 108	14.0	3.1	22.6	41.5	20.3
Ca 101	14.1	5.9	19.0	38.2	19.3
Local Mantega	*13.5*	*8.4*	*20.4*	*32.6*	*18.7*
Ca 106	12.6	6.5	25.0	28.3	18.1
Local Etuhare	*14.2*	*4.0*	*21.8*	*27.7*	*16.9*
Ca 007	7.1	*	25.4	*	na
Local Liquiça	*	*	*	*55.5*	*na*
Ca 103	18.1	6.8	*	42.7	na
Local Merah	*15.6*	*	*11.7*	*27.1*	*na*
Local Manatuto	*	*2.9*	*	*	*na*
Location average	*17.7*	*7.0*	*25.48*	*42.9*	*23.7*
F prob (Variety) 0.0565, Location)<.001					

* No data. na Did not include all sites

A Biplot analysis of cassava root yield of the tested varieties across the four sites and four years is presented in Figure 14. The biplot shows the position of each variety in relation to the 16 test locations. The two components of the biplot (PC1 and PC2) account for 45.08 % of the total variation in the original data set. Four of the twelve test locations are near the center of graph. Only the two Loes experiments (Loes 13 and Bet 10) and Betano 2010 are quite some distance from the center.

From the centre, Loes 2011 is positioned above and Loes 2013 is positioned below suggesting that the rank of order is very different for these two years. This suggests that rank order of varieties in Loes 2013 is quite different to that of Loes 2010. In addition the test site Loes 2013 sits well to the right of the center, suggesting that there is no correlation between varieties yields in Loes across the 3 years (ie. 2010, 2011 and 2013). Flooding of the Loes 2011 trial may account for this effect. There, does, however, appear to be a good relationship between varieties harvested at Loes in 2013 and those at Betano in 2010.

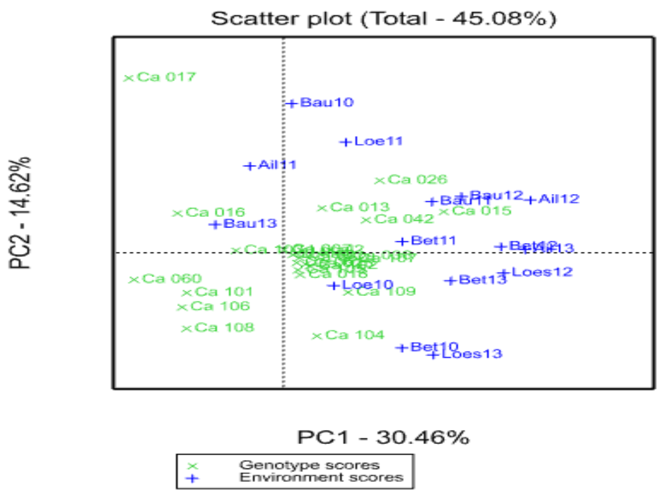


Figure 14. Biplot analysis of cassava root yield across 4 years (2010-2013)

Conclusion

The good performance of Ai-luka 2 and Ai-luka 4 during 2013 and across the past four years provide continued support for their choice as released varieties. These varieties have consistently maintained a high yield advantage since 2010 to date and have proven popular with Timorese farmers. Despite the popularity of the released varieties, a high number of Timorese farmers also select one or more local varieties as those which they wish to continue planting. The local variety of most merit is Mantega which proves to be highly popular at farmer field days, and is rated very highly for its buttery yellow colour. This suggests that improved varieties of a similar colour may prove to be popular.

Ca 109 was also released as Ai-Luka 1 during the year as an industrial crop. Because it is bitter, this variety is less susceptible to rodent predation and is suitable for starch production only. The Café Cooperativa Timor (CCT) has distributed Ai-Luka 1 widely to farmers in a project which buys back planting material and dried chips for commercial starch production.

2.4 Rice

2.4.1 Irrigated rice trials, 2014

Twenty five rice (*Oryza sativa* L) varieties (21 imported and 4 local varieties) were evaluated at three on-farm locations in Timor Leste during 2013-2014 (Table 25). Three trials were conducted during the wet season and one in the dry. The source of these varieties are presented in the Annual Research Report for 2012.

Table 25. Planting and harvest details of rice varietal trials in 3 sites, wet season 2014.

Location	*Elevation (masl)*	*Latitude (º S)*	*Longitude (º E)*	*Planting date*	*Harvest date*	*Days to maturity*	*Mean yield (t/ha)*
Aileu	960	8.517	125.655	28/2/2014	12/7/2014	134	2.09
Baucau	124	8.517	126.217	28/2/2014	25/6/2014	117	2.98
Maliana	358	8.947	125.205	11/3/2014	10/6/2014	111	3.38
Maliana (dry season)	358	8.947	125.205	30/7/2014	18/11/2014	116	3.93

Methods and materials

Seedlings of each variety were taken from the nurseries at three weeks of age and transpanted into research plots 2 m x 3 m in size. Hills were spaced at a distance of 20 cm x 20 cm and 2 seedlings were planted per hill. The trial was designed as a Randomized Complete Block (RCBD) with 3 replicates and 25 treatments (varieties). All data collected were entered into EXCEL spreadsheet then to GenStat ANOVA for analysis. Field days to evaluate farmers preferences for each varieties were held at Baucau and in Maliana. At both sites the milled rice of select varieties were cooked and farmers were asked whether they considered the rice to be either soft, fragrant, sticky or oily. Farmers were asked to select two varieties that they would like to plant.

Results

Varietal yields were not significantly different at either the wet season trial at Baucau or during the dry season at Maliana. The results for those sites are not presented here. At the wet season trial at Maliana, M20, M31 and M29 all yielded over 4 t/ha (Table 26). Nakroma yielded just below the average yield of the local varieties.

The field day results at both Baucau and Maliana indicated that farmers preferred the more aromatic varieties with a coefficient of determination (R^2) of 0.626 in Maliana and 0.620 in Baucau explaining the relationship between farmers choice and fragrance of the cooked rice. At the field day in Maliana, MLN, M29, ATB and M17 were the preferred varieties (Table 27), while at Baucau Nakroma, MLAT and M32 were the preferred varieties.

At Aileu during the wet season, rice grain yields were much lower (Table 28) but the yield differences higher. The highest yielding varieties at this site was M26, M17 and M40.

Table 26. Irrigated rice trial results, Maliana wet season, 2014

Code	*Yield (t/ha)*	*100 seed weight (g)*	*Seeds/panicle*	*Plant height at harvest (cm)*	*Tillers/plant*	*Yield advantage over locals (%)*
M20	4.22	2.33	139	98	69	25.0
M31	4.21	2.83	127	86	72	24.8
M29	4.10	2.60	129	98	71	21.6
M13	3.96	2.63	96	79	67	17.3
BCU	*3.90*	*2.47*	*100*	*78*	*60*	15.4
N5	3.74	2.60	104	88	66	10.8
M03	3.73	2.60	108	83	59	10.6
M19	3.70	2.87	114	84	62	9.6
N4	3.61	2.73	115	83	62	6.8
M17	3.48	2.70	105	90	63	3.0
MLN	*3.44*	*2.60*	*83*	*87*	*58*	2.0
M32	3.41	2.77	130	86	64	1.1
M01	*3.37*	*2.77*	*129*	*91*	*70*	*0.0*
ATB	*3.33*	*2.27*	*106*	*82*	*60*	-1.4
N3	3.32	2.67	105	84	59	-1.6
Nakroma	3.31	2.93	93	93	65	-1.9
M38D	3.26	2.30	59	71	56	-3.3
M26	3.14	2.70	116	83	56	-6.9
M10	3.06	2.70	113	93	70	-9.5
AIL	*2.84*	*2.73*	*97*	*92*	*55*	-16.0
M39C	2.67	3.27	110	97	64	-21.0
N2	2.38	2.27	85	86	62	-29.4
N6	2.38	2.90	105	92	62	-29.6
M40A	2.15	2.77	77	78	55	-36.3
M37D	1.94	2.50	113	110	72	-42.5
F prob	*0.001*	*<.001*	*0.48*	0.002	<.001	
LSD (p <0.05)	*1.05*	*0.34*	*ns*	14.36	6.81	
% CV	*19*	*8*	*30*	10	7	

Table 27. Preferred rice varieties, field days at Maliana and Baucau, 2014.

Variety	*Farmer's choices (%)*	*Oily (%)*	*Fragrant (%)*	*Sticky (%)*	*Like (%)*
Maliana farmer field day					
MLN	51	69	89	43	74
M29	26	60	40	40	57
ATB	17	69	60	77	63
M17	17	40	57	29	63
Baucau farmer field day					
Nakroma	86	72	74	61	77
HLAT	14	55	31	50	71
M32	9.3	53	42	46	67
HLB	9.3	49	39	65	60
M31	4.7	30	58	58	60

Table 28. Irrigated rice trial results, wet season Aileu 2014

Variety	*Yield (t/ha)*	*100 seed weight of (g)*	*Plant height at harvest (cm)*	*Tiller number prior to harvest*	*Panicle length (cm)*	*Plant density/(m²)*	*Yield advantage (%)*
M 26	2.32	2.50	61	14	20.4	24.8	111.4
M17	2.08	2.62	60	15	22.3	24.8	89.1
M40 a	2.07	2.58	46	15	19.4	24.9	88.6
M13	1.88	2.53	51	13	19.9	24.8	71.2
M31	1.76	2.64	63	16	20.0	24.8	60.5
N6	1.66	2.67	52	14	20.7	24.7	51.4
M01	1.60	2.53	61	12	22.9	24.8	46.2
M20	1.55	2.64	52	15	18.7	24.7	40.8
M19	1.52	2.55	54	14	19.4	24.8	38.5
HLAT	1.50	2.27	53	13	20.8	24.7	37.0
M 24	1.49	2.56	57	13	17.1	24.8	35.5
M29	1.45	2.57	60	14	20.3	24.9	32.5
Nakroma	1.40	2.76	52	14	21.3	24.6	27.9
N3	1.40	2.63	52	11	19.2	24.6	27.1
N2	1.36	2.60	71	14	22.9	24.8	24.1
HLB IR 5	1.21	2.58	55	15	19.7	24.8	10.4
M32	1.21	2.62	60	14	20.0	25.0	10.4
M42d	1.20	2.63	56	15	23.8	24.9	8.9
N 5	1.17	2.52	49	13	20.2	24.8	6.6
M10	1.02	2.52	56	11	16.6	24.3	-7.1
HLM	0.88	2.49	48	13	18.0	24.8	-19.9
HLAI	0.80	2.58	61	14	17.8	24.6	-27.6
M37d	0.79	1.92	42	16	19.4	25.0	-28.3
M34	0.36	2.64	46	12	20.7	24.8	-66.9
F prob	*<.001*	*<.001*	*<.001*	*0.692*	*<.001*	*0.634*	
% CV	*29.75*	*3.59*	*9.55*	*19.05*	*3.7*	*1.13*	
LSD (p<0.05)	*0.71*	*0.15*	*8.70*	*ns*	*1.23*	*ns*	
Mean locals	*1.10*	*2.56*	*54.37*	*14.21*	*20.53*	*24.81*	

2.4.2 Upland rice trials, 2013-2014

The upland rice *(Oriza sativa* L.*)* lines under evaluation during the 2013-2014 wet season composed of 25 varieties selected from the original 100 supplied by IRRI in 2010. The trial was conducted at Darasula research station (8.51667S and 126.21667E), Baucau District at an elevation of 756masl. The research was conducted from November to June 2014.

Materials and methods

Of the 25 rice varieties (Table 29), 23 were imported from the International Rice Research Institute (IRRI). Two were locals coded RLL and RLMB. The trial was planted 19 November 2013 and harvested on 14 April, 2014. The plot size was 2 m by 3 m with planting distance 20 cm x 20 cm at 3-4 seeds per hill. Seeds were mixed with 0.2 g of the commercial insecticide, *Sevin* in order to protect the seed from ants and other pests. After two and half months, at flowering, the trial was resprayed with *Sevin*. The experimental design was Randomized Complete Block Design, with 3 blocks and 25 varieties.

Data were entered into an Excel spread sheet and analysed using GenStat 16th ed. To identify the significant differences between treatments a One-Way Anova was applied.

Results and discussion

Grain yields in Darasula in 2014 were reasonably consistent across varieties and there was no significant difference between entries despite them being different by a large margin (Table 29). R003, R012 and R06 were particularly high yielding compared with locals. This was also the case when the results were compared across 2 years (Table 30). These results indicate that the trial should be repeated in 2014-2015 and include at least the top six varieties summarized in Table 30.

There was no significant difference between the number of tillers per plant (averaged 10-14) nor seeds per pannicle (averaged 85-100). Some differences in yield potential were due to plant densities. Local varieties were also significantly taller.

Table 29. Results of upland rice trial, Baucau 2013-2014

Variety	*Source*	*Yield (t/ha)*	*Plant height (cm)*	*Plant density/m2*	*Seed weight 100 (g)*	*Panicle length (cm)*	*Days to harvest*	*% higher than locals*
RO03	Philippines	2.57	78	19	2.73	27	132	45.6
RO12	IRRI	2.52	67	19	2.66	23	146	42.7
RO06	CIAT	2.44	57	18	2.53	25	132	38.2
RO92	IRRI	2.33	72	19	2.66	23	158	27.4
RO91	IRRI	2.25	61	18	2.26	22	146	27.4
RO29	IRRI	2.22	56	18	2.55	23	146	25.7
RO48	IRRI	2.18	44	17	2.52	24	146	23.5
RO102	CIAT	2.17	49	17	2.59	24	146	22.9
RO43	CIAT	2.17	70	17	2.57	23	132	22.9
RO24	IRRI	2.14	60	18	2.55	24	158	21.2
RO46	IRRI	2.06	62	19	2.57	24	158	16.7
RO64	IRRI	2.05	80	19	2.54	25	132	16.1
RO10	CIAT	1.90	77	15	2.56	25	146	7.6
RLL	*Local Loilubo*	*1.85*	*98*	*17*	*2.83*	*25*	*158*	*4.8*
RO41	IRRI	1.82	57	17	2.64	24	146	3.1
RO28	IRRI-KOREA	1.74	59	17	2.64	25	132	-1.4
RO69	IRRI	1.73	48	17	2.67	24	158	-1.9
RLMB	*Local Bah wai*	*1.68*	*96*	*18*	*2.85*	*28*	*158*	*-4.8*
RO55	IRRI	1.60	57	16	2.62	23	146	-9.3
RO50	IRRI	1.58	53	17	2.57	23	158	-10.4
RO36	IRRI	1.49	42	16	2.71	24	146	-15.5
RO22	IRRI	1.34	59	17	1.66	25	158	-24.0
RO52	CIAT	1.29	67	16	2.68	24	146	-26.9
RO21	IRRI	1.27	54	17	2.69	23	146	-28.0
RO99	IITA	1.13	90	17	2.62	28	132	-35.9
F prob		*0.99*	*<.001*	*0.93*	*0.48*	*<.001*	*<.001*	
LSD(p<0.05)		*ns*	*1.75*	*4.23*	*0.63*	*2.67*	*2.13*	
% CV		*14.45*	*1.60*	*14.60*	*14.70*	*5.50*	*5.55*	
Mean locals		*1.77*						

Table 30. Rice yield comparison 2012-2014, Darasula, Baucau

Variety	*Yield (t/ha) 2012*	*Yield (t/ha) 2014*	*Average 2 year yield (t/ha)*
RO03	1.26	2.57	1.91
RO12	1.24	2.52	1.88
RO06	1.00	2.44	1.72
RO102	1.08	2.17	1.62
RO29	1.02	2.22	1.62
RO46	1.14	2.06	1.60
Mean local	*0.35*	*1.77*	*1.06*

2.5 Peanuts

2.5.1 Replicated trials, 2013-2014

Peanut (*Arachis hypogaea* L.) lines under evaluation during 2013-2014 were originally sourced from ICRISAT in India. These were selected by ICRISAT breeders for their adaptation to conditions similar to those found in Timor. Peanut variety trials have been conducted for a number of years which allowed the selection of a big-seeded variety, Utamua (PT 05) for release in 2007. The characteristics of the varieties used in the trials are presented in Table 31.

Table 31. Replicated peanut variety trial line characteristics, 2013-2014

SoL code	*Name*	*Type*	*Skin colour*
PT 20**	ICGV 99017	Spanish bunch	Brown
PT 21	*Local Mean*	*Timor*	*Red*
PT 22	*Local Boot*	*Timor*	*Brown*
PT 124*	ICGV 97120	Virginia	Brown
PT 131*	ICGV 97100	Virginia	Brown
PT 132*	ICGV 97131	Virginia	Brown
PT 133*	ICGV 97135	Virginia	Brown
PT 134*	ICGV 97137	Virginia	Brown
PT 136*	ICGV 98180	Virginia	Brown
PT 137*	ICGV 98184	Virginia	Brown
PT 138*	ICGV 98187	Virginia	Brown
PT 141*	ICGV 99171	Virginia	Brown
PT 142*	ICGV 99174	Virginia	Brown

* Medium-duration cycle ** Foliar disease resistant

Materials and methods

Trials were grown successfully in four research centers during the rainy season 2013-2014. The trial was also repeated in the dry season of 2014. Fifteen entries held in each trial including the recommended Utamua variety (PT 05), PT 14, PT 20 and two local varieties which acted as checks (PT 21 and PT 22).

All sites contained three replicates of 25 m^2 plots and arranged in a randomized complete block. Planting hills (one seed per hill) were spaced at 40 cm x 20 cm and no fertilizer or irrigation was applied. Planting and harvest dates are presented in **Table 32**.

Table 32. Planting and harvest details of peanut varietal trials, 2013-2014

Location	*No. of entries*	*No. of replicates*	*Planting date*	*Harvest date*	*Mean yield (t/ha)*
Aileu	15	3	12 Dec 2013	12May 2014	0.73
Baucau	15	3	23 Jan 2013	04 June 2014	0.77
Betano	15	3	16 Dec 2013	08 May 2014	1.14
Betano (Bailoro)	15	3	30 May 2014	26 Aug 2014	0.70
Loes	15	3	20 Dec 2013	29 Apr 2014	0.61

Data at each site were analysed separately using GenStat Edition 16 where analysis of variance or REML analysis was used in order to determine varietal effects and apply base on the data available.

At harvest, all plants were dug, dried and weighed. The weight of fresh and then dry pods were measured. Yield and plant densities were measured from the whole plot. Yield components (pod and seed dry weight, number of seeds per pod, percentage of good pods) were obtained from plot samples of 100 pods. The number of pods per plant, the shelling percentages (from dry weights) and the seed yield (without shell) were obtained from the previous parameters.

Results

The mean yield across all sites in 2014 showed that PT 131 and PT 142 were the best performing varieties with yield advantages of 3% - 16% respectively above local varieties. Betano research station had the highest yields of all locations (Table 33).

Table 33. Variety yields across research stations and seasons, 2013-2014

Code	*Aileu 2014 (Rainy)*	*Baucau 2014 (Rainy)*	*Betano 2014 (Rainy)*	*Betano 2014 (Dry)*	*Loes 2014 (Rainy)*	*Mean over sites*	*Yield advantage (%)*	*St.dev*
PT 131	0.93	1.52	1.65	0.65	0.67	1.08	16	0.47
PT 142	0.82	0.78	1.34	1.02	0.84	0.96	3	0.23
PT 136	0.57	1.01	1.04	1.09	0.98	0.94	0	0.21
PT 021	*0.97*	*0.75*	*1.34*	*1.27*	*0.34*	*0.93*	*0*	*0.41*
PT 133	0.71	0.86	1.61	0.70	0.76	0.93	-1	0.39
PT 020	0.74	1.90	0.70	0.72	0.51	0.91	-2	0.56
PT 138	0.46	0.40	1.20	0.86	1.23	0.83	-11	0.39
PT 022	*0.79*	*0.26*	*1.74*	*0.59*	*0.64*	*0.80*	*-14*	*0.56*
PT 137	0.89	0.98	1.23	0.56	0.25	0.78	-16	0.38
PT 124	0.14	0.90	1.17	0.68	0.59	0.70	-26	0.38
PT 141	1.11	0.27	1.07	0.65	0.30	0.68	-27	0.40
PT 132	0.72	0.66	0.94	0.26	0.51	0.62	-34	0.25
PT 014	0.62	0.52	1.06	0.61	0.24	0.61	-35	0.30
PT 134	0.80	0.42	0.46	0.46	0.61	0.55	-41	0.16
Utamua	0.67	0.26	0.60	0.31	0.63	0.49	-47	0.19
f.prob	*<.001*	*0.058*	*<.001*	*<.001*	*0.052*	*0.79*		
LSD (P<0.05)	*0.30*	*ns*	*0.23*	*0.23*	*ns*			
% CV	*24.4*	*74.2*	*12*	*19.8*	*46.3*			
Site mean	*0.73*	*0.77*	*1.14*	*0.70*	*0.61*			

Based on the results of a field day held in Loes, the preferred variety was Utamua. Farmers selected Utamua because of its large seed size and superior taste. The second most popular variety selected by farmers was new variety PT 138. Farmers preferred these two varieties over the locals.

Table 34. Farmer preferences for peanuts varieties, Loes, 2013-14

Variety	*No. Females*	*Female (%)*	*No. Males*	*Male (%)*	*Total (%)*
Utamua	5	13	10	26	38
PT 138	0	0	14	36	36
PT 014	2	5	10	26	31
PT 131	5	13	5	13	26
PT 132	3	8	7	18	26
PT 134	4	10	6	15	26
PT 022	*5*	*13*	*4*	*10*	*23*
PT 136	2	5	7	18	23
PT 141	2	5	5	13	18
PT 133	1	3	4	10	13
PT 020	1	3	4	10	13
PT 124	3	8	1	3	10
PT 142	1	3	3	8	10
PT 021	*0*	*0*	*1*	*3*	*3*
PT 137	0	0	0	0	0

2.5.2 Peanut trials, multi-year and multi-location analysis

Materials and Methods

Seventee successful peanut trials (4 in 2011, 2 in 2012, 6 in 2013 and 5 in 2014) were implemented over the period from 2011 to 2014 at 4 different sites (Aileu, Baucau, Betano, and Loes), testing the performances of 15 varieties.

Cross-site analyses were conducted using ANOVA (GenStat Edition 16) in order to evaluate the performance and consistency of the tested varieties across years and locations (genotype / environment).

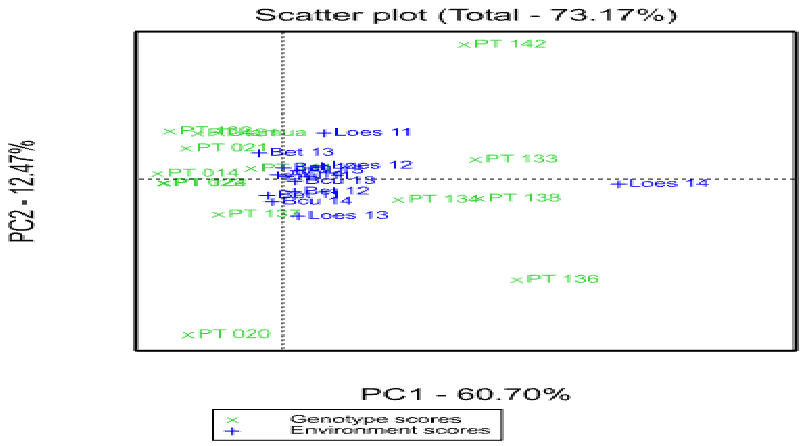
Results

Mean site yield performances varied from 0.17 t/ha to a maximum of 1.79 t/ha (Baucau 2011 and Loes 2012) with only three sites yielding over 1 t/ha (See previous ARR for details).

The same fifteen entries were in each of the 17 trials. Fifty percent of variability within this data was accounted for the BiPlot analysis. BiPlot visualization of how varieties performed by environment (year/season and location) is represented in Figure 15. Data on this Biplot is partitioned by quadrant.

Mean yield showed no significant different between varieties, and the highest mean yield than other varieties was showed by PT 021, PT 138, and PT 142 (0.91 t/ha) and lowest mean yield was showed by new variety PT 124 (0.63 t/ha) and PT 134 (0.62 t/ha). The Biplot showed that higher yield sites were in Loes 2011-2012 and Betano 2013 compared to other locations. Utamua remains amongst the top yielding varieties when averaged over 4 years in 17 sites.

Graphically the Biplot showed that higher yield sites were in Loes and Betano compared to other locations. There is no variety showed higher yield than other varieties in Loes 2011-2012 and Betano 2013; however, PT 142 and PT 138 showed clear advantage in many years when compared to other varieties. Utamua, PT 142, PT 137, PT 138 also performed well in all research stations.



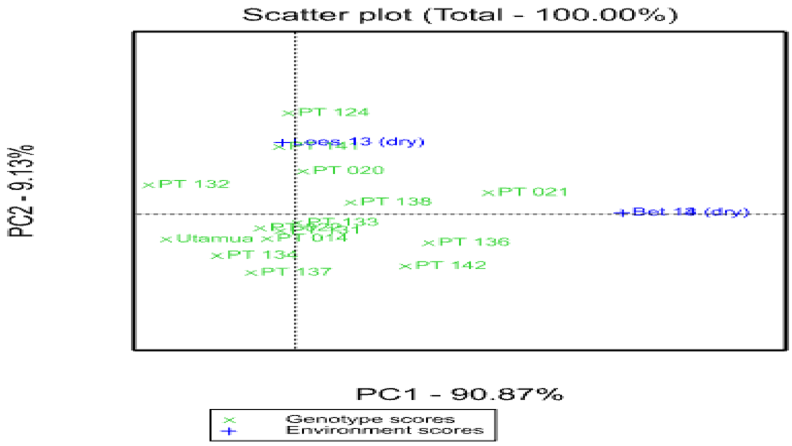


Figure 15. Biplot analysis (15 peanut varieties in 17 environments, 2013 - 2014)

Conclusion

Yield measurements over all sites showed no significant difference between varieties in 2014-2015. Some varieties showed good mean yield at each site from 2011 – 2014 and the failure of half the trials in 2012 prevented the identification of a variety from the new set that was included during 2011-2014. Based on the multi-year and multi-location data analysis it can recommended that peanut varieties PT 138, PT 142 can be advanced to evaluation on farmers fields' under the OFDT program.

2.6 Winged beans

Winged bean (*Psophocarpus tetragonolobus* (L.) D.C. is extensively cultivated in Southeast Asia, the South Pacific and Africa and is known as a source of nutritious food. In Timor Leste winged beans grow uncultivated in the forests of Lautem, Baucau, Viqueque, Manatuto (Soibada) and other Districts. In the Laga Sub District of Baucau it is known as *lari-lari* and in Venilale Sub District as *wewe*. Parts of the plant commonly consumed include the pods, buds, tubers and seed. In 2014, 3 new high yielding varieties were planted on farmers fields as OFDTs. One variety was from Papua New Guinea (PNG), the second from Indonesia (IND) and the third from Thailand (Thai). Insufficient local seed was available to grow a local control with these introduced varieties.

Materials and methods

Trials were installed during the wet season of 2013-2014 between the months of November 2013 and June 2014. Sixty-five sites were planted with the beans across a range of ecosystems in the Districts of Baucau, Viqueque, Aileu, Ainaro, Liquiça, Maliana and Manufahi. Each site was 25 m^2 in area and were on representative farm soils. At harvest, the number of pods/plot, pod weight and dry seed weight was recorded. Data were analysed using GenStat version 16 ANOVA general. Components recorded included yield (t/ha), number of seeds/pod, pods/plant, weight of 100 dry seeds and the number of plants/m^2

Results and discussion

At harvest, the seed yields of all introduced varieties were similar as were all their yield components (Table 35). Yields at individual sites varied widely as shown in the high CV. However overall mean yields were reasonable. As discussed in the PhD thesis of William Erskine (*pers comm*), yields in PNG and other parts of SE Asia range from 400 kg/ha to 2 t/ha (but can go as high as 4 t/ha). Researchers from each District stated that farmers tended to harvest green beans for consumption before they could be dried and harvested meaning that the recorded yields did not reflect the true yields. It was recommended by the researchers that the trials be conducted over a couple of seasons before the new varieties are considered for release.

Table 35. Yield (t/ha) and yield components, winged bean, 2013-2014

Variety	*Yield (t/ha)*	*Plants/m^2*	*Pods/plant*	*Seeds/pod*	*100 Seed weight (g)*
IND	0.73	1.88	15.0	12.9	28.0
PNG	0.80	1.86	15.4	12.6	30.8
Thailand	0.90	1.91	15.4	13.1	31.2
F.pro	*0.59*	*0.97*	*0.99*	*0.85*	*0.22*
LSD (P<0.05)	*ns*	*ns*	*ns*	*ns*	*ns*
% CV	*120.0*	*78.0*	*120.5*	*41.3*	*38.08*

For many farmers, winged bean was a new crop to cultivate. Other farmers had past experience growing older types. Some farmers knew of winged beans as a crop that was grown by their ancestors. Farmers in Venilale Sub-District sold fresh pods in the local market, one of whom earned $127 from the enterprise. Other farmers considered the dry seed looked similar to pigeon pea. When dry beans were boiled with maize it was not broken as with soybean. The beans can also be fried similar to maize and its tuber baked like sweet potato, taro and cassava. One farmer in Ainaro liked the crop because it can be cooked as *sedok* (traditional mixed food) and was tasty. Most interviewed farmers stated they would like to replant the crop. The only disadvantage of growing winged beans identified by farmers was that it has a long maturation period.

2.7 Mung bean

2.7.1 Mung bean OFDTs 2013-2014

Mung beans (*Vigna radiata* L.) has been cultivated widely in the Indian sub-continent for over 4000 years, in China, SE Asia and more recently in some parts of Europe, USA and Australia. Approximately 1,500 ha of mung beans are grown in Timor-Leste, mainly in the Districts of Cova Lima, Bobonaro and Manatuto with average yields ranging from 600-900 kg/ha (MAF statistics). The beans can be boiled and eaten as a soup or ground as a paste for cooking. Some people process mungbean into bread. Because it is a legume, the plant is able to fix nitrogen within the soil leading to improved soil nutrition for following cereal crops such as maize and upland rice.

The following research was designed to evaluate four varieties on farmers' fields. These three varieties were tested for three years in replicated trials on research stations and subsequently recommended by researchers to further test in farmer's fields. Three varieties were introduced and compared with a local variety.

Methods and materials

Twenty five mungbean on-farm trials (OFDTs) were installed across three Districts (four Sub Districts) of Timor-Leste. The Districts were Aileu, Bobonaro and Viqueque (Table 36). The test varieties were Delta, sourced from Australia, plus Murai and Merpati sourced from Indonesia (Table 37).

Table 36. Details of planting date per sub-district, 2013-2014

District	*Sub District*	*No. trial sites*	*Elev (masl)*	*Soil characteristics*	*Number harvested*	*Planting date*	*Harvest date*
Viqueque	Viqu villa	8	67.7	Flat	3	June	Sept
Bobonaro	Balibo	9	471.9	Terrace	5	February	April
Aileu	Laulara	5	739.6	Terrace	0	Nov	Not harvested
	Remexio	3	1141.8	Slope	0	Nov	Not harvested
Total		25			8		

Table 37. Mung bean test variety details, 2013-2014.

Population	*Source*	*Seed size*	*Pod size*	*Seed colour*	*Seed lustre*
Delta	Australia	Large	Short	Green	Bright
Murai	Indonesia	Small	Short	Green	Dull
Merpati	Indonesia	Small	Short	Green	Bright
Local	Tmor- Leste	Large	Long	Green	Dull

Plot sizes were 3 m x 3 m. The researchers visited the site once every two weeks from sowing to harvest. Each farmer received 100 g of seed for sowing. Local varieties were used at each site to compare with introduced varieties.

All data collected during fortnightly observations were then entered directly onto mobile phones then sent via internet for collation.

Latitude, longitude, and elevation were recorded at all sites using channel GPS receiver (Garmin ETrex) to an accuracy of ± 4 m. In addition, the slope of the land was defined at each site as was the orientation of the test location. Based on elevation and location, each site was allocated to a particular Agro-Ecological Zone (AEZ) (ARPAPET 1996).

Results

All trials established at the beginning of the wet season in Aileu failed due to waterlogging or other reasons. Five of the eight trials on the flat areas in Viqueque also failed as did 4 of the 9 sites in Balibo, Bobonaro (Table 36).

Most of the sites were established at the elevation 0 – 100 masl (four sites) or above 400 metres above sea level (3 sites at 400 – 500 masl and one at 600-700 masl).

Although there was no difference between yield components of the test varieties, grain yields for the test varieties were higher than the local (Table 38)

Table 38. Yield and yield component of mung bean, OFDTs, 2013-2014

Variety	*Yield (t/ha)*	*Density (Plants/m²)*	*Pods/plant*	*Seeds/pod*	*100 seed weight (g)*
Delta	1.3ab	31.1	10.2	9.7	4.92
Local	1.0a	30.0	9.07	9.6	4.53
Merpati	1.4b	36.9	8.26	11.1	6.12
Murai	1.6b	35.0	9.67	11.0	5.52
F.Prob	*0.02*	*0.79*	*0.96*	*0.75*	*0.67*
LSD (P<0.05)	*0.34*	*ns*	*ns*	*ns*	*ns*
%CV	*26.6*	*48.6*	*80.2*	*36.2*	*52.8*

Factors affecting mung bean yields, 2013-2014

Variety yields were affected by location (District, sub district and AEZ (Table 39). Much of this difference may have been due to the amount of slope and whether it was on flat, terraced or sloping land (topography). According to the researchers, lowland crops tended to perform better because they were located in more fertile soil. However this observation was not supported by analysis by soil type/soil texture nor soil pH.

Table 39. Various factors affecting mung bean yield in OFDTs, 2013-2014

Factors	*F prob.*	*Significant*
Variety	0.003	✓
District	<.001	✓
Variety. District	0.481	No interaction
Sub-District	<.001	✓
Var.Sub-District	0.481	No interaction
AEZ	<.001	✓
Var. AEZ	0.481	No interaction
Sloping classes	0.009	✓
Var. Slopping classes	0.685	No interaction
Soil colour	0.972	ns
Var. Soil colour	0.062	No interaction
Soil texture	0.156	ns
Var.Soil texture	0.630	No interaction
Topography	0.019	✓
Var.Topography	0.643	No interaction
pH	0.070	ns
Var.pH	0.503	No interaction

Farmers opinions

Farmers preferred to plant three new mungbean varieties of mungbean because they were faster to flower, produced more pods and dried evenly compared to locals. The farmers also considered the beans to taste good. Fresh pods can be boiled as vegetables to consume with rice or mixed with rice.

Conclusions

Based on the results of this trial and farmer interviews, it can be concluded that Murai, Merpati and Delta gave higher yields than locals. The new varieties performed well over 500 masl and the trials need to be repeated next season.

2.8 Climbing beans

2.8.1 Climbing bean replicated trials, 2013-2014

Red beans (*Phaseolus vulgaris* L.) are commonly grown in Timor as a food crop to both consume and sell. In the wet season, climbing beans are planted with maize in a multi-cropping system. Beans have a tall plant in maize to climb up and, in turn, the legume improves soil nutrition through its nitrogen fixation. Climbing beans planted in the dry season are provided with a wooden tripod to climb up.

Farmers receive low yields from their local varieties. In earlier replicated trials yields from local varieties were 0.42 t/ha compared to introduced varieties yielding 1.02 t/ha (SoL Annual Report, 2012). Nineteen new varieties were initially introduced in 2010 and over time the best 10 of these were selected for further investigation.

Materials and Methods

List of varieties and their characteristics

Ten climbing bean varieties (including 2 locals) were tested in 2013. In 2014, RWV 2409 was replaced with the local Leber. This variety was previously planted in Lisalara (Maubara) during 2009 and showed good yields. In the 2013-14 wet season trials either 10 or 11 varieties were included. Among the 11 varieties tested, eight varieties were introduced from Rwanda (Africa and three were found locally; one from Hohra'e Ki'ik (Maubisse), one from Urulefa (Maubisse) and the other one from Leber (Bobonaro). Details and characteristics of these varieties are described in Table 40.

Table 40. List of varieties and characteristics of climbing bean planted in 2013-14

No	*Variety name*	*Variety Code*	*Source*	*Seed colour*	*Seed type*	*Plant height (m)*
1	RWV 1348	R 03 *	Rwanda (Africa)	Pink	Long thin	2-3
2	RWV 2409	R 05 **	Rwanda (Africa)	Red	Long rounded	2-2.5
3	Decelaya	R 06	Rwanda (Africa)	Red	Long rounded	2-2.5
4	Umubano	R 07	Rwanda (Africa)	Light brown	Thin rounded	2-2.5
5	Mwirasi	R 08	Rwanda (Africa)	Dark blue	Long rounded	2-3
6	Gasilidia	R 10	Rwanda (Africa)	Dark blue	Long rounded	2-2.5
7	MAC 28	R 15	Rwanda (Africa)	Pink	Long rounded	2-2.5
8	Yol X	R 17	Rwanda (Africa)	Yellow	Long rounded	2-2.5
9	*Local Maubisse*	*L1Mb*	*Maubisse (T.L)*	*White*	*Thin rounded*	*2-2.5*
10	*Local Urulefa*	*L2Mb*	*Maubisse (T.L)*	*Red*	*Long rounded*	*2-2.5*
11	*Local Leber*	*L3Lb*	*Maubisse (T.L)*	*White*	*Long rounded*	*0.8*

* Fresh pod colour is green, and the mature pod is red and dry and ready to harvest is brown

** Not included in 2014. Replaced with local Leber

Design of trials

All trials were designed as a randomised complete block with three replicates. The plot size and distance between plots were different at each location because the wooden tripods to support the vines varied in design. In Urulefa a triangle was constructed, in Venilale and Ossu a pole with tent model (*para-para*) was used, in Hohrae Ki'ik one or two poles/hill were used depending on the the number of seeds that germinated, and in Seloi Malere one timber piece/hill was used. The length of pole also varied by site. In Urulefa the poles were 1.5 m long but in other locations, 2 m. In Urulefa and Ossu seeding was at 40 cm x 40 cm spacing, in Venilale at 50 cm x 20 cm. In Hohrae Ki'ik and Aileu seeds were planted at spaces of 50 cm x 50 cm. Two seeds per hill were planted at most sites.

One trial was planted in the dry season at Aileu and the remainder during the wet season (Table 41).

Table 41. Climbing bean trial details, 2013-2014

Location	*Elevation (masl)**	*Planting date*	*Days to maturity***	*Soil pH*	*Mean yield (t/ha)*
Aileu, dry season 2013	927	23/05/2013	124	6.5	0.8
Urulefa, wet season 2014	1350	28/10/2013	179	6.5	1.1
Venilale, wet season 2014	800	24/01/2014	133	7.0	1.9
Ossu, wet season 2014	941	13/12/2013	148	6.0	0.3
Hohra'e Ki'ik, wet season 2014	1633	26/11/2013	132	6.5	1.7

* (masl): Meters above sea level
**Days to maturity: Taken from last harvest day of late maturity varieties

The sites were neither watered nor received fertilizer. Plots were weeded three times at monthly intervals. Data from the trials were first entered into a MS Excel spreadsheet before being transferred for further analysis in GenStat Discovery Edition 16th with 32 *Anova* LSD ($P < 0.05$) in order to determine varietal effects. Yield that showed no significant effect was also analysed with covariates in order to determine the impact on yield. The existence and degree of correlation between yield and other yield components were then identified using simple linear regressions for each location. The percentage of variability accounted for was then equivalent to an adjusted R^2.

Results

Dry season, Aileu 2013

Aileu is a new research site for climbing bean with medium elevation and located close to potential bean production areas in the Municipalities of Ainaro, Manufahi (Turiscai) and Ermera. Climbing bean yield in Aileu during 2013 varied across the site because of uneven soil fertility. Some of the plants grew vigorously and some not. Germination also differed across sites and harvesting was spread over a maximum of 124 days. Statistical analysis indicated that there was no significant difference betweeen the variety yields (Table 42) despite very high yields from Mwirasi compared with the locals.

Table 42. Yield and yield components of climbing bean varieties, Aileu 2013 dry season.

Variety	*Yield (t/ha)*	*No. plants/m²*	*No. pods/plant*	*No. seeds/pod*	*100 seed weight (g)*	*Yield advantage over mean of locals (%)*
Mwirasi	1.3	2.39	25.6	3.9	56.5	185
RWV2409	1.1	1.56	39.1	3.4	65.7	147
Yol X	1.0	2.56	26.9	3.9	39.9	121
Gasalidia	1.0	1.39	27.7	3.8	72.6	118
RWV1348	0.8	1.61	37.6	5.5	30.5	74
Decelaya	0.8	1.72	22.1	4.6	51.2	73
Mac28	0.7	1.17	50.3	3.9	61.9	53
Umubano	0.5	1.56	19.8	3.2	89.4	18
Local Maubisse	*0.5*	*0.83*	*21.6*	*3.2*	*66.3*	*6*
Local Urulefa	*0.4*	*0.89*	*19.1*	*3.0*	*170.1*	*-6*
Average	0.8	1.57	28.98	3.8	70.41	79
F Prob.	*0.1*	*0.1*	*0.6*	*0.3*	*0.2*	
LSD. (p<0.05)	*ns*	*ns*	*ns*	*ns*	*ns*	
% CV	*46*	*44*	*67*	*29*	*77*	

Wet season, Urulefa 2013-2014

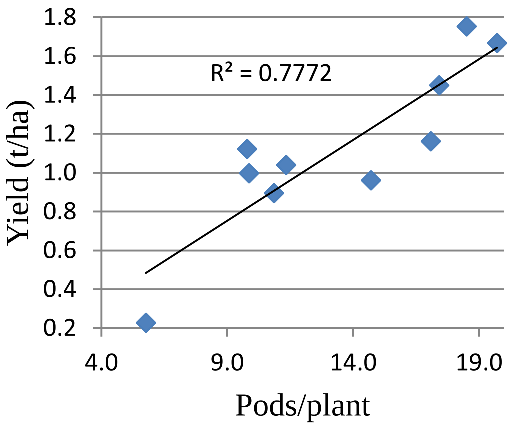
Plant density in the trial at Urulefa were more consistent in 2014 and planting early in the wet season improved yields compared with previous years (Table 43). The highest yielding variety at the research station at Urulefa in 2014 was Decelaya (1.8 t/ha) and the lowest yield was from the local Leber (0.2 t/ha). Pod numbers of Decelaya were the second highest (18.5 pods/plant) and these pods were of good size. Decelaya matured later than the average but earlier than RWV 1348 which produced pods 42 days later than three locals.

Table 43. Yield and yield components, climbing beans, Urulefa 2014 wet season

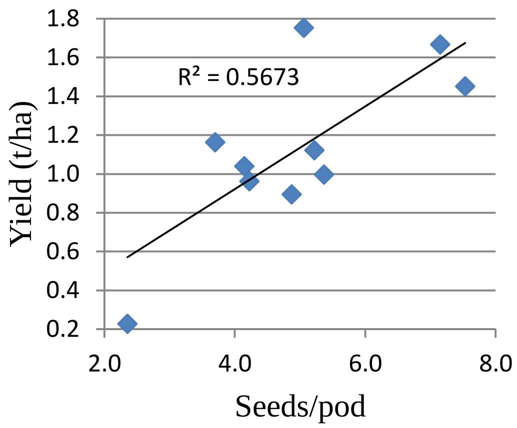
Variety	*Yield (t/ha)*	*Prod. Covariate (t/ha)*	*No. plants /m²*	*No. pods /plant*	*No. seeds /pod*	*100 seed weight (g)*	*Days to harvest*	*Yield advantage over mean of locals (%)*
Decelaya	1.8	1.6	3.8	18.5	5.1	49.5	162	124
Umubano	1.7	1.8	3.6	19.7	7.2	33.1	162	113
RWV 1348	1.5	1.5	3.7	17.4	7.5	30.0	177	85
Local Urulefa	1.2	1.1	3.4	17.1	3.7	47.3	142	48
MAC 28	1.1	1.1	3.6	9.8	5.2	62.4	155	43
Mwirasi	1.0	1.0	3.7	11.3	4.1	56.2	149	33
Gasilidia	1.0	1.2	3.8	9.9	5.4	49.8	142	27
Local Maubisse	*1.0*	*0.9*	*3.8*	*14.7*	*4.2*	*40.4*	*142*	*23*
Yol X	0.9	1.0	3.7	10.9	4.9	44.0	162	14
Local Leber	*0.2*	*0.2*	*3.7*	*5.8*	*2.4*	*46.2*	*122*	*-71*
Average	1.1	1.1	3.7	13.5	5.0	45.9	152	44
F Prob.	*0.024*	*<.001*	*0.396*	*0.026*	*<.001*	*<.001*	*<.001*	
LSD. (p < 0.05)	*0.75*	*0.52*	*ns*	*8.07*	*0.68*	*6.32*	*14.29*	
% CV	*39*	*25*	*6*	*35*	*8*	*8*	*6*	

None of the varieties showed any disease symptoms during growth. Some trials were attacked by insect pests resulting in small holes in the leaves but damage was consistent across varieties.

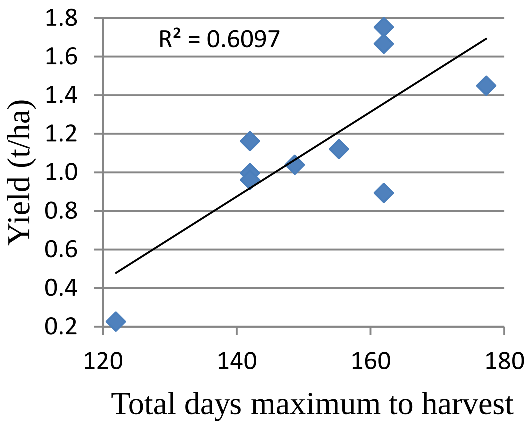
Grain yields were correlated between the number of pods/plant and seeds/pod. Yields were also correlated to days to maturity (Figure 16).



a) Yield vs pods/plant



b) Yield vs seeds/pod



c) Yield vs total days maximum to harvest

Figure 16. Correlations between yield and bean yield components, Urulefa 2014

Wet season, Venilale 2014

There was no significant difference in variety yields or yield components in the wet season trial in Venilale 2014 although Declaya again gave the highest yield despite its low plant density (Table 44). Decelaya was large seeded. Heavy rain at sowing caused many of the seeds to rot and at podding the plants were attacked by an insect pest locally known as *walang sangit*.

Table 44. Yield and yield components, climbing beans, Venilale, 2014 wet season.

Variety	*Yield (t/ha)*	*Plants/m²*	*Pods/plant*	*Seeds/pod*	*100 seeds weight (g)*	*Total days maximum to harvest*	*Yield advantage over mean of locals (%)*
Decelaya	2.4	5.8	38.7	4.2	29.1	133	11.11
Local Urulefa	*2.3*	*8.0*	*28.2*	*4.9*	*21.7*	*133*	*7.24*
Local Leber	*2.2*	*8.0*	*19.2*	*4.3*	*34.3*	*133*	*1.04*
Yol X	2.0	8.0	24.0	4.7	22.9	133	-5.95
Local Maubisse	*2.0*	*5.5*	*32.3*	*4.7*	*24.8*	*133*	*-8.28*
MAC 28	1.9	8.0	24.1	4.1	26	133	-11.41
Gasilidia	1.8	6.5	27.7	3.3	32.3	133	-16.07
RWV 1348	1.8	7.3	28.6	5.3	16.6	133	-17.61
Umubano	1.7	7.2	20.7	4.5	24.7	133	-23.06
Mwirasi	1.3	6.8	24.0	4.1	18.7	133	-37.85
Average	1.9	7.1	26.8	4.4	25.11	133	-10.08
F.Prob.	*0.361*	*0.094*	*0.409*	*0.113*	*0.055*		
LSD (p < 0.05)	*ns*	*ns*	*ns*	*ns*	*ns*		
% CV	*26*	*16*	*35*	*15*	*25*		

Wet season, Ossu 2013-2014

Climbing bean yields in Ossu during the wet season of 2014 were very low yielding averaging only 277 kg/ha (Table 45). Plant densities were low because of waterlogging and many of the plants rotted during vegetative growth. Fresh pods on remaining plants were attacked by the insect pests reducing the number of seeds in the pod. The highest yielding varieties were Mwirasi (491 kg/ha), Yol X (422kg/ha) and Declaya 345kg/ha. As at Urulefa, yield was related to the number of pods per plant ($R^2 = 0.53$).

Table 45. Yield and yield components, climbing beans, Ossu 2014 wet season.

Variety	*Yield (kg/ha)*	*Plants/m²*	*Pods/plant*	*Seeds/pod*	*100 seed weight (g)*	*Maximum number of days to harvest*	*Yield advantage over mean of locals (%)*
Mwirasi	491	4.8	15.2	2.6	28.6	116	108
YOL X	422	5.8	6.1	3.5	36.0	145	79
Decalaya	345	3.3	7.9	4.2	36.0	148	46
MAC 28	345	4.7	2.3	12.9	24.1	126	46
Local Maubisse	*293*	*4.5*	*5.2*	*4.2*	*28.3*	*141*	*24*
Local Urulefa	*270*	*4.8*	*4.8*	*2.8*	*40.3*	*130*	*14*
Gasilida	170	5.3	3.4	4.1	28.6	141	-28
Umubano	161	3.0	3.7	6.5	29.2	136	-32
Local Leber	*146*	*4.2*	*5.1*	*1.9*	*39.9*	*116*	*-38*
RWV 1348	123	3.5	1.9	6.4	29.1	145	-48
Average	276.6	4.4	5.6	4.9	32.0	134	17.0
F.Prob.	*0.006*	*0.38*	*<.001*	*<.001*	*0.169*	*0.023*	
LSD (P < 0.05)	*183*	*ns*	*4.39*	*2.92*	*ns*	*20.30*	
% CV	*38*	*33*	*46*	*34*	*23*	*9*	

Wet season, Hohra'e Ki'ik 2013-2014

The site at Hohra'e Ki'ik was the highest elevation of climbing bean trial locations in 2014 (Table 46) and grain yields were also the highest. The highest yielding variety was RWV 1348 (2.6 t/ha) followed by Decelaya and Mwirasi (Table 46). RWV 1348 had a much lower plant population than other varieties but flowered well and had a large number of pods per plant and seeds per pod. Its seed size was significantly lower than other varieties. The local variety, Leber, was a short plant (less than 0.8 m) which did not climb, producing a small number of pods. Some replicates of the variety Umubano were shaded by nearby trees affecting its yields.

Table 46. Yield and yield components, climbing beans Hohra'e Ki'ik 2014 wet season.

Variety	*Yield (t/ha)*	*No. plants/m²*	*No. pods/plant*	*No. seeds/pod*	*100 seed weight (g)*	*Days to harvest*	*Yield advantage over mean of locals (%)*
RWV 1348	2.6	5.1	64.1	9.9	8.8	132	152
Decelaya	2.5	7.8	26.4	8.2	15.5	132	144
Mwirasi	2.4	6.9	27.2	8.6	15.5	126	135
Umubano	2.3	9.3	30	7.8	12.6	132	130
Gasilidia	1.6	8.4	19.8	7.6	13.9	132	62
Local Urulefa	*1.5*	*6.9*	*21.1*	*5.6*	*21.6*	*114*	*50*
Yol X	1.4	7.4	18	7.1	15.8	130	43
Mac 28	1.2	7.6	13.6	6.8	16.9	132	15
Local Maubisse	*1.1*	*8.5*	*9.5*	*5.9*	*22.4*	*123*	*10*
Local Leber	*0.4*	*7.9*	*4*	*3.6*	*36.7*	*102*	*-60*
Average	1.7	7.6	23.37	7.1	18.0	125	68
F.Prob.	*0.003*	*0.003*	*0.003*	*<.001*	*<.001*	*<.001*	
LSD (P < 0.05)	*1.00*	*1.60*	*22.72*	*1.1*	*5.51*	*6.11*	
CV (%)	*34*	*12*	*57*	*9*	*18*	*3*	

Similar to Urulefa, higher yields were correlated with the number of pods per plant and the number of seed per pod. Grain yield also tended to be greater in the later maturing varieties. In this trial yield was negatively correlated with increasing seed weight (Figure 17).

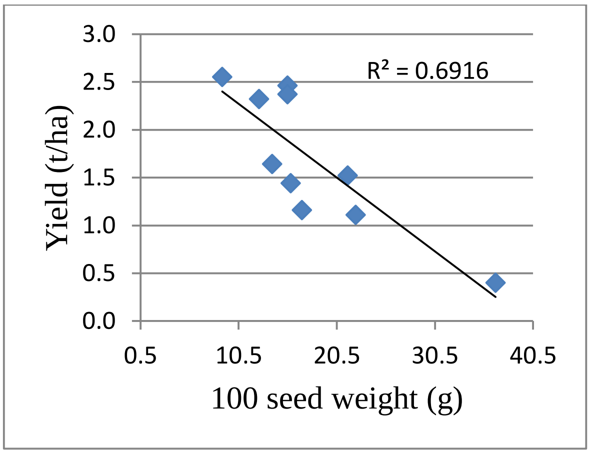


Figure 17. Relationship between climbing bean seed weight and yield

Conclusion

Yields were not consistent across the sites in 2013-2014 and no variety performed better at all sites. Decelaya performed better at Urulefa and Venilale while Mwirasi was higher yield in Aileu and Ossu and RWV 1348 was high in Hohra’e Ki’ik. There was no significant difference across varieties at either Venilale or Ossu.

2.8.2 Climbing bean, multi-year and location analysis

Materials and methods

Successful climbing bean variety trials (including 4 dry season trials) were implemented by SoL between 2009 and 2014 at 10 different sites. The performance of 11 climbing bean varieties (including 3 locals) was compared.

The entire dataset comprised 208 data points, i.e. variety per environment combinations. An environment (here synonymous with trial) is defined by the site, year and season (for instance Maubisse dry season 2010, Venilale wet season 2013, etc). At each site a performance was calculated. The sites were at Maubisse (Maub), Turiscai (Tur), Venilale (Ven), Aileu (Ail), Lisalara (Lis), Holarua (Hol), Ossu (Oss), Urulefa (Ulu), Aituto (Aitt) and Hohra’e Ki’ik (Hoh).

Cross-site analyses were conducted using biplots (GGE Plot procedure in GenStat 16) in order to evaluate the performances and consistency of the tested varieties across years and locations (genotype/environment).

Results

The average yield of the entire dataset (21 environments, 198 data points) was 0.95 t/ha. Yield averages from trial to trial was varied from a very low 28 kg/ha to a maximum of 2.7 t/ha (Lisalara 2010 and Maubisse 2010 respectively) (Table 47, Table 48, Table 49).

Table 47. Climbing bean yields for 9 varieties from 11 trials, 2009-2011

Variety	*Maub. 2009*	*Tur. 2009*	*Ven. 2009*	*Ail. 2010*	*Lis. 2010*	*Maub. 2010w*	*Hol. 2010*	*Oss. 2010*	*Ven. 2010*	*Maub. 2010*	*Maub. 2011*
RWV 1348	0.12	0.14	0.91	0.21		4.28	0.47	0.48	0.6	0.43	0.14
Mwirasi	0.34	0.24	0.51	0.33	0.01	3.63	0.32	0.13	0.44	0.85	0.29
Decelaya	0.28	0.08	0.43	1.12	0.04	2.68	0.37	0.53	0.29	0.6	0.04
MAC 28	0.44	0.22	0.63	0	0	3.65	0.16	0.11	0.35	0.7	0.11
YOL X	0.14	0.18	1.07	0.23	0.03	2.96	0.1	0.29	0.59	0.39	0.14
Gasilidia	0.08	0.17	0.38	0.24	0.02	2.2	0.18	0.14	0.25	0.99	0.05
Umubano	0.08	0.02	0.36	0.28	0	1.91	0.32	1.1	0.22	0.27	0.13
RWV 2409	0.36	0.2	0.41	0.18	0.11	2	0.15	0.05	0.29	0.7	0.05
Local Maubisse	*0.3*	*0.14*	*	*0*	*0.01*	*1.17*	*0.31*	*0.09*	*0.35*	*0.39*	*0.04*

* This table and figures describing the data are presented in the SoL 2013 Annual Research Report.

Table 48. Climbing bean yields for 10 varieties from 6 trials, 2012-2013

Variety	*Ulu. 2012*	*Ulu. 2013*	*Ven. 2013*	*Oss. 2013*	*Ait. 2013*	*Ail. 2013*
RWV 1348	4.6	0.24	0.44	0.14	2.03	0.8
Mwirasi	2.9	0.18	0.9	0.57	1.13	1.3
Umubano	2.2	0.16	0.27	0.41	2.45	0.5
Gasilidia	2.7	0.14	0.34	0.12	1.37	1
Decelaya	2.1	0.09	0.23	0.14	2.26	0.8
MAC 28	2.7	0.1	0.27	0.04	1.64	0.7
YOL X	1.6	0.12	0.39	0.08	1.98	1
Local Urulefa	*2.7*	*0.11*	*0.35*	*0.24*	*0.97*	*0.4*
RWV 2409	1.9	0.13	0.32	0.03	1.11	1.1
Local Maubisse	*2*	*0.16*	*0.42*	*0.3*	*0.62*	*0.5*

Table 49. Climbing bean yields for 10 varieties from 4 trials, 2014

Variety	*Ulu. 2014*	*Ven. 2014*	*Oss. 2014*	*Hoh. 2014*
Decelaya	1.8	2.4	0.35	2.5
RWV 1348	1.5	1.8	0.12	2.6
Umubano	1.7	1.7	0.16	2.3
Local Urulefa	*1.2*	*2.3*	*0.27*	*1.5*
Mwirasi	1.0	1.3	0.49	2.4
Yol X	0.9	2.0	0.42	1.4
Gasilidia	1.0	1.8	0.17	1.6
MAC 28	1.1	1.9	0.35	1.2
Local Maubisse	*1.0*	*2.0*	*0.29*	*1.1*
Local Leber	*0.2*	*2.2*	*0.15*	*0.4*

Climbing bean yields from all trials established from 2009-2014 showed that RWV 1348 produced the highest mean yield of all varieties (Table 50). The local variety from Urulefa was the second highest. This variety was planted in 10 environments, while other varieties were planted in 21 environments. When average yield data was collected from 10 environments only (similar to local Baucau and local Urulefa) the new variety Mwirasi produced a higher yield than local Urulefa. Mwirasi is one of the superior varieties that was included in many trials and consistently showed a higher yield than the local.

Table 50. Mean climbing bean yields for 11 varieties from 21 trials, 2009-2014

Variety	*Mean yield (t/ha) 11 locations (2009-11)*	*Mean yield (t/ha) 6 locations (2012-13)*	*Mean yield (t/ha) 4 locations (2014)*	*Mean yield (t/ha) from 2009-14***	*Mean yield over locals (%)*
RWV 1348	1.02	1.41	1.76	1.40	66
Local Urulefa	*	*0.87*	*1.47*	*1.17*	*39*
Mwirasi	0.8	1.08	1.32	1.07	27
Decelaya	0.7	0.92	1.51	1.04	24
Umubano	0.64	1.02	1.30	0.99	17
MAC 28	0.7	0.91	1.18	0.93	10
Gasilidia	0.59	0.88	1.14	0.87	3
YOL X	0.64	0.8	1.14	0.86	2
Local Leber	*	*	*0.74*	*0.74*	*-12*
Local Maubisse	*0.42*	*0.65*	*1.10*	*0.72*	*-14*
RWV 2409	0.5	0.67	*	0.59	-31

*Not planted ** Mean yield from 11, 6 and 4 locations

Figure 18 presents the biplot resulting from the analysis of 10 varieties in 6 environments. The two components combined explain 88% of the variation in the table of yield of 10 varieties across the 6 sites (2012-13). Multiple analysis showed that the highest yielding varieties were obtained from RWV 1348 in Urulefa and Umubano in Aituto. Both of these locations are at high elevations compared with other locations during the trials. Both varieties are small seeded. The combination figure of 10 varieties in all environments during 2009-11 was presented in the SoL Annual Research Report 2013.

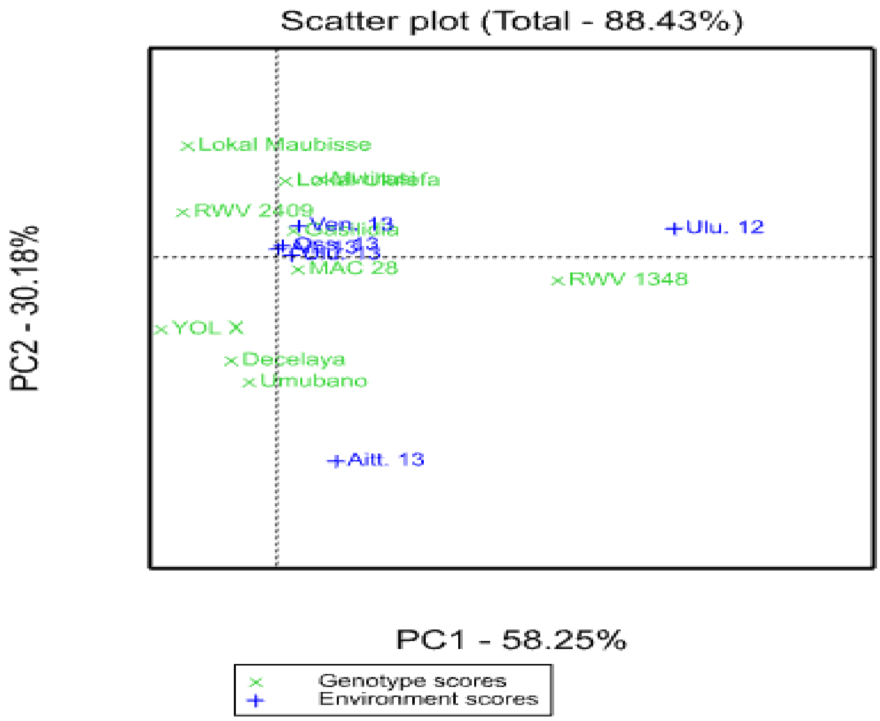


Figure 18. Ranking BiPlot of 10 climbing bean varieties in six environments, 2012-2013

The two components combined together explain about 95% of the variation in the production table of 10 varieties in 4 environments in 2014 (Figure 19). Varieties further to the right of the line perform better. RWV 1348 showed good yield in Hohra'e Ki'ik and Urulefa but poor in Ossu. Decelaya was good in Hohra'e Ki'ik and Venilale. This suggests that the variety is good in upland area with low elevation. However, variety RWV 1348 showed high yields in Hohra'e Ki'ik and Urulefa but low in Ossu which was included in high elevation. This suggests that the variety was influenced by elevation but not from other factors.

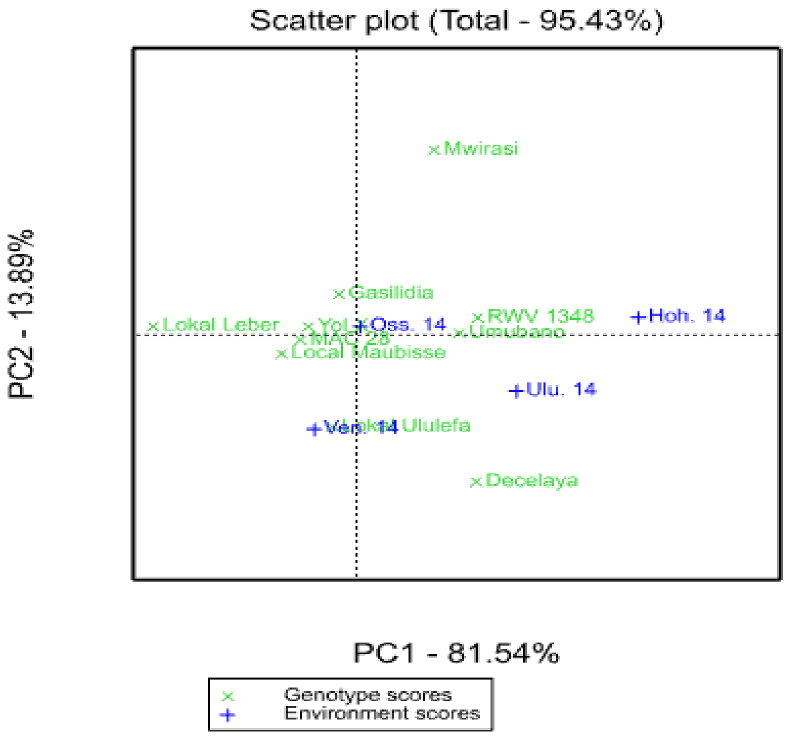


Figure 19. Ranking BiPlot of 10 climbing bean varieties in 4 environments, 2014

Conclusion

Trials conducted in 21 environments with 11 varieties between 2009 and 2014 showed that RWV 1348 had a yield advantage of more than 66% over the mean of 3 locals included in the trial. The local from Urulefa had the second highest yield but this variety was only tested in 10 environments while other varieties were tested in 21 environments. If varieties were compared with Local Urulefa in similar environments, RWV 1348 produced double the yield of the locals. Two other varieties (Decelaya and Mwirasi) were also higher yielding than Local Urulefa.

The highest yielding varieties may be included in taste tests and their seed multiplied for inclusion in future on-farm trials.

3. Source seed production and quality control

Introduction

Source seed production and quality control are two distinct activities. Breeder seed, foundation seed and certified seed need to be produced each year by MAF as part of the national seed system. The seed department in the MAF sets a target production for each seed class. Breeder seed and foundation seed are produced on research centres under control of a Government seed officer as a representative of the breeder. Certified seed crop is grown by selected seed growers who have long experience producing quality seed under strict supervision of seed officers. Further seed processing of certified seed is conducted at the MAF seed warehouse under control/management of MAF seed officers.

Seed quality control is also the responsibility of the seed department. Field inspection, seed sampling, seed testing, and seed inspection are the core activities of seed quality control. Seed quality control staff provide services to both certified seed growers and commercial seed producers. Thirty-one commercial seed producers were serviced in 2014. The service includes issue of a 5-year certificate to produce commercial seed, the provision of an annual seed production permit, field inspection, seed sampling, and seed testing. They also provide training on seed production, processing and quality control.

In 2014 there were 27 staff members in the seed department with at least one seed officer in each district excepting Dili and Ermera.

3.1 Seed production of rice, maize, and peanut seed 2013-2014

Between August, 2013 and October, 2014, maize and peanut breeder seed and foundation seed was produced at Betano and Loes research centres. Source rice seed was multiplied on farmers' fields. Seed of these categories were stored at warehouses at Betano, Loes and Triloca research stations. Availability of this seed as of October, 2014 is presented in Table 51. Note that breeder and foundation seed at Betano failed in 2013-2014 and seed from 2012-2013 will need to be used in 2014-2015.

Table 51. Breeder seed and foundation seed availability, Oct. 2014

Variety	*Production year*	*Breeder seed (kg)*	*Foundation Seed (kg)*	*Seed warehouse*
Sele (maize)	2012-2013	15	322	Betano research centre
Sele (maize)	2013-2014	0	0	Betano research centre
Noi Mutin (maize)	2012-2013	150	10	Loes research centre
Noi Mutin (maize)	2013-2014	217	0	Loes research centre
Nakroma (rice)	2013-2014	20	80	Triloca research station

Seed production by contract growers was conducted in the 7 districts of Aileu, Baucau, Bobonaro, Manufahi, Liquiça, Viqueque and Manatuto. The cultivated area to produce certified seed in 2013-2014 was about 34 ha of maize, 14 ha of rice and 15 ha of peanut. These fields were inspected by seed officers but the certified seed production target for 2013/2014 season was 15 t of maize, 7 t of rice and 11 t of peanut.

The number of contracted seed growers for each district is presented in Table 52. There were 176 seed growers involved in certified seed production and about 39 % of them were women.

Table 52. Number and gender of contract seed growers in each district

District	*Maize Sele*		*Maize Noi Mutin*		*Rice Nakroma*		*Peanut Utamua*	
	M*	*F**	*M*	*F*	*M*	*F*	*M*	*F*
Aileu			7	0	1			
Baucau			3	1	24	14	21	1
Bobonaro	3	5					2	4
Liquiça	1	2	5	5				
Manufahi	9	0	19	14			1	8
Viqueque			5	7	4	0		
Manatuto			2	8				
Total	*13*	*7*	*41*	*35*	*29*	*14*	*24*	*13*
	20		*76*		*43*		*37*	
Grand total	*176*							

* M = male, F = female

Clean seed produced in 2013-2014 slightly exceeded the required 7 t for rice and 15 t for maize, but peanut seed multiplication was slightly short of the target 11 t target (Table 53). This seed will be distributed in 2014-2015.

Table 53. Clean Seed production of Nakroma, Sele and Utamua. 2013-2014

District	*Rice (kg Nakroma)*	*Maize (kg Sele)*	*Maize (kg Noi Mutin)*	*Peanut (kg Utamua)*
Aileu	872	0	952	0
Baucau	5,000		1,324	4,249
Bobonaro	0	1,700	0	3,307
Liquiça	0	692	1,125	0
Manufahi	0	5,000	2,665	0
Viqueque	2,000	0	4,038	0
Total	*7,872*	*7,392*	*10,104*	*7,556*

3.2 Rice, maize and peanut seed distribution, 2013-2014

Seed harvested during 2012-2013 was distributed for the 2013-2014 planting season to support research and seed multiplication in MAF-SOL and other programs. About 21.3 t of Nakroma, 7.6 t of Utamua and 37.7 t of maize seed were distributed within the period of Sept 2013 – August 2014 (Table 6). Most of the seed was distributed directly through MAF (36%) or distributed with the MAF/IFAD-funded drum project (36%).

Table 54. Rice, maize and peanut seed distribution, Sept 2013 to Aug 2014

Commodity	*Seed Recipients*									*Total (kg)*
	NGO (kg)	*MAF District (kg)*	*Raumoko*	*MAF/SOL source seed (kg)*	*MAF/SOL Community seed (kg)*	*RDP4 (kg)*	*FAO (kg)*	*IFAD (kg)*	*OFDT (kg)*	
Rice-Nakroma	500 (2%)	18,320 (86%)	0	1,130 (5%)	600 (3%)	205 (1%)			585 (3%)	21,340
Peanut-Utamua	140 (2%)	1,679 (22%)	0	3,756 (49%)	1,848 (24%)				180 (2%)	7,603
Maize (Sele +Noi Mutin)	1,015 (3%)	4,244 (11%)	821 (2%)	351 (1%)	2,780 (7%)	485 (1%)	4,215 (11%)	23,346 (62%)	465 (1%)	37,722
Total	*1,655 (2%)*	*24,243 (36%)*	*821 (1%)*	*5,237 (8%)*	*5,228 (8%)*	*690 (1%)*	*4,215 (6%)*	*23,346 (35%)*	*1,230 (2%)*	*66,665*

3.3 Production and distribution of sweet potato and cassava stem cuttings

Sweet potato

To supply sweet potato cuttings for the 2013-2014 season, multiplication of the cuttings started in June 2013. The area under cultivation started small and increased in size using cuttings from the original site until the time of distribution (Nov 2013 - March 2014). By November, there was more than 1 ha of sweet potato field for cutting multiplication. The sites were located at Betano research centre (0.3 ha), on a contracted farmer's field in Aileu (0.08 ha), on Loes research centre (0.25 ha), on a contracted farmer's field in Bobonaro (0.25 ha) and on Triloca research station (0.08 ha).

More than 435,000 sweet potato cuttings were distributed from this component in 2013-2014 (Table 55). Most cuttings were distributed to farmer groups (67%) and NGOs (22%) with the remainder going to research and other MAF programs.

Table 55. Sweet potato and cassava cutting distribution, 2013-2014.

Commodity	*NGO*	*MAF District*	*Source seed*	*CSPG and farmer groups*	*OFDT*	*Total*
Sweet potato	97,598 (22%)	7,650 (2%)	6,800 (2%)	292,949 67%)	30,410 (7%)	435,407
Cassava	23,200 (24%)	5,300 (5%)	17,500 (18%)	46,750 (48%)	4,330 (4%)	97,080

Cassava

To supply cassava cuttings for the 2013-2014 season (Nov 2013 – March 2014), about 5 ha of cassava field were established in Nov 2012. It takes 10 – 12 months of growth before cassava can be harvesting for cuttings. Multiplication plots were located at Loes research centre (1 ha), Corluli station in Bobonaro (1 ha), Betano research centre (1 ha) an on a contracted farmer field in Viqueque (2 ha). Planting distance was at 100 cm x 100 cm. To stimulate more stem /plant, plants were pruned when they were about 40 cm high. An average of 2 – 3 branches/plant were maintained during the growing period. Unfortunately, the crops were affected by flooding or, in one case, fire and only 97,080 cuttings were produced and distributed (Table 55). Most of the distributed cuttings in 2013-2014 were allocated to farmer groups and CSPGs (48 %).

Seed warehouse and national seed laboratory

Seed processing units and seed warehouses have been established in six districts and play an important role in seed processing. Good seed processing can improve the pure live seed content of each lot by reducing the number of impurities, empty, cracked and diseased seed. By the end of 2014, warehouses in Aileu, Baucau, Bobonaro, Manufahi, Liquiça and Viqueque were operational and possessed essential equipment including silos (2000 and 1000 litres), air screen cleaners, rice and maize threshers, batch driers, sealers, compressors, generators and germinators.

Seed laboratories are also established in Dili, Baucau (Triloka) and Betano. Seed samples submitted to these laboratories and measured using International Seed Testing Association (ISTA) rules. Reliable seed testing results provide important information for the seed users, seed producers and seed officers. Each laboratory is equipped with all the necessary instruments including moisture meters, germinators, seed dividers, ovens, purity tables, balances and microscopes.

Figure 20. Training of seed testing techniques

Capacity building

The seed department received considerable training during the year. Training included seed production, seed testing and seed technology. Both certified and commercial seed producers were also provided with training on harvest and post-harvest of corn and rice seed production. Training was provided in-country and in Bogor, Indonesia

4. Community based seed production

Introduction

Community based seed production is the decentralized production, storage and marketing of quality seeds by organized groups of farmers operating as community seed production groups (CSPG) or as commercial seed producers (CSP). The distinction between a CSPG and a CSP is that the CSPG normally has 10-20 farmer members producing sufficient seed to meet their needs. Any seed surplus from the group is normally sold, bartered or shared with neighbours within the Suco. In contrast, the CSP has 25-100 members and produces seed primarily for commercial purposes. They generally have their own brand and label seed packets for sale.

Any seed group wishing to become a CSP has to register with the MAF seed department to get a 5-year certificate to produce seed. After certification, the CSP must then register with the MAF seed department for an annual permit informing them of the crop, variety, area and location of their seed plots. CSPGs and CSPs both receive training on seed production, storage and marketing from extension staff of MAF. As experience develops these CSPGs and CSPs continue seed production activities on their own with little or no extension support. The CSPGs and CSPs are self-regulated farmer organizations hence they are expected to follow basic seed production procedures on their own and produce quality seed.

A number of superior crop varieties developed and released by MAF have yield advantages ranging from 15% to 131% (SoL, 2013). However, the potential benefits of these are not being realized by a majority of farmers in Timor Leste because seed and other planting material is not sufficiently available. This shortage among the poor farmers is being addressed by encouraging groups to multiply seed to increase accessibility to this resource. Community seed production has been implemented in a step-wise manner. In 2011-2012 community groups were established in 7 Districts, 10 Districts in 2012-2013 and all 13 Districts in 2013-2014. Thirty-one CSPs producing commercial seeds of MAF released varieties were also established in 2013-2014.

The introduction of a community seed production program has seen an impressive increase on seed production at the community level. In 2013-2014, MAF-SoL supported 1018 groups (CSPGs) across 13 districts, in 61 of the 65 sub-districts and 349 of the 397 rural Sucos growing one of five major food crops: maize, rice, peanuts, sweet potato and cassava. By proportion, the program was able to cover all Districts, 94% of the Sub-Districts and 88% of all the rural Sucos during the 2013-2014 wet season (Table 56).

Table 56. CSPGs by crop variety and district, 2013-2014

District	*2013-2014 Cropping Season*						*No. of groups**		
	Maize Sele	*Maize Noi Mutin*	*Rice Nakroma*	*Peanuts Utamua*	*Cassava*	*Sweet Potato*	*2013-2014*	*2012-2013*	*2011-2012*
Aileu	52	17	8	40	0	9	99	79	40
Ainaro	52	1	5	12	3	5	73	84	40
Baucau	56	0	56	19	0	3	121	80	40
Bobonaro	18	25	17	12	0	3	75	80	40
Covalima	2	29	13	14	0	0	58	0	0
Dili	20	0	0	1	1	10	31	0	0
Ermera	26	13	8	13	3	5	67	24	0
Lautem	25	2	19	29	0	5	74	24	0
Liquiça	32	18	3	12	0	11	73	77	40
Manatuto	21	0	24	14	1	9	77	24	0
Manufahi	26	11	6	21	1	4	65	80	40
Oecusse	27	26	4	34	4	17	101	49	0
Viqueque	40	12	19	26	4	3	104	80	40
Total (2013-2014)	*397*	*154*	*182*	*247*	*17*	*84*	*1,018*		
Total (2012-2013)	*239*	*109*	*114*	*173*	*10*	*36*		*681*	
Total (2011-2012)	*105*	*0*	*59*	*52*	*25*	*39*			*280*

* As several CSPGs grew more than one crop, the sum of the CSPGs by crop was often larger than the number of CSPGs in a district. The 72 CSPGs that associated themselves to become registered CSPs are not included in this list.

4.1 Community seed production in 2013-2014

Nine varieties of five major crops were multiplied by CSPGs during the wet season of 2013-2014. These were Sele and Noi Mutin varieties of maize, Nakroma rice, Utamua peanut, Hohrae 1, Hohrae 2 and Hohrae 3 varieties of sweet potato and Ai luka 2 and Ai luka 4 varieties of cassava. During the season, 96 t of maize seed, 68 t of rice seed and 18 t of peanut seed totaling 182 t of improved seeds were produced by these groups.

Maize seed production

A total of 551 community groups were involved in seed production of Sele or Noi Mutin varieties of maize in 2013-2014 (

Table 57). A total of 96 t of seed was produced by 551 CSPGs with an average of 174 kg seed/CSPG.

Each group had received 5 kg seeds from MAF/SoL at planting time and cultivated Sele or Noi Mutin in one single plot (normally 0.2 ha) maintaining sufficient isolation distance with other maize varieties. MAF/SoL provided basic seed production training to all concerned MAF Suco Extension Officers (SEOs) working with the groups about one month before planting time, and follow-up training was provided on post-harvest operations and quality control one month before the harvest. The SEOs then provided coaching and mentoring support to these CSPGs on production, processing and storage through their regular visits with CSPGs following a coaching and mentoring approach.

Table 57. Maize seed production by CSPGs in 2013-2014

District	*Number of CSPGs growing maize seed*	*Total seed produced (kg)*	*Average seed production (kg/CSPG)*
Aileu	69	12,075	175
Ainaro	53	9,100	172
Baucau	56	9,800	175
Bobonaro	43	9,275	216
Covalima	31	5,425	175
Dili	20	3,500	175
Ermera	31	6,300	203
Liquiça	40	5,775	144
Lautem	27	6,125	227
Manatuto	21	3,150	150
Manufahi	37	6,475	175
Oecusse	43	9,450	220
Viqueque	52	9,450	182
TOTAL	*551*	*95,600*	*174*

Rice seed production

One hundred and eighty-two CSPGs were involved in seed production of Nakroma rice during 2013-2014 (Table 58). Each group had received 5 kg of seed at planting time and cultivated the crop in a single plot (normally 0.25 ha) maintaining sufficient isolation distance from other varieties. In most cases, CSPGs adopted either ICM (integrated crop management) or SRI (System Rice Intensification) techniques. The SEOs working with the farmers received basic seed production training about one month before planting time, and follow-up training on post-harvest operations and quality control was provided to them one month before the harvest. The SEOs then provided coaching and mentoring support to the CSPGs on production, processing and storage through their regular visits and meetings with CSPGs.

Table 58. Rice seed production by CSPGs, 2013-2014

District	*No. of CSPGs growing rice seed*	*Total seed produced (kg)*	*Average seed production (kg/CSPG)*
Aileu	8	3,420	428
Ainaro	5	3,420	684
Baucau	56	21,280	380
Bobonaro	17	11,020	648
Covalima	13	5,200	400
Dili	-	-	-
Ermera	8	3,420	428
Liquiça	3	1,140	380
Lautem	19	2,139	113
Manatuto	6	2,280	350
Manufahi	24	8,400	380
Oecusse	4	1,520	380
Viqueque	19	4,940	260
TOTAL	*182*	*68,179*	*375*

Peanut seed production

Utumua peanut seed was grown by 247 CSPGs during 2013-2014 (Table 59). Each group had received 10 kg of seed at planting time and planted the certified seed on a single plot (approximately 0.065 ha) with sufficient isolation distance from other peanut varieties.

About one month before planting time, basic seed production training was provided to all SEOs working with these farmers. They also received further training on post-harvest operations and quality control before harvest. These skills were subsequently extended to the peanut farmers.

Table 59. Peanut seed production by CSPGs in 2013-2014

District	*No. of CSPGs growing peanut seed*	*Total seed produced (kg)*	*Average seed production (kg/CSPG)*
Aileu	40	2,484	62
Ainaro	12	759	63
Baucau	19	1,311	69
Bobonaro	12	1,863	155
Covalima	14	1,104	79
Dili	1	69	69
Ermera	3	897	69
Liquiça	120	966	81
Lautem	0	2,139	74
Manatuto	14	1,380	66
Manufahi	21	966	69
Oecusse	34	2,277	67
Viqueque	26	1,725	66
TOTAL	*247*	*17,940*	*73*

There was increase in number of MAF-SoL CSPGs successfully growing peanuts which increased from 52 in 2011-2012 to 247 in 2013-2014. Similarly, there is more than ten-fold increase in peanut seed production from 1.7 t in 2011-2012 to 18 t in 2013-2014 by MAF-SoL CSPGs with an average of 73 kg/CSPG from 0.065 ha seed plot (Table 59). The reasons for significantly higher yield in Bobonaro are due to CSPGs prior-experience of peanut cultivation (of local varieties) and selection of fertile plot for seed production.

Sweet potato cutting production

One of the major lessons learned in 2011-2012 and 2012-2013 from sweet potato cultivation was that the survival rate of the sweet potato cuttings was low when the perishable cuttings were transported to CSPGs from distant research centres. To minimize the mortality rate, SoL established 37 sweet potato cuttings production centres locating at least one centre in each district so that Sucos within the district received fresh cuttings for timely planting. Each centre was at least 0.02 ha in area and received about 2000 cuttings for planting. These centres had the capacity to produce 20,000-40,000 cuttings in a year. A few of these centres sold cuttings to the MAF and NGOs for further multiplication. At least 1 million cuttings are targeted for sale from the exiting 37 centres during the 2014-2015 planting season.

Cassava cutting production

After two years of experience in the districts it was obvious that unless an incentive mechanism was built in to the system it would be difficult to maintain and sustain cassava cutting production centres. Farmers mentioned that it was a challenge to keep the plots free from grazing animals over the long growing period required to produce cassava stems. To solve this problem, MAF/SoL provided select farmer groups barbed wire to fence the seed plots and a buyback guarantee was provided so long as the centres' met minimum planting material quality standards. Eleven production centres in eight districts were identified covering 4.32 ha. These centres will be provided with sufficient planting material in December 2014 to produce approximately 0.5 million cuttings by the end of 2015.

4.2 Commercial seed producers

Following the establishment of a national seed system for released varieties (NSSRV), all commercial seed producers must obtain registration a certificate from the MAF Seed Department for marketing of commercial seed. In 2013-2014, 19 Farmer Associations (FAs) and 12 former contract grower groups formally registered with the MAF seed department as a Commercial Seed Producers (CSPs) to produce and sell seed of MAF released varieties. According to the NSSRV Guidelines for Commercial Seed Production, the registered seed producers are required to register their crop, varieties and the area to be cultivated with MAF Seed Department on an annual basis. During the seed production process, District Seed Officers (DSOs) from MAF seed department undertake visits to check CSPs fields and seed standard. Following approval by the DSOs, seed from CSPs can be sold with their own brand and truthfully labelled. More than 47 t of maize and 48 t of rice was produced commercially during 2013-2014 (Table 60).

Table 60. Summary Result of maize and paddy seed production by CSPs in 2013/2014

District	*Number of CSPs planting maize*	*Maize seed produced (kg)*	*No. CSPs planting rice*	*Rice seed produced (kg)*
Aileu	2	6,330	-	-
Ainaro	2	3,085	-	-
Baucau	3	4,450	3	22,350
Bobonaro	1	980	2	13,000
Covalima	-	-	-	-
Dili	-	-	-	-
Ermera	1	1,840	-	-
Liquiça	1	7,320	-	-
Lautem	2	4,372	-	-
Manatuto	3	15,295	-	-
Manufahi	5	2,570	-	-
Oecusse	-	-	-	-
Viqueque	2	900	2	6,000
TOTAL	*22*	*47,142*	*7*	*48,150*

All maize and rice seed produced by the CSPs was purchased by MAF through contractors. The companies paid, on average, USD1.50/kg for both the maize and rice seed from the CSPs. Future purchases of seed directly from farmers in Timor-Leste will reduce the need to import seed from other countries.

4.3 Access to seed for vulnerable households

Vulnerable households (VHs) in the rural areas of Timor-Leste generally live in relatively remote areas some distance from extension services and do not have easy access to new technologies. Improving their accessibility to improved varieties is a challenge for MAF. Vulnerable households are the poorer sector of the community, often women-headed households, and are normally not part of a group. They also lack knowledge on who to contact and where to get improved seeds. Considering these problems, a mechanism to improve access of seeds to VHs was developed and piloted in February 2012. This mechanism strengthens the linkage between seed users and seed producers in the community. Following an agreed procedure, the SEO and Aldeia chiefs jointly identify vulnerable households based on three criteria:

i) poorer households who are not members of existing MAF groups in the Aldeia,
ii) poor widows or women headed households, and
iii) possess land and are interested in growing improved varieties.

Once the list of VHs (normally 30 household per Aldeia) is approved by the Chief of the Suco, the vulnerable households are informed by the Aldeia chief and SEO that they can collect seed or cuttings of MAF released varieties from the nearby CSPGs within the Suco. The CSPGs, in the presence of a SEO, checks the names against the approved list of VHs and provide an agreed quantity of seeds (normally 1 kg peanut, or 2 kg maize or paddy) or sweet potato cuttings (200 cuttings /VH). The seeds are distributed approximately one month before planting time and the cuttings at planting time. After distribution, the CSPGs submit an invoice with the list of recipients and signature for payment to the District community seed coordinator who in turn pays the CSPG. In 2013-2014, seed and cutting distribution from CSPGs to vulnerable households was implemented in 10 of the 13 districts covering 31 Sucos and 106 Aldeias. A total of 2588 households (31% headed by women) received seeds or cuttings at the start of the 2013-2014 growing season.

4.4 Integration of savings and loans by Commercial Seed Producers

CSPs are becoming a strong social capital in communities where they have been established. After considerable training support and mentorship from MAF extension services, these groups now have improved i) institutional capacity, ii) technical capacity, iii) management capacity and iv) networking capacity but they have limited v) financial capacity. Since the CSPs were established primarily for commercial purposes, financial education is a key for improving financial capacity. For this reason, 17 CSPs were assisted to integrate savings and loan activities into their groups during 2013 and 2014. Membership was voluntary. Savings and loans programs address the financial needs of CSP members and encourages members to save money and allow members to take out loans when necessary at lower interest rates compared to that charged by money lenders. The Oecusse based NGO, BiFANO provided technical assistance for 9 months to establish savings and loans schemes in these CSPs. After this period, it is expected that these CSPs will be able run savings and loan activities on their own with no support from the NGO.

5. Farming systems research

5.1 Maize and velvet bean systems

Introduction

Velvet bean *(Macuna pruriens)* is traditionally cultivated in Timor Leste as a cover crop to suppress weeds and for consumption at last resort. Areas planted with velvet bean are Maliana (Hataz) Uatolari, Viqueque villa and Kribas (Manatuto). It is known as *Gabe* in the local languages of Kemak and Makasae, *Idate* in Laherek, *Dibia* in Tokodede and *Vaha'a* in Fataluku. Velvet bean is bitter to eat and has high levels of L-Dopa. It should be boiled at least three or four times before being consumed. Some villagers (in Bahalara-Uain village for example) boil the beans five times and then soak them in cool water for one night prior to one last re-boiling for consumption.

Velvet bean is considered as a green manure crop that increases soil nitrogen levels, improves soil texture and structure, reduces erosion, suppresses weeds, and has the potential to increase maize yields (Correia *et al.* 2013). This system is also often used in Honduras (Houngnandan *et al.* (2000). The trials described in this chapter evaluated the system on farmers' fields in Timor-Leste.

Materials and methods

Velvet bean trials were established in 15 sites in 4 villages in the Viqueque Villa Sub-District, Viqueque District. All sites were on the South coast of Timor Leste at an altitude of 0-100 masl (AEZ 6 according to ARPAPET 1996).). The trials were planted at the beginning of the wet season in 2013. The last observations of the trials were in August, 2014 (Table 61). Plot sizes were 5 m x 5 m with two velvet bean varieties (black and spotted color). Plots were visited fortnightly and measurements of plant density were taken by measuring the height of the foliage at the last observation.

Results and discussion

At the last of 7 observations the velvet bean biomass covered the land from 4-10 cm deep (Table 61). By this stage most of the leaf litter had dropped and it was obvious that the biomass was dependent on planting distance and soil fertility.

Most interviewed farmers were enthusiastic about replanting velvet bean. Some had previous experience with the cover crop during the Indonesian period but it was then planted at the edge of the field. The on-farm trialing of this system will continue into 2014-2015.

Table 61. Velvet bean OFDT biomass production 2013-2014

OFDT code	*Village*	*Latitude*	*Longitude*	*Elev. (masl)*	*Planting date*	*Last observation date*	*Dry velvet biomass depth at last observation (cm)*
123BL1	Bahalara-Uain	-8.947	126.276	26	22/11/2013	24/08/2014	8
123LL1	Bibileo	-8.957	126.279	7	10/12/2013	24/08/2014	7
123LL2	Bibileo	-8.957	126.280	20	10/12/2013	24/08/2014	7
123LL6	Bibileo	-8.951	126.272	15	10/12/2013	25/06/2014	6
123UL2	Uma-Uain Craic	-8.915	126.397	19	8/12/2013	23/08/2014	5
123UL1	Uma-Uain Craic	-8.923	126.396	6	8/12/2013	23/08/2014	5
123LL4	Bibileo	-8.957	126.278	54.8	22/11/2013	25/06/2014	6
123LL3	Bibileo	-8.956	126.279	2	23/11/2013	24/08/2014	4
123CL2	Carau-balu	-8.937	126.413	1	5/12/2013	25/06/2014	8
123BL2	Bahalara-Uain	-8.956	126.280	48.9	22/11/2013	25/06/2014	10
123BL3	Bahalara-Uain	-8.565	126.163	56.6	23/11/2013	16/06/2014	7
123LL8	Bibileo	-8.958	126.280	15	10/12/2013	26/06/2014	8
123CL1	Carau-balu	-8.521	126.223	76.5	10/12/2013	23/08/2014	4
123LL7	Bibileo	-8.573	126.164	45.5	26/11/2013	26/06/2014	8
123LL5	Bibileo	-8.572	126.164	49.1	10/12/2013	24/08/2014	7

5.2 Long-term maize and velvet bean trial soils

Introduction

After implementing a maize/velvet bean trial at Betano research station for five successive years in a row (see Correia et al, 2013 for details), it was observed that the soil in some plots appeared harder than others. Mr. Patrick Neimeyer from FAO examined the trial and took samples to measure their bulk density (BD), organic matter (OM) and aggregate stability (AS).

Methods and materials

The trial consisted of 5 treatments with three replicates, totaling 15 plots. The indicator crop for the trial was maize and treatments were: a) Ploughing the soil before planting maize, b) Ploughing the soil and planting with maize and velvet bean, c) no ploughing and planting maize with velvet bean, d) using glyphosate herbicide and then planting maize and e) using glyphosate herbicide and then planting with maize and velvet bean.

Bulk density

These BD samples were taken at the soil surface to a depth of 4 cm. One soil sample was taken from each plot using a bulk density metal ring of known volume. This is an estimation of compaction and results are measured in grams of soil/cm^3. Over time bioactivity in soils should increase, causing an increase in macro-porosity, and aggregation and therefore a decrease in bulk density.

Organic matter measurement

The BD samples were also used to measure the percentage of OM and AS. OM was measured by Loss on Ignition (LOI). Sieved soil samples were heated at 150^{o}C for two hours to remove water. The samples were weighed and then put in an induction oven at 350^{o} C for two hours. The samples were allowed to cool and weighed a second time. The amount of OM was calculated by dividing the loss in weight after treatment.

Aggregate stability

Aggregate stability was measured by submerging a dried soil aggregate and then measuring the amount of time needed for the aggregate to lose integrity. Soils were rated from 0 (lowest) to 5 (highest). This is known as a "slake test" and is not a qualitative test but offers insight into a soils ability to maintain aggregation during rapid wetting. As OM increases aggregation and aggregate stability increase. The procedure is outlined at http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051287.pdf

Results and discussion

Average organic matter levels in soils planted with velvet bean, a green manure crop, were greater than plots without (Table 62). The glyphosate only treatment has the lowest percentage OM. This is to be expected considering glyphosate killed all weeds on the site early in the season. Glyphosate herbicide was sprayed on the ground before the velvet bean was planted resulting in that treatment having higher OM than with glyphosate only.

Table 62. Soil measurements from long term maize/velvet bean trial, 2014

Treatment	*Mean % organic matter*	*Mean bulk density*	*Mean aggregate stability*
Plowing	4.88	0.80	1
Plowing and velvet bean	6.44	0.83	1
Velvet bean	6.58	0.90	2.3
Glyphosate	4.35	0.83	2.3
Velvet bean and glyphosate	5.40	1.00	2.7

Bulk densities in plowed areas were measured to be lower but all plots possessed bulk densities in acceptable ranges for clay soils.

Aggregate stability as measured by slaking was greater in non-tilled areas. Plowing reduces the soils natural ability to hold together during wetting. This is likely the result in a reduction of micro-biotic life that provides "organic glues" that hold the soil particles together. Turning the soil by plowing disrupts habitat for the microbes and therefore aggregate stability is reduced. Casual observations of macro-porosity in the plots also showed an abundance of earthworm activity in the treatments with velvet bean.

These observations show that cover cropping with velvet bean can have a positive impact on soil quality in Timor Leste.

5.3 N and P application on maize yields

Introduction

Maize yields in Timor-Leste are low compared with other parts of Asia. This may be due to the low level of soil nutrients in which the plants are cultivated. To investigate whether this problem can be resolved by applying inorganic fertilizers, a trial containing five rates of N and three rates of P was designed to be conducted on a series of soil types.

Methods and materials

Five rates of nitrogen and three rates of phosphorus were applied to maize at four locations during the wet season of 2013-2014 and into the dry season of 2014. All trials were replicated three times with a randomized complete block design and the trials were planted with the MAF released Sele variety. Trials sites included different soil types at research stations in Aileu (Quintal Portugal), Betano (Betano Research Station), Loes (Loes Research Station) and Urulefa Research Station (Ainaro) (Table 63). The plot size was 5 m x 5 m.

Results

Sele responded to applications of N and P fertilizer at one of the four sites being at Betano Research Station. The results of this experiment are presented in Table 63. This trial was conducted during the wet season and the plant density was reasonably consistent across the treatments (Table 64). Grain yield tended to increase with nitrogen applications ranging from 0-120 kg/ha. For some reason the yields and cob sizes were low at 60 kg/ha. An increase in the rate of applied P also resulted in increased yield.

Table 63. Details of planting and harvest date, maize variety trials, 2013-2014

Location	*Season*	*Planting date*	*Harvest date*	*Maturity days*	*Rainfall during trial*	*Response?*
Loes (Loes)	Dry	24 Apr. 2014	26 August 2014	120	0	ns
Aileu (K. Portugal)	Rainy	20 Nov. 2013	15 April 2014	150	1045	ns
Betano (Betano)	Rainy	Nov. 2013	April 2014		Not recorded	Yes
Urulefa (Maubisse)	Rainy	16 Oct. 2013	18 April 2014	180	1985	ns

Table 64. Maize yield and yield components, Betano, 2013-2014.

Factor	*Rate (kg/ha)*	*Yield (t/ha)*	*Plant density (/m^2)*	*Cobs/plant*	*Cob weight (g)*	*Seeds/cob*
N	0	2.29	5.3	1.0	43.2	174.3
	15	2.45	5.2	1.0	48.5	183.2
	30	2.91	5.2	1.0	58.5	231.4
	60	2.00	5.6	0.8	38.9	151.5
	120	3.02	5.0	1.0	59.8	218.5
P	0	2.24	4.8	0.9	50.5	193.8
	20	2.19	5.4	0.8	45.1	177.2
	40	2.71	5.4	1.0	52.3	198.9
F.prob		*0.03*	*0.03*	*0.03*	*0.01*	*0.01*
LSD (P<0.05)		*0.66*	*0.42*	*0.10*	*10.7*	*30.9*
% CV		*30.6*	*9.3*	*16.7*	*25.0*	*24.2*

5.4 Effect of hilling up on sweet potato varieties

Introduction

The trial described in this section was aimed to identify the impact of hilling up on sweet potato variety yields and its effect on attack by sweet potato weevil (*Cylas formicarius*).

Methods and materials

The trial was sited on a farm at approximately 10 masl in the District of Viqueque, sub district Viqueque Villa and Suco Uma-Uain, hamlet Loho. It was installed as a two way randomized block design with three replications and the plot size was 3.5 m x 3.5 m. The first factor, hilling up, possessed treatments: a) no hilling up, b) hilling up once and c) hilling up twice. The second factor consisted of 4 varieties, a) CIP 83, b) Hohrae 3 (HOH3), c) CIP 72 and d) a local sweet potato variety from Baucau. Cuttings were planted at one per hill at a distance between hills of 50 cm x 50 cm (4 cuttings/m^2). The trials was not irrigated or fertilized.

Results

Variety

The plots in all treatments yielded between 12 and 32 t/ha. All modern varieties out-yielded the local Baucau variety, but yield differences between modern varieties were no significant (Table 65). This effect was related to tuber weight and to a lesser extent, the number of tubers per plant. Most of the tubers for all varieties were of good quality and the plant densities were very similar. Insect attack was higher on the larger tubers with the % of tuber damage being greater on the large tubered CIP83.

Table 65. Effect of variety on sweet potato yield, 2013-2014

Variety	*Yield (t/ha)*	*Plant density (/m^2)*	*Tubers/plant*	*Tuber weight (kg)*	*% tuber damage*	*% good tubers*
CIP 83	27.0a	2.80	4.5a	0.23a	18.5a	81.5
HOH 3	25.9a	2.59	5.0a	0.21a	12.7b	87.3
CIP 72	32.0a	2.27	7.4b	0.19a	8.7b	83.0
Local Baucau	12.4b	2.53	4.2a	0.12b	13.5b	86.5
F.Prob	0.004	0.379	<.001	0.006	0.014	0.78
LSD (p<.05%)	10.13	ns	1.43	0.06	5.58	ns
%CV	42.6	25	27	32.5	42.7	16.3

Hilling up

Hilling up frequency had no effect on tuber yields (Table 66). The farmers did, however, observe that, after hilling up, the plant tended to produce larger tubers from the main root. This observation applied also for the local varieties. Larger tubers were mentioned to be easier to sell at the local market. However large tubers were more susceptible to being attacked by sweet potato weevil (*Cylas formicarius*) and needed to be harvested at maturity.

Table 66. Effect of hilling up on sweet potato yield, 2013-2014

Frequency of hilling up	*Yield (t/ha)*	*Density (plants/m^2)*	*Tubers/plant*	*Tuber weight (kg)*	*% tuber damaged*	*% of good tubers*
No hilling up	23.2	2.69	5.3	0.17	15.9	84.1
Hilling up once	24.2	2.36	5.5	0.19	11.8	82.0
Hilling up twice	25.5	2.59	5.0	0.19	12.3	87.7
F.Prob	*0.86*	*0.45*	*0.70*	*0.40*	*0.19*	*0.60*
LSD (p<.05)	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
% CV	*42.6*	*25*	*27*	*32.5*	*42.7*	*16.3*

6. Social science research

6.1 OFDT Farmers baseline data (*Buka Dadus Los*)

Baseline data was collected from 273 farm households conducting On-Farm Demonstration Trials (OFDTs) during 2013-2014 to evaluate their household conditions of food and economy, social systems and farming practices. The Buka Dadus Los (meaning ‘looking for true and reliable data’) was not always complete for each of the participating households.

Farmer households and gender participation

Farming households in Timor-Leste are usually extended families, often with 3-10 family members. As shown in Table 67, the maximum number of persons in one OFDT farm household was 25 (where the grandparents, husband, wife and children and some other relatives all lived under one roof), with the minimum being a single person. On average, the OFDT households in the eight districts had 8.7 (~9) persons living in the house. The members of the households normally work together on the farm, with children tending animals while older family members do light duties such as milling, watering and collecting firewood.

Table 67. Member number per household

Members per household	*District*								
	Aileu	*Ainaro*	*Baucau*	*Bobonaro*	*Ermera*	*Liquiça*	*Manufahi*	*Viqueque*	*Total*
1	1			1				1	3
2	1	1				2		4	8
3	1	2	1	4	1	1		3	13
4		1	5	5		1	4	15	31
5	7	2	15	12		4		11	51
6	8		12	5	1		2	9	37
7	7	4	12	10	1	1		4	39
8	6		12	6		2	3	10	39
9	6	2	5	1		1		1	16
10	9	3	2	3			1	2	20
11		3		1			1		5
12		1	1	1		1			4
13		3	2						5
15		1							1
25			1						1
Total	*46*	*23*	*68*	*49*	*3*	*13*	*11*	*60*	*273*

Even though the household members work collectively in farm operations, the heads of household play the most important roles in making household decisions. This includes managing and controlling the farm, and deciding on household expenditures. Of the 273 households, 69% were headed by men and 31% headed by women (Table 68). The percentage of female headed households in 2013-2014 was greater than in 2012-2013 when 24% of the 143 OFDT households were headed by women.

Table 68. Gender of head of households

		Number			Percent	
District	*Sub district*	*Female*	*Male*	*Total*	*Female*	*Male*
Aileu	Aileu vila	1	3	4	25	75
Aileu	Laulara	12	11	23	52	48
Aileu	Liquidoe	3	4	7	43	57
Aileu	Remexio	4	8	12	33	67
Ainaro	Maubisse	5	18	23	22	78
Baucau	Baucau	14	16	30	47	53
Baucau	Vemase	11	17	28	39	61
Baucau	Venilale	2	8	10	20	80
Bobonaro	Balibo	5	38	43	12	88
Bobonaro	Maliana	4	2	6	67	33
Ermera	Hatolia	1	2	3	33	67
Liquiça	Liquiça	2	11	13	15	85
Manufahi	Alas	2	5	7	29	71
Manufahi	Same	1	3	4	25	75
Viqueque	Ossu	8	13	21	38	62
Viqueque	Viqueque	10	29	39	26	74
	Total	*85*	*188*	*273*	*31*	*69*

Farm activities are often implemented jointly by men and women. Table 69 shows per district where, in 2013-2014, men and women worked together in cultivating maize and rice, and where they worked separately. For all OFDTs together, planting maize was mostly done jointly (51%) and 40% of the households reported that maize was planted by women only, with only 2% being planted by men only. For rice, it was planted by both men and women (27% or 98% of rice farmers). The total number of farmers who reported on gender roles in planting maize and rice was 251 and 80 farmers respectively. In Aileu, Ainaro, Liquiça and Manufahi none of the interviewed farmers were growing rice during the 2013-2014 growing season.

Table 69. Role of gender in planting maize and rice

	Maize						Rice						
	Both		Female		Male		Both		Female		Male		
District	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*Total*
Aileu	36	78	10	22									46
Ainaro	13	59	9	41									22
Baucau	20	29	40	59	3	4	7	10	6	9			68
Bobonaro	3	6	32	65			13	27			1	2	49
Ermera			3	100			3	100					3
Liquiça			13	100									13
Manufahi	9	90	1	10									10
Viqueque	57	95			2	3	50	83					60
Total	*138*	*51*	*108*	*40*	*5*	*2*	*73*	*27*	*6*	*2*	*1*	*0.4*	*271*

Group work and social assistance

Thirty nine percent of the 2013-2014 OFDT households were involved in group work and 56% received some assistance from MAF, NGOs or others. Table 70 shows how many of the OFDT households in each district belonged to groups in their villages or hamlets. In Ermera, all OFDT households belonged to such groups.

Table 70. Group participation of OFDT households

	Group work				
	Number			*Percent*	
District	*No*	*Yes*	*Total*	*No*	*Yes*
Aileu	28	18	46	61	39
Ainaro	1	22	23	4	96
Baucau	61	7	68	90	10
Bobonaro	37	12	49	76	24
Ermera		3	3		100
Liquiça	8	5	13	62	38
Manufahi	4	7	11	36	64
Viqueque	28	32	60	47	53
Total	*167*	*106*	*273*	*61*	*39*

Besides their involvement in group activities, the farmers also received assistance from institutions working in agriculture (i.e. MAF, NGOs, and others such as Churches). The types of assistance provided included seeds, tractors, training and others. As indicated in Table 71, 56% of the farmers who participated in OFDTs received one or more types of assistance during the 2013-2014 growing season.

Table 71. Assistance received by interviewed households

	Assistance received				
	Number			*Percent*	
District	*No*	*Yes*	*Total*	*No*	*Yes*
Aileu	23	23	46	50	50
Ainaro		23	23		100
Baucau	37	31	68	54	46
Bobonaro	29	20	49	59	41
Ermera	1	2	3	33	67
Liquiça	12	1	13	92	8
Manufahi	1	10	11	9	91
Viqueque	18	42	60	30	70
Total	*121*	*152*	*273*	*44*	*56*

Comparing the type of assistance farmers received during the 2013-2014 growing season, the study showed most farmers (55%) in the eight districts received seed. Thirty percent received subsidized tractor use, 12% training and 4% other (Table 72). The assistance sources were from MAF (46%), MAF-NGOs (30%), NGOs (19%) and MAF-other (4%) (Table 73).

Table 72. Type of assistance received by interviewed households

	Type of assistance								
	Seeds		*Tractor*		*Training*		*Other*		
District	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*Total*
Aileu	19	50	3	8	11	29	5	13	38
Ainaro	23	100							23
Baucau	25	47	25	47			3	6	53
Bobonaro	18	95	1	5					19
Ermera	2	100							2
Liquiça	1	100							1
Manufahi	3	19	10	63	3	19			16
Viqueque	42	47	33	37	14	16	1	1	90
Total	*133*	*55*	*72*	*30*	*28*	*12*	*9*	*4*	*242*

Table 73. Source of received assistance given to farm households

	Source of assistance										
	MAF		*MAF-NGO*		*NGO*		*MAF-Other*		*Other*		*Total*
District	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	
Aileu	4	17	12	52	6	26			1	4	*23*
Ainaro	1	4	3	13	19	83					*23*
Baucau	27	87	1	3			3	10			*31*
Bobonaro	13	68	3	16	3	16					*19*
Ermera	2	100									*2*
Liquiça	1	100									*1*
Manufahi	5	50	5	50							*10*
Viqueque	17	40	22	52			3	7			*42*
Total	*70*	*46*	*46*	*30*	*28*	*19*	*6*	*4*	*1*	*1*	*151*

Seed and coping strategies

The OFDT farmers were asked if they had experienced a lack of seeds in the 2013-2014 growing season, and if yes, what strategy they had used to obtain seed. This mainly focused on maize seed, and 79% of the OFDT households reported that they had sufficient seed (Table 74).

The 21% of farmers who did not have sufficient seed pursued a range of strategies to obtain seed (Table 75). Most farmers solved their lack of seed by buying seed in the market (75%) followed by MAF and/or MAF-SoL, asking family, buying from family and in the market, NGO and own seeds.

Table 74. Lack of seed experienced by interviewed households

	Lack of seeds				
	Number			*Percent*	
District	*No*	*Yes*	*Total*	*No*	*Yes*
Aileu	22	24	46	48	52
Ainaro	2	21	23	9	91
Baucau	60	7	67	90	10
Bobonaro	44	4	48	92	8
Ermera	3		3	100	
Liquiça	13		13	100	
Manufahi	10	1	11	91	9
Viqueque	59	1	60	98	2
Total	*213*	*58*	*271*	*79*	*21*

Table 75. Seed source - if farmers needed new seed

	Aileu		*Ainaro*		*Baucau*		*Bobonaro*		*Manufahi*		*Viqueque*		*Total*	
Source seed	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Bought in market	19	79	20	100			4	100					43	75
MAF-SoL					3	43					1	100	4	7
From family	2	8							1	100			3	5
MAF district					3	43							3	5
Market and family	2	8											2	4
NGO	1	4											1	2
Own seeds					1	14							1	2
Total respondents	*24*		*20*		*7*		*4*		*1*		*1*		*57*	

Number of plots of land and period under cultivation

The farmers were asked how many plots of land they had planted in the 2013-2014 growing season. Of the 268 OFDT households, most (53%) reported they had 2-4 plots, less than half of the farmers (47%) reported they had one plot only, and only 0.8% of farmers reported they had farmed on 5-6 plots during the 2013-2014 growing season (Table 76). No information is available on the size of the plots, as these were not measured during the survey.

Table 76. Number of plots planted by farmers 2013-2014

	Number of plots												
	1		*2*		*3*		*4*		*5*		*6*		
District	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*Total*
Aileu	14	30	22	48	8	17	2	4					46
Ainaro	1	4	5	22	13	57	3	13	1	4			23
Baucau	31	46	32	47	5	7							68
Bobonaro	17	37	24	52	3	7	1	2			1	2	46
Ermera	1	33	2	67									3
Liquiça	8	67	4	33									12
Manufahi	9	90	1	10									10
Viqueque	44	73	16	27									60
Total	*125*	*47*	*106*	*40*	*29*	*11*	*6*	*2*	*1*	*0.4*	*1*	*0.4*	*268*

A large number of the plots had been cultivated for many years. As indicated in Table 77, two-thirds of the farming plots had been used for 10 years or longer. This may affect the availability of soil nutrients. As farmers continually use the same plots without specific measures to improve soil nutrients, it may result in declining and low yields, making it more difficult for households to meet their own food needs. The issue on soil nutrients and the duration of the plot utility is important for improving farm productions.

Table 77. Years of farm use

	Duration of plot used																						
District	*1*		*2*		*3*		*4*		*5*		*6*		*7*		*8*		*9*		*10*		*>10*		*Total*
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	
Aileu	1	2	2	4	1	2	4	9	1	2	2	4	1	2			3	7	4	9	27	59	46
Ainaro																			10	43	13	57	23
Baucau	5	7	3	4	7	10	2	3	10	15	3	4	3	4	2	3			8	12	25	37	68
Bobonaro			3	7	2	4	1	2	1	2	1	2	2	4							36	78	46
Ermera			2	67																	1	33	3
Liquiça	1	8	2	15	1	8											1	8			8	62	13
Manufahi			1	10	1	10	4	40	1	10	2	20			1	10							10
Viqueque	1	2	1	2	3	5	3	5	3	5	1	2			1	2			3	5	44	73	60
Total	*7*	*3*	*14*	*5*	*15*	*6*	*14*	*5*	*16*	*6*	*9*	*3*	*6*	*2*	*4*	*1*	*4*	*1*	*25*	*9*	*154*	*57*	*268*

Revenue

The income of interviewed farmers during 2013-2014 was sourced from various activities. As indicated in Table 78, farmers did many activities for raising household revenue with most sourced from livestock (55%), crops and plantation (42%). The rest were sourced from doing paid work (labour) (18%) and small business such as selling firewood (11%), operating a kiosk (4%), selling fuel (1%) and working for a company (0.4%). The average amount that farmers received from selling livestock was $ 268; from food crops $ 114 and from plantation crops $ 132. Paid work amounted to $ 334, operating a kiosk amounted to $ 250, firewood accounted for $ 57, company and fuel amounted $ 250 and $ 413 respectively. Beyond the above sources, some farmers (12%) also got income from government pension which in dollar value was accounted for $ 779 on average (Table 79).

Table 78. Source of income

Source of income	*Aileu*		*Ainaro*		*Baucau*		*Bobonaro*		*Ermera*		*Liquiça*		*Manufahi*		*Viqueque*		*Total*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Livestock	38	83	11	48	23	34	24	49	2	67	10	77	7	64	36	60	151	55
Food crops	5	11	23	100	30	44	10	20	3	100	5	38	6	55	33	55	115	42
Plantation crops	22	48	23	100	17	25	4	8							48	80	114	42
Fishing	11	24	13	57	5	7	13	27			2	15	2	18	4	7	50	18
Pension	4	9	7	30	4	6	14	29			1	8	3	27	1	2	34	12
Paid work	7	15			1	1	3	6			1	8					12	4
Firewood	2	4	5	22							1	8	1	9	2	3	11	4
Kiosk							1	2							2	3	3	1
Sell fuel							1	2					1	9			2	1
Company							1	2									1	0.4
N	*46*		*23*		*68*		*49*		*3*		*13*		*11*		*60*		*273*	

Table 79. Amount of money received from each activity

	Amount received from									
District	*Pension*	*Fuel*	*Employment*	*Livestock*	*Kiosk*	*Company*	*Fishing*	*Crops*	*Plantation*	*Firewood*
Aileu	529		168	252	534			54	225	71
Ainaro	195		158	141	160			86	211	
Baucau	283		270	243				180	181	50
Bobonaro	1452	1000	639	539		250		108	186	44
Ermera				100				220		
Liquiça	150		200	196	20			38		10
Manufahi	360		650	411	15		200	248		
Viqueque	298	120	320	161	425			62	26	
Average	*779*	*413*	*334*	*268*	*250*	*250*	*200*	*114*	*132*	*57*

Food crops

Forty three crops (exclude other = 4%) were reportedly grown by OFDTs households in the eight districts during the 2013-2014 growing season (Table 80). Identified crops were soursop, lemon grass, snake bean, soybean, pomelo, cashew, toad (leafy vegetable), swimming bean, mahogany and passion fruit. However, mostly, farmers grew maize (85 %) cassava (77 %), sweet potato (73 %), pumpkin (58 %), taro (54 %) and short season maize and string bean (48 % each) as the main crops on their farms while irrigated and dry land rice was only cultivated by 21 % and 11 % of households respectively.

Along with the above food crops, farmers in the eight districts also grew beans and wild food as part of their farm operation. The beans were string bean (48%), red bean, mung bean (19% each) and black turtle bean (*Phaseolus vulgaris*) (6%) while the wild food was yam (29%), jicama (20%), elephant foot's yam (18%) and velvet bean (11%) (Table 80). Beyond the above crops, farmers also grew fruit tree and vegetable (mango, lemon, spinach, tomato, chilies and mustard green) for household cash and consumption.

Table 80.   Crops cultivated on interviewed farmer's fields

English	*Tetum*	*Latin*	*Number*	*Percent*
Maize	Batar bo'ot	*Zea mays L.*	231	85%
Cassava	Aifarina	*Manihot esculenta Cranz*	211	77%
Sweet Potato	Fehuk midar	*Ipomea batatas L.*	200	73%
Pumpkin	Lakero	*Cucurbita spp*	159	58%
Taro	Talas	*Colocasia esculenta*	147	54%
Early maize	Batar lais	*Zea mays L.*	132	48%
String bean	Foretalin	*Phaseolus vulgaris*	130	48%
Arrowroot	Kontas	*Maranta arundinacea*	102	37%
Cucumber	Pipinhu	*Cucumis sativus*	101	37%
Yam	Kumbili	*Dioscorea spp.*	79	29%
Peanut	Forerai	*Arachis hypogaea L.*	74	27%
Irrigated rice	Hare irigasaun	*Oryza sativa L.*	56	21%
Jicama	Singkumas	*Pachyrhizus erosus*	55	20%
Mung Bean	Foremunggu	*Vigna radiata*	53	19%
Red Bean	Koto	*Phaseolus vulgaris*	51	19%
Elephant Foot Yam	Maek	*Amorphophallus paeoniifolius*	49	18%
Papaya	Aidila	*Carica papaya*	42	15%
Sorghum	Bata rain as	*Sorghum bicolour*	40	15%
Irish potato	Fehuk ropa	*Solanum tubersosum L.*	35	13%
Upland rice	Hare rai maran	*Oryza sativa L.*	30	11%
Velvet bean	Lehe	*Mucuna pruriens*	29	11%
Banana	Hudi	*Musa sapientum fixa*	29	11%
Coconut	Nu'u	*Cocos nucifera*	26	10%
Eggplant	Brinjela	*Solanum melongena*	19	7%
Chili	Aimanas	*Capsicum sp.*	18	7%
Pigeon pea	Tunis	*Cajanus cajan*	18	7%
Black turtle bean	Fore metan	*Phaseolus vulgaris*	16	6%
Other maize	Batar seluk	*Zea mays L.*	10	4%
Wing bean	Duhaen	*Psophocarpus tetragonolobus*	9	3%
Mango	Has	*Mangifera sp.*	8	3%
Spinach	Bayam	*Spinacia oleracea L.*	7	3%
Mustard green	Mostarda	*Brassica juncea*	4	1%
Watermelon	Pateka	*Citrullus lanatus* var. *lanatus*	4	1%
Pineapple	Ainanas	*Ananas comosus L.*	3	1%
Jackfruit	Kulu	*Artocarpus heterophyllus*	3	1%
Malunggay	Marungi	*Moringa oleifera*	3	1%
Teak tree	Aiteka	*Tectona grandis*	2	1%
Lemon	Derok	*Citrus L.*	2	1%
Cacao	Kakao	*Theobroma cacao*	2	1%
Basil	Ruku	*Ocimum basilicum*	2	1%
Tobacco	Tabako	*Nicotiana tabacum L.*	2	1%
Sugarcane	Tohu	*Saccharum officinarum*	2	1%
Tomato	Tomate	*Solanum lycopersicum L.*	2	1%
Other			12	4%

N =273.

From the total number of more than 43 crops grown (Table 80), most famers (85%) grew 4-13 crops on their farm in a year (Figure 21). This was done by OFDTs farmers for reducing the failure of cultivating one or two commodities in one or two seasons.

As shown in Table 80, farmers in the eight districts grew a wide range of tuber crops (cassava, sweet potato, taro and arrow root on their farm) for household consumption during the year. These crops can be harvested at any time during the year for household consumption and therefore, was the best for addressing household food insecurity during the hungry periods.

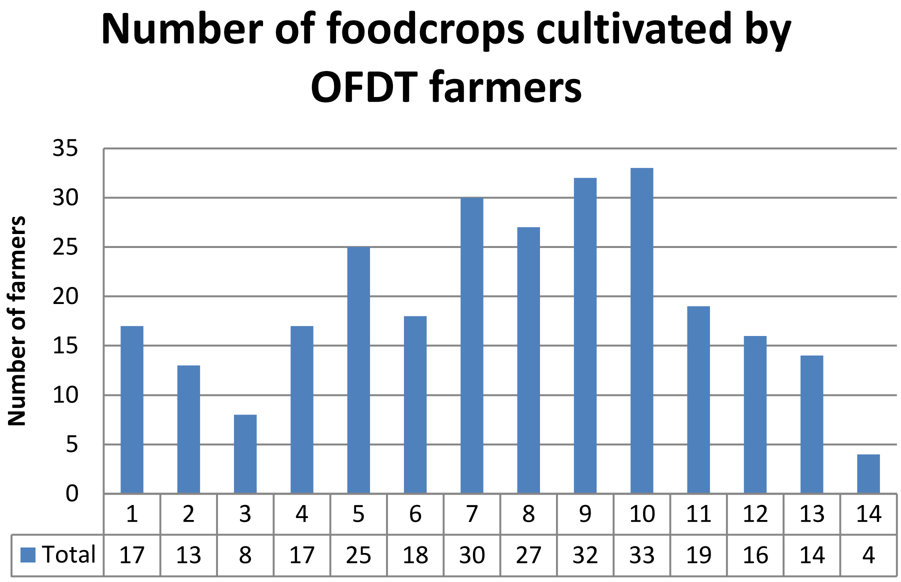


Figure 21. Food crops cultivated by interviewed farmers

Maize harvest assessment for the 2013-2014 growing season

The interviewed farmers were asked whether they considered that the season was either good, average or bad. The study showed that 85% of the OFDT farmers reported they received average or good maize production during the year (Table 81). Only 15% of them reported they had a poor maize crop.

Table 81. 2013 maize harvest result

	Average		*Bad*		*Good*		*Total*
District	*N*	*%*	*N*	*%*	*N*	*%*	*number*
Aileu	22	48	13	28	11	24	46
Ainaro	17	74	6	26			23
Baucau	53	79	7	10	7	10	67
Bobonaro	35	88	1	3	4	10	40
Ermera					3	100	3
Liquiça	1	8	11	85	1	8	13
Manufahi	5	50	2	20	3	30	10
Viqueque	45	76			14	24	59
Total	*178*	*69*	*40*	*15*	*43*	*16*	*261*

Food security

Food security was evaluated based on the availability of domestic production of maize for household consumption during the 2013-2014 growing season. Maize was considered as the main source of household's food security assessment in the study whether the households had sufficient, insufficient or surplus maize for consumption during the year. From the total of 252 OFDTs households reporting household food security during the survey, 26% of them reported they had insufficient maize to consume during the year (Table 82). The rest reported had either sufficient to consume or a surplus. These accounted for 59% and 15% respectively.

Table 82. Household food security by district

District	Enough N	Enough %	Insufficient N	Insufficient %	Surplus N	Surplus %	Total
Aileu	23	50	13	28	10	22	46
Ainaro	8	36	14	64			22
Baucau	47	75	12	19	4	6	63
Bobonaro	31	86	2	6	3	8	36
Ermera			1	33	2	67	3
Liquiça	4	31	9	69			13
Manufahi	5	50	2	20	3	30	10
Viqueque	31	53	12	20	16	27	59
Female	46	57	20	25	15	19	81
Male	103	60	45	26	23	13	171
Total	*149*	*59*	*65*	*26*	*38*	*15*	*252*

When compiling the food security data of OFDT households from 2007-2008 to 2013-2014, it seems the number of households reporting had insufficient and sufficient food to consume during the year was better than in the previous years. It showed the best figures ever among the households participated in OFDTs since the implementation of the program in 2006-2007 except in 2009-2010 and 2010-2011 (Table 83).

Table 83. Household food security by year

Year	*Insufficient %*	*Sufficient %*	*Surplus %*	*Number of respondents*
2007-2008	38	47	15	502
2008-2009	29	54	17	262
2009-2010	16	73	11	354
2010-2011	21	72	7	232
2011-2012	47	45	8	114
2012-2013	35	48	17	127
2013-2014	26	59	15	252

Farmers who reported they had insufficient food to consume during the year were also asked in which month the shortage began. The results showed that the farmers first faced a lack of food (or the food started diminishing) in March and all maize stocks were consumed by the following February (Figure 22). It would appear that some households had food reserves for only one-two months and some had reserves for around 10-11 months. Most (68%) of farmers reported their food was exhausted by October-January. These months (October-January) was the peak of the hungry season of the country that occurred during a busy farming period around the country. In Timor-Leste most farmers prepare their land for farming before the month of November, grow maize during the November to December and harvest them at the beginning of the year (during the month of February and March).

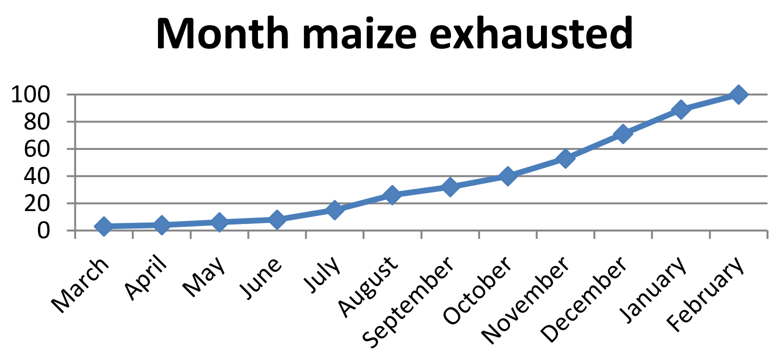


Figure 22. Month maize stores exhausted

Those who reported they had insufficient food to consume during the year reported that their crops were lost because of or negatively affected by drought, wind, weeds, animal, pests and disease. As shown in Table 84, most farmers (48%) reported their production was lost because of drought, by wind (23%), animal damage (13%), weeds (11%), pests (3%) and disease (2%).

Table 84. Farmer's perceptions of factors reducing harvest yields by district

District	*No rain*	*Wind*	*Animals*	*Weeds*	*Pests*	*Disease*
Aileu	8	4	2		1	
Ainaro	5	1		4		
Baucau	7	4	2		1	1
Liquiça	9	4	4	2		
Manufahi	2	2		1		
Total number of respondents	*31*	*15*	*8*	*7*	*2*	*1*
% of causes	*48%*	*23%*	*13%*	*11%*	*3%*	*2%*
% respondents reporting lost	*48%*	*23%*	*12%*	*11%*	*3%*	*2%*

Among the above factors, a shortage of maize also occurred because some of the farmers sold their food crops for cash at the market. As shown in Table 78, 42% of farmers who participated in OFDTs also sold their food crops for cash and the average amount the farmers received from selling the food crops in the eight districts was $ 114.

Storage

As in previous years, most farmers stored their maize as unsheathed cobs in sacks, as sheaves or in baskets (Table 85). Only 8% of farmers stored their maize (maize grain) and other crops in a drum.

Table 85. Storage methods for maize seed and other crops

	Storage methods										
	Sack		*Sheaves*		*Drum*		*Basket*		*Other*		*Total*
District	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	
Aileu	4	9	28	61	1	2			13	28	46
Ainaro	21	100									21
Baucau	36	68	14	26	2	4			1	2	53
Bobonaro	2	6	18	50	15	42			1	3	36
Ermera	1	33			1	33	1	33			3
Liquiça	1	8	10	77	1	8	1	8			13
Manufahi	1	13	5	63	1	13			1	13	8
Viqueque	31	54	21	37	1	2			4	7	57
Total	*97*	*41*	*96*	*41*	*22*	*9*	*2*	*1*	*20*	*8*	*237*

One hundred and thirty-eight farmers using drums for on-farm storage were interviewed and it was found that 51% of them used the drums to store maize seed, 39% for general grain storage and 10% for water or other uses (Table 86).

Table 86. Use of drums across seven districts

	Use of drum								
	Seeds		*Grain*		*Water*		*Other*		
District	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*Total*
Aileu	4	40	2	20	4	40			10
Ainaro	15	60	10	40					25
Baucau	6	33	5	28	6	33	1	6	18
Bobonaro	21	54	18	46					39
Liquiça	1	50			1	50			2
Manufahi	3	75	1	25					4
Viqueque	21	53	18	45	1	3			40
Total	*71*	*51*	*54*	*39*	*12*	*9*	*1*	*1*	*138*

Economic status

The economic status of OFDT households was assessed using two indicators - housing condition and the number of possessions. It was assumed that farmers with concrete houses (corrugated iron roof, concrete walls and floor) and held many possessions were considered to be of higher economic status (wealthier) than those without (poorer).

A house consists of roof, walls and floor. As indicated in Table 87, the majority of the interviewed farmer households (78%) possessed a roof made of metal and/or asbestos and only 22% of them reported had their roof made of palm leaves and/or grass. This is in contrast to 2007 when 56% of households possessed thatched or palm leave roofs. For walls, 78% (17% of full block walls and 61% of non brick walls) of the farmers reported their walls made up of one material and only 15% reported their walls was made up of two materials while for the floor, only 17% of the farmers reported that their floor was made of cement board/tiles.

Table 87. Housing conditions of OFDT farmers across the eight Districts

House structure	*Aileu*	*Ainaro*	*Baucau*	*Bobonaro*	*Ermera*	*Liquiça*	*Manufahi*	*Viqueque*	*Average*
N	*46*	*23*	*68*	*48*	*3*	*13*	*10*	*60*	*271*
				%					
Roof									
Metal	98	78	94	58		77	30	70	77
Asbestos							20		1
Palm leaves/grass	2	22	6	42	100	23	50	30	22
Walls									
Full brick walls	26	4	26	17		8	30	7	17
Cement blocks	26	4	26	17		8	30	7	17
Non brick walls	72	83	49	38	100	69	40	75	61
Bamboo	65	35	29			38		38	32
Palm fronds	2	17	3	38	100	15	40	20	17
Clay/sod	4	22	6			15		2	5
Wood			7					10	4
Metal		9	3					5	3
Half brick walls	2	8	24	17		15		18	15
Cement blocks and palm frond			7	15		8		10	7
Cement blocks and bamboo			4					2	1
Cement blocks and metal			1					3	1
Cement blocks and wood			3						1
Cement blocks and other	2								0.4
Clay/sod and bamboo			1			8			1
Clay/sod and palm frond			1						0.4
Clay/sod and wood				2					0.4
Clay/sod and metal		4							0.4
Metal and palm fronds			3						1
Metal and Bamboo		4							0.4
Rock and palm fronds								2	0.4
Rock and bamboo			1						0.4
Palm fronds and other								2	0.4
Floor									
Dirt/clay	70	100	66	44	100	92	80	87	72
Cement board/tiles	11		13	54		8	20	5	17
Wood				2					0.4
Bamboo	2								0.4
Other	17		21					8	10

Household possessions consisted of a number of items the households held in the eight districts. Twelve items were reported possessed by the OFDTs farmers and mostly farmers in the eight districts held items such as chair, mobile phone and radio (Table 88). Farmers who reported they had television or motor bike accounted for 23% and 18% respectively and those who reported they had drums in their house accounted for 28%.

At the district level, all farmers in Baucau seemed to be wealthier than farmers in other districts. As indicated in Table 88, all farmers in Baucau had at least one of the listed items in Table 88 while in Ermera farmers possessed only four of the items.

Table 88. Ownership of household goods

Possession	*Aileu* %	*Ainaro* %	*Baucau* %	*Bobonaro* %	*Ermera* %	*Liquiça* %	*Manufahi* %	*Viqueque* %	*Average* %
Chair	48	83	91	82	100	54	73	67	74
Phone	83	96	78	78	33	46	91	50	73
Radio	43	87	76	12	67	15	27	27	44
Drum	13	65	12	43		15	27	35	28
Television	9	13	34	35	33	15	27	15	23
Motorcycle	13	30	16	33		8	18	8	18
Bicycle		4	6				73	2	5
Refrigerator			6	6					3
Generator			4	2					1
Car	2		1	2					1
Thresher			4						1
Rice mill			4						1
Total respondents	*46*	*23*	*68*	*49*	*3*	*13*	*11*	*60*	*273*

Comparing the household economic condition across years, the overall economic status of OFDT households has steadily improved since 2006-2007. As shown in Table 89, more farmers possessed motorbikes and phones than in previous years.

Table 89. Wealth measures across years

Description	*2006-07* %	*2007-08* %	*2008-09* %	*2009-10* %	*2010-11* %	*2011-12* %	*2012-13* %	*2013-14* %
Tin/board roof	n/a	76	69	79	70	62	76	78
Full block wall	n/a	19	17	24	24	13	12	17
Half block wall	n/a	22	10	13	13	12	15	10
Cement / floor tiles	n/a	34	22	35	30	19	36	17
Mobile phone	3	10	6	43	65	35	71	73
Motorbike	5	5	3	11	22	10	13	18
Car	2	3	1	2	4	0.9	9	1
Diesel generator	3	3	2	3	9	1.4	1	3
Total # respondents	*340*	*502*	*362*	*354*	*237*	*156*	*136*	*273*

6.2 Summary of case studies conducted during 2014

In 2014, the SoL socio-economic research team engaged in, or provided support to various studies and surveys. In this section a description of the activities and the results is given. For the completed surveys and studies separate reports are available which provide more detailed information than is provided in this section.

6.2.1 Leveraging social relationships for seed diffusion in Timor-Leste

This is a study made by Modesto Lopes for his MSc degree at the University of Western Australia (UWA). Part of the study titled Typology of successful Community Seed Production Groups (CSPGs) for the multiplication and distribution of high yielding maize seed in Timor-Leste was re-written as a paper published in the journal Agronomy for Sustainable Development with the title "Harnessing social capital for maize seed diffusion in Timor-Leste" (Lopes *et al*, 2015). The study looked at the members of 30 maize CSPGs who were interviewed in mid-2013, close to two years after their establishment. The 30 groups were selected in five districts (six groups per district), and in each group three members were randomly selected for interviews.

The factors that were assessed for their influence on the success of the CSPGs are shown in Figure 23.

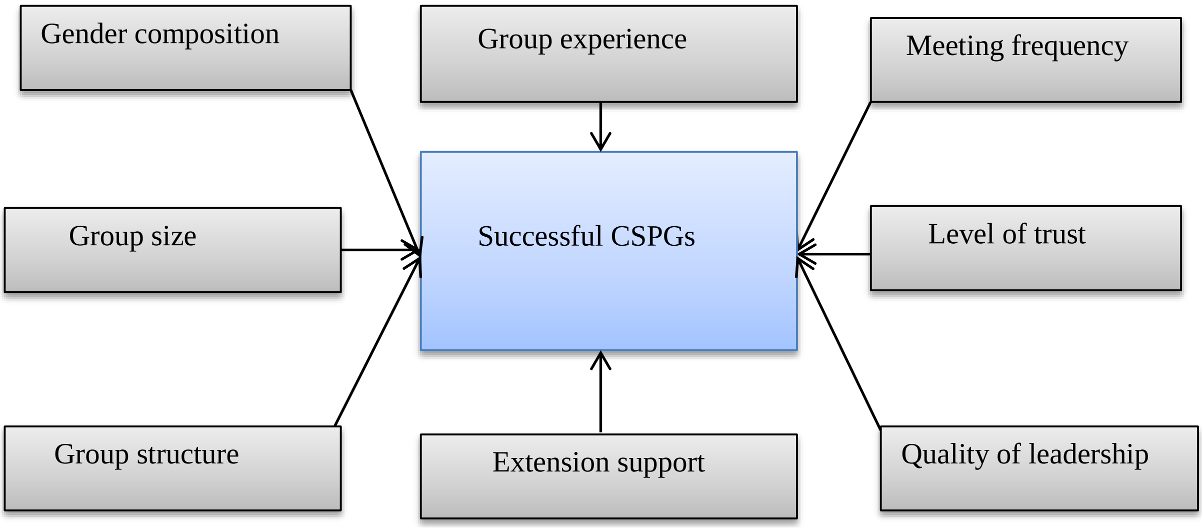


Figure 23. Research Framework

The study showed: 1) that the groups had an increased production in their second year of operation; 2) that seed was being disseminated between the group members; 3) that the sale of extra seed generated income; and 4) that the success of these groups inspired other farmers to establish similar groups.

Several characteristics were correlated with the quantity of shared seed distributed to individual group members, as a measure of group effectiveness: meeting frequency (r=0.69), the number of positive leadership traits (r=0.57), the level of group trust (r=0.51), and the number of defined management roles within the group (r=0.41). These traits all reflect the strength of social capital and group governance. From this it can be concluded that development can be furthered through positively aligning and leveraging existing social capital among farmers for technology dissemination.

6.2.2 Study of eight CSPGs growing maize, rice and peanut

This is a study of eight Community Seed Production Groups (CSPGs) (see Table 90) which were established in 2012 in the districts Ermera, Manatuto and Lautem, where Seeds of Life did not have prior project activities. The objective of the study was to determine the capacity of each group.

Table 90. Selected sucos and CSPGs for longitudinal study

No.	*District*	*Sub-District*	*Suco*	*Name of CSPG*	*Crop variety cultivated by CSPG*	*Capacity assessment of the CSPG, mid-2014 (*)*
1	Ermera	Railaco	Lihu	Lesrema	Sele	A
2			Tocoluli	Aihatato-Haburas	Noi Mutin	A
3		Hatolia	Ailelo	Loron Matan	Noi Mutin	B
4	Manatuto	Laclo	Umacaduac	Remis	Utamua	In CSP now
5		Lalaeia	Lifau	Fela Hametin	Nakroma	A
6	Lautem	Lospalos	Fuiloro	Haburas	Nakroma	B
7		Lautem	Maina I	Lautem2	Sele	In CSP now
8			Baduro	Moris Mesak	Utamua	B

(*) The CSPGs were assessed by the District Community Seed Coordinators, and given one of three rankings: (A): well performing; (B) reasonably performing; (C) poor performing.

A total of 64 members belonging to the eight groups were interviewed a first time in the second and third quarter of 2013, when they had harvested their first crop, and a second time in January-February 2014. The first round of interviews focused on obtaining general information on the farmer’s household, agriculture practices, seed use and storage, familiarity with improved varieties, food security and coping strategies. The second round of interviews focused on gender differences in agriculture activities, seed use, food security and coping strategies.

One further round of data collection with the farmers in these eight groups is planned for mid-2015. The scope of the questions still needs to be determined, but an initial assessment of impact will be part of it.

6.2.3 Social relationships impact adoption of agricultural technologies

This study was based on data collected during the SoL baseline survey in October 2011. The data was analysed by Liv Pommer Jensen for her MSc degree at the University of Edinburgh, UK, with the title Adoption of agricultural technologies: Factors related to adoption of improved food crop varieties in Timor-Leste.

The study aimed to identify factors related to adoption of improved food crop varieties across agro-ecological zones, using binary logistic regression on the data collected from 1,511 rural households. The factor found to be most strongly related to adoption was having a relationship to an improved food crop variety grower and the closeness of this relationship. Furthermore, with differences across agro-ecological zones, the following factors were found to be related to adoption: districts where SoL activities related to the improved food crop varieties had taken place; familiarity and involvement with the SoL program developing the improved food crop varieties; gender; age; number and size of farming plots; travel time between household and farming plot; and ownership of means of transportation. Overall, the findings of the study suggested that adoption can be improved by targeting social networks and designing programs sensitive to agro-ecological zones.

In the second half of 2013, the master thesis was condensed into a co-authored peer reviewed paper which was published in June 2014 in the journal Food Security with the title "Social relationships impact adoption of agricultural technologies: the case of food crop varieties in Timor-Leste" (Jensen *et al* 2014).

6.2.4 Savings & Loan members in Farmers' Associations

In mid-2013, two associations of CSPGs – one based in Liquiça, the other one in Baucau – started to implement savings and loan (S&L) activities with the members. These activities were inspired by S&L and community empowerment activities that had been supported by World Neighbours in the Oecusse enclave over the period 2006-2012.

Combining farming group activities with S&L activities may help to strengthen the social cohesion in the groups, and the program therefore wanted to document the experience gained in supporting this. A baseline survey of members involved in the S&L activities (28 in Baucau; 33 in Liquiça) was therefore conducted in December 2013 and January 2014. A final survey will be conducted in 2015. Table 91 shows what motivated the S&L members to become involved in these activities, and Table 92 shows what benefits they expect to obtain from it, or have already obtained from it (for those who had already taken out a loan at the time of the survey).

Table 91. Motivation to join S&L activities

Reason to join S&L activities	*Total sample*	*Male (N=34)*	*Female (N=27)*	*Baucau (N=28)*	*Liquiça (N=33)*
To borrow	87%	85%	89%	82%	91%
Easy to get money in emergency situation	69%	65%	74%	75%	64%
To learn how to manage income	54%	59%	48%	68%	42%
Get a share of the profit at the end of each year	54%	62%	44%	64%	46%
To invest	44%	44%	44%	43%	46%

Clearly the main reasons for joining S&L activities are financial: the need to borrow money and to have a back-up in case of emergency. Slightly less than half of the respondents think about investments, regardless of whether the head of household's occupation is agriculture or something else. Correlation analysis (using the chi square test) shows that there is no correlation between gender and the reasons to join, but there is a correlation with the suco for the reason "learn how to manage income": a higher proportion of members in Tequinomata (Baucau) joined the group with this perspective in comparison to Fahilebo (Liquiça).

Table 92. Expected or already received benefits from joining the S&L activities

Expected or already enjoyed benefits from joining S&L activities	% who mention each benefit: Total sample	Total male (N=34)	Total female (N=27)	Total Baucau (N=28)	Total Liquiça (N=33)	Average ranking score*
Pay education costs for children	85%	85%	85%	86%	85%	4.60
Start new micro-enterprise	48%	38%	59%	57%	39%	3.60
I can better deal with emergency needs	71%	82%	56%	89%	55%	3.30
Fulfil food insufficiency	39%	38%	41%	50%	30%	3.10
Buy household tools or equipment	28%	27%	30%	29%	27%	2.80
Other	5%	6%	4%	7%	3%	2.70
Educates me to manage income	64%	68%	59%	71%	58%	2.20
Improve the house or build a new one	39%	41%	37%	50%	30%	2.00
Inject capital into an existing micro-enterprise	10%	9%	11%	14%	6%	1.80
Buy animals and raise them	21%	29%	11%	29%	15%	1.50
Free from usury practices	7%	9%	4%%	14%	0%	1.00
Get share in profit at the end of the year	30%	41%	15%	43%	18%	0.90
Buy agricultural tools and inputs	8%	12%	4%	11%	6%	0.00

* Calculated among respondents who mention it and made valid ratings.

As indicated in Table 92, where the answers are sorted by their average ranking score, the three most important expected benefits are: paying education costs, starting new micro-enterprises, and dealing with emergency needs[1]. Surprisingly, there is no correlation between respondents who said they joined the group to invest (in response to the question linked to Table 91) and those who mentioned they expect being able to start a new micro-enterprise. This might suggest respondents understood "investment" in the first question in many possible ways (invest in education, in the house, in tools, in a micro-enterprise, etc).

Among the 61 respondents, only 13 mentioned they expected to spend the money for agricultural purposes, which is at the bottom of the table. Indeed, the loan is first expected to be used for more "immediate" spending such as education or emergencies. Only after these needs are met, then it is expected to be used for more "longer term purposes" as starting a new micro-enterprise, improving the house, buying assets for the house or for agriculture. This could be seen as a sign that the S&L members do not see agriculture as their main pathway to improve their livelihood. Many factors can explain this situation: limited access to the market, limited access to agricultural inputs or just a preference for non-agricultural income generation activities. Alternatively, they may already be adequately endowed with agricultural tools, and so they see less of a need to invest in additional tools.

6.2.5 Distribution of sweet potato cuttings to vulnerable households

In February 2013, sweet potato cuttings sourced from four CSPGs in suco Maumeta, district Liquiça, were distributed to 120 vulnerable households in the same suco. Household vulnerability was based on a combined assessment of housing condition and owned assets, area of land cultivated to food crops, amount of harvested maize per household member and the stated length of the 'hungry season'. This was the first time such farmer-to-farmer exchange targeted at vulnerable households was prepared, and a small study was organized to learn from this experience.

[1] If the ranking is done on the percentage of respondents who listed the benefit, the three benefits that were mentioned by more than half the respondents were: 1) pay for education; 2) to be able to deal better with emergencies, and 3) to learn how to manage income.

In November 2013, the Seeds of Life Socio-Economic Research Team visited the suco and tried to contact all listed recipients, to check if they had indeed received the sweet potato cuttings, if they had planted them out, if they had been able to harvest, and to try to assess if they were indeed vulnerable households.

Of the 120 names on the lists, which were from three of the four aldeias in the suco, 92 persons could be contacted. From these, 57 (62 %) had received cuttings and 35 (38 %) had not received any. The lists of names had been prepared prior to the distribution, and even though there were thumbprints on the lists, these persons stated that they had not received cuttings, nor 'signed' for it.

All recipients planted out sweet potato cuttings, mostly on the same day (64 %) or the next day (29 %), and most of the farmers (79 %) planted the cuttings on plots next to the house. Some 61 % of farmers took one or more measures to make the cuttings grow better, with the most frequent practices being watering the plants (45 % of farmers) and weeding the crop (39 %).

Drought was the most important problem encountered (by 67 % of the farmers), and 88 % of the farmers who had experienced crop failure had not watered their plants; of the 25 farmers who had watered the plants, only three experienced crop failure.

Sweet potato, both tubers and leaves, had been harvested by 54 % of the farmers who had planted the cuttings. The harvest results were used by all as food for the household, but there was also sharing with others, selling of tubers and leaves, and feeding it to animals.

A promising finding of the survey was that a large majority (91 %) of the farmers who had received cuttings had replanted, or intended to replant sweet potato – including 21 of the 25 farmers whose crop had failed were planning to do so. Replanting would mostly be for a same area (57 %), or a bigger area (29 %). Since most of the farmers had planted the sweet potato on a plot adjacent to the house, with some occasional watering during the dry season, they should be able to keep some plants alive so that they can produce their own cuttings for the next season.

The survey also tried to answer the question if the recipients of the cuttings were indeed vulnerable households. Based on a combined assessment of housing condition, assets owned by the household, size of cultivated food crop plots, size of the maize harvest per member of the household, and the stated length of the 'hungry season', it would appear that perhaps up to one third of the recipients would probably not be considered particularly vulnerable. From the perspective of increasing the number of improved variety growers, this does not matter very much; from the perspective of providing vulnerable households with access to improved varieties, this was a slight disappointment.

To achieve a better targeting to vulnerable households, more intensive briefing and orientation of the key decision-makers (such as: SEOs, Aldeia and Suco Chiefs) prior to the distribution of the cuttings on the purpose of the distribution (i.e. to give vulnerable households access to improved varieties; not simply to increase the number of growers of improved varieties) will probably be more effective and less costly than imposing stricter control mechanisms.

6.2.6 Distribution monitoring of food crop seed/cutting distributions

From October 2013 to March 2014, MAF and NGOs distributed about half a million sweet potato cuttings nationally of the MAF released varieties Hohrae 1, 2 and 3. About 120,000 cuttings were sourced from CSPGs and the rest was sourced from research stations or contract growers. The cuttings were distributed to NGOs, to farmer groups or to individual farmers, with 70% being handled by MAF and 30% by the NGOs.

Between July and October 2014, 339 farmers were interviewed in 38 sucos in seven districts, to obtain feedback on the distribution of the sweet potato cuttings, and of some other seeds and planting materials.

Overall, the uptake of sweet potato cuttings after distribution was satisfying: 99% of the farmers who received cuttings had planted them, and 77% had harvested already at the time of the survey, or were going to. Even though most cuttings suffered from drought during transportation, only very few cases of complete damage were observed: 89% of the cuttings received by farmers were good enough to be transplanted (the high percentage may partly be because SEOs discarded the obviously unusable cuttings they had received before distributing the cuttings to the farmers). Measures to keep the sweet potato cuttings fresh during transportation (e.g. by wrapping them in white sacks, banana stems, etc.) helped to improve the quality of cuttings on arrival.

The main issues revealed through the survey were linked to the lack of information and socialization to farmers, which sometimes affected the poorer farmers more specifically:

- half of the beneficiaries got the information about the distribution very late (the day before or the same day as the distribution, or even no information at all),
- only 15% of the beneficiaries knew the name of the variety they had received,
- only 31% of the farmers watered the cuttings after planting them resulting in some dying from desiccation. Animals ate other farmers' cuttings (no fencing). These aspects could be improved by follow-up from SEOs.

MAF stakeholders highlighted the fact that the distribution was late in the season in some districts. According to them, better coordination between national and district level as well as sourcing cuttings locally would help improve the situation. The program has followed up on this recommendation, and in 2014 preparations were made to establish a network of sweet potato cuttings distribution centers. Figure 24 shows the locations of such centers in the country.

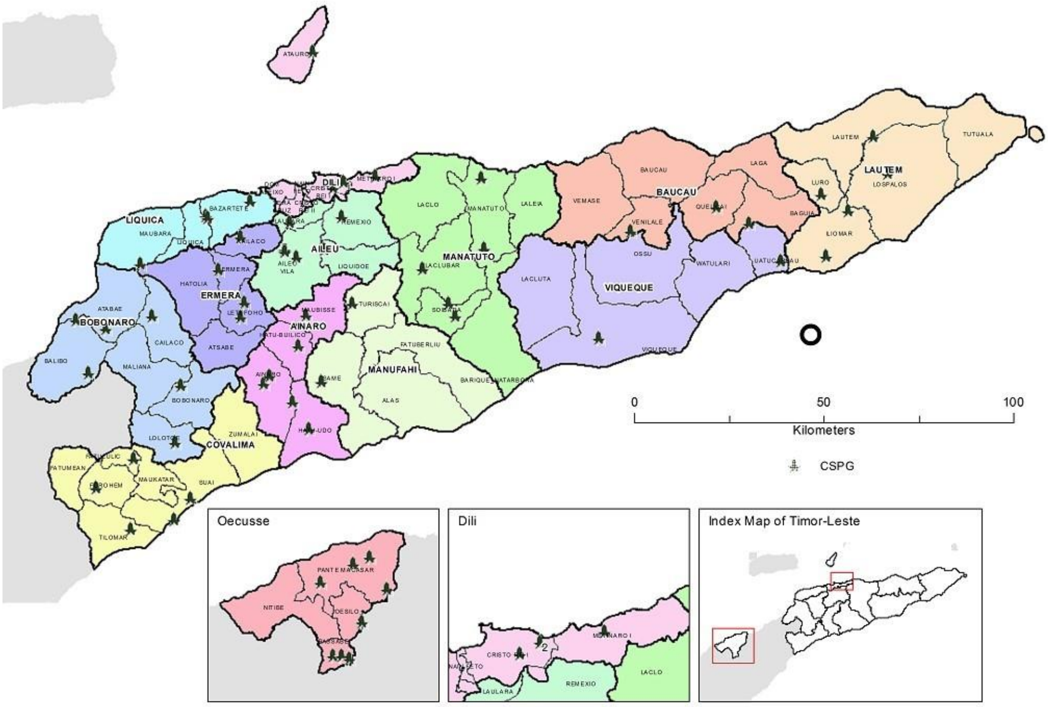


Figure 24. Location of sweet potato cuttings distribution centres

During the survey, information was also obtained about the distribution of seeds and of cassava cuttings. One difference between seeds and cassava cuttings was that the beneficiaries are often informed earlier about a seeds distribution and receive seeds earlier than for cassava cuttings. The uptake of the varieties was very satisfying: about 90% of the beneficiaries planted all the seeds/cuttings they received and 82% of cassava cuttings recipients could harvest their crops (or were going to).

As for the familiarity of farmers with the improved varieties, the survey again showed the importance of socializing the names of the varieties to beneficiaries of distributions. Indeed, 83% of the farmers who said they haven't heard of "Hohrae" (107 in total) actually had received sweet potato cuttings during the last planting season. Similarly, 24% of the farmers who said they haven't heard of "Ai-luka" actually had received cassava cuttings. The same case was observed for seven beneficiaries of peanut distribution. Also, 63 respondents first said they didn't remember the name of the sweet potato variety they were given but then said they were familiar with the name "Hohrae". The same case was encountered for 23 farmers who received Ai-luka cuttings.

6.2.7 2014 adoption survey

In August-September 2014, 702 respondents were interviewed in 60 sucos throughout the 13 districts to obtain accurate data on the level of adoption of the improved varieties, and on a range of related subjects. Compared to the baseline survey of 2011 and the mid-term survey conducted in 2013, the 2014 adoption survey showed a marked increase in adoption rates of improved varieties (see Table 93).

Table 93. Adoption rates of improved varieties

	Baseline survey (2011)	*Mid-term survey (2013)*	*Adoption survey (2014)*
Adoption of one or more MAF varieties (national):	18%	25%	33%
Regional: West	12%	18%	25%
Centre	20%	26%	39%
East	31%*	32%	39%
Program related: Districts of early SoL2**	30%	36%	42%
Other districts	11%	20%	29%
Adoption per variety: Sele (maize)	13%	15%	20%
Noi Mutin (maize)	-	2%	10%
Nai (maize)	-	-	0.3%
Nakroma (rice)	11%	15%	14%
Utamua (peanut)	16%	11%	12%
Hohrae (sweet potato	7%	7%	9%
Ai-luka (cassava)	3%	3%	5%

* Excluding Viqueque and Lautem ** Liquiça, Aileu, Baucau and Manufahi

The main factors that were found to be influencing adoption of improved varieties are linked to CSPGs. The fact that there is a CSPG in the suco, that farmers know about its existence as well as being a member of a CSPG increases the chances that farmers will be adopters.

While the main reason for wanting to grow a MAF variety appears to be because it was given free, a more positive motivation is expected to emerge as promotion, awareness and access to improved varieties increases with decentralisation and commercialisation of quality seed production and supply.

The respondents who were growing improved varieties provided information how long they had been growing these, and whether they were planning to keep on growing them (see Table 94).

Table 94. Characteristics of adopters

	First source of seeds or cuttings	*Average area grown per adopter (ha)*	*% of adopters growing improved varieties for more than one year*	*Average duration of adoption (years)*	*Proportion of adopters planning to continue growing the improved variety (%)*
Sele (maize)	43% MAF	0.3	42	1.9	99
Noi Mutin (maize)	52% MAF	0.3	20	1.4	98
Nakroma (rice)	50% MAF	0.4	52	2.0	97
Utamua (peanut)	34% MAF	0.1	48	1.9	96
Ai-Luka (cassava)	30% CCT	0.2	27	1.6	100
Hohrae (sweet potato)	52% MAF	0.1	49	2.1	100

As indicated in the table above, adopting farmers have been growing the new varieties on average for around two years, and nearly all of them intend to keep on growing the improved varieties.

Overall, 25% of farmers have heard of at least one improved variety. The most known varieties are Nakroma (32% of the rice farmers who do not yet grow Nakroma, equivalent to 9% of the farmers), Sele (15% of non-Sele growing maize farmers, 12% of farmers), Noi Mutin (13% of the maize farmers who do not yet grow Noi Mutin; 12% of farmers) and Utamua (10% of non-Utamua growing peanut farmers; 3% of farmers).

As expected, a higher proportion of farmers familiar with the improved varieties are located in districts with longer involvement in the program. Also, the fact that a farmer lives in a suco where there is a CSPG doubles the chance that s/he will be familiar with those varieties (42% versus 21% for farmers living in sucos where there isn't a CSPG).

Seed multiplication and distribution through CSPGs has been the main approach to improved seed access in the first three years of SoL 3. It is therefore important to know to what extent farmers are aware of, and participate in such CSPGs. In general, a lot of farmers are still not aware of the existence of CSPGs. In fact, 49 of the 60 sampled sucos had existing CSPGs but only 22% of the respondents said they were aware there is a CSPG in their suco. While many farmers (46%) said there wasn't a CSPG in their suco, in the majority of cases (75%) there actually was one or more. About a third of the farmers who said they knew about the existence of a CSPG in their suco were members of it, and half of these (48%) had been members for only one year[2].

The goal of the SoL program is to improve food security through the increased productivity of major food crops. The survey therefore included a section focusing on food security. Reported food insecurity is still quite high: 82% of respondents said their family experienced "hungry months" during the year. On average, this hungry season lasted 3.6 months.

Data about consumption of self-grown food crops was also collected to calculate periods of food shortage (i.e. periods when families have no self-grown maize, rice, peanut, cassava or sweet-potato to eat). Eighty-one % of the respondents experienced at least one month of food shortage and on average the duration of food shortage was 4.2 months.

This result seems inconsistent with the finding of the 2013 mid-term survey (i.e. 2.7 months of food shortage), and suggests that farmers probably underestimated their food-consumption in the 2014 survey.

A key target for SoL is that by the end of the program, some 65,000 households are growing one or more improved food crop varieties. By mid-2014, it was estimated that 40,957 households have adopted at least one such improved variety. The program seems therefore well on its way towards achieving that end-of-program target.

Three recommendations to further increase adoption of improved varieties are:

- increase access to seeds in the western region where adoption is much lower than in other regions;
- support MAF (and other agencies/NGOs) to increase the effectiveness of their seed distribution;
- increase publicity, control and guidance of existing CSPGs in order to ensure these groups ensure a wider diffusion of seeds and cuttings into their local communities.

[2] This is linked to the rate of program expansion in establishing CSPGs: from 2011 (a total of 280 CSPG in 7 districts), 2012 (680 CSPG in 10 districts) and 2013 (1,018 CSPG in all 13 districts). It is expected that there will be about 1,350 CSPGs by the end of the program.

6.2.8 Potential commercialization of national seed system.

Since 2012, SoL has collaborated with the Master of Public Administration in Development Practice program, at the School of International and Public Affairs, at Columbia University, New York, by hosting master students as part of the summer student placement program. In 2014, Molly Schneider joined SoL for a three-month period, from June to August, and conducted surveys with Commercial Seed Producers, farmers and input suppliers to identify potential pathways for the commercialization of the National Seed System.

The focus of the study was to interview and study members of farmers associations, smallholders and agriculture input suppliers, and to identify linkages between them to strengthen Timor-Leste's emerging commercial seed market. The private sector for agricultural inputs in Timor-Leste has remained sporadic and underdeveloped. Yet, low yields of both commercial and staple crops create a large demand for inputs.

Starting in 2013, SoL supported a range of activities to connect commercial seed producers (CSPs) to public and private channels for seed sales. Ideally, MAF will purchase most of the quality assured seed produced by the CSPs in order to substitute the large amount of seed imported annually by the government. SoL has also made efforts to provide business training and marketing advice for seed sales to the CSPs, and to connect them to regional and national input suppliers (*loja agrikulturas* and regional traders). The purpose of this is to start building a network of commercial seed suppliers and buyers that is not solely dependent on government seed purchases.

Figure 25. The farmers' association Fitun Leste in Baucau

Developing the commercial viability of the CSPs depends not only on the ability to produce quality seed but also on producing and marketing a product that meets the demand of smallholder farmers through existing supply chains.

The main findings of the study, and the recommendations that follow from it, are given below.

- Initially, since farmer associations have more confidence in MAF to buy their seeds, forward contracting for seed purchase should be developed between MAF and the CSPs. However, for the medium to long term, serious efforts need to be made within the NGO community and with MAF to improve targeting for, and gradually reduce the free distribution of seeds. Free distribution has thus far crowded out the development of a commercial market for staple seeds. Unless efforts are made to phase out the wide scale free distribution of seeds, entrepreneurs will continue to be reluctant to invest in a commercial market for seeds.
- Based on data collected from smallholder farmers, there is a potential market for packaged improved seeds in their local markets. SoL should work to help CSPs establish sales in these areas.
- Agriculture shops and input retailers reported to be interested in both the retail of small seed packs of staple crop seeds, and being connected to regional traders. Thus, SoL should work to connect the CSPs to regional traders who can supply input retailers with pre-packed SoL improved seed.
- SoL and CSPs should make efforts to improve national marketing of improved varieties through Timorese media outlets in order to expand knowledge of the varieties and increase the consumer demand. Additionally, thought should be given to the development of a "*Fini ba Moris*" brand, which could prove to be a beneficial marketing technique to improve demand for quality assured seeds.
- Based on feedback from CSPs, smallholder farmers and input suppliers, SoL should advise CSPs to package seed in a variety of different sized packs: 5 kg, 2 kg, 1 kg, 500 g, 250 g. Reporting on seed sales should be improved in order to track the popularity of different sized packs in different markets.
- Overall, both the users and retailers of improved seeds and general agricultural inputs need to be more informed about the product that they are using. SoL should continue to work with partners to improve the dissemination of information about agricultural products at every point of the agricultural input value chain. This can be done though product labeling, marketing and general dissemination of information through public media channels such as television, radio and newspapers.

Several of the above recommendations were being implemented during the 2014-2015 growing season, in particular through support with a network of agriculture shops (*loja agrikultura*) in the districts.

7. Climate and Cropping Systems

7.1 Meteorology with Automatic Weather Stations

Collection of weather data continued throughout the 2013-2014 cropping season in all districts except Ermera which is represented by the ALGIS network. A number of stations were relocated from farmer's fields and onto Government land near to the location of the original weather station. For example, after field trials were completed in Holarua, Same, the station was relocated to the historical Posto Administrativo on the hill top in Same Vila. This will allow current weather data to be compare with historical weather and improve understanding in changes to climate.

With improved telecommunication systems, 3 GSM (Global System for Mobile communication) stations were installed to test capability for direct daily data transfer from the station to the internet. Three stations were installed at Laklubar, Baguia and Fohorem. This has proven relatively successful although there are still problems with continuous data transfer during the wet season. There is now a comprehensive agro-meteorological weather station network across Timor-Leste with 46 stations operated by ALGIS, MAF/SoL and JICA (Figure 26). Twenty two of these were monitored by MAF/SoL (Table 95).

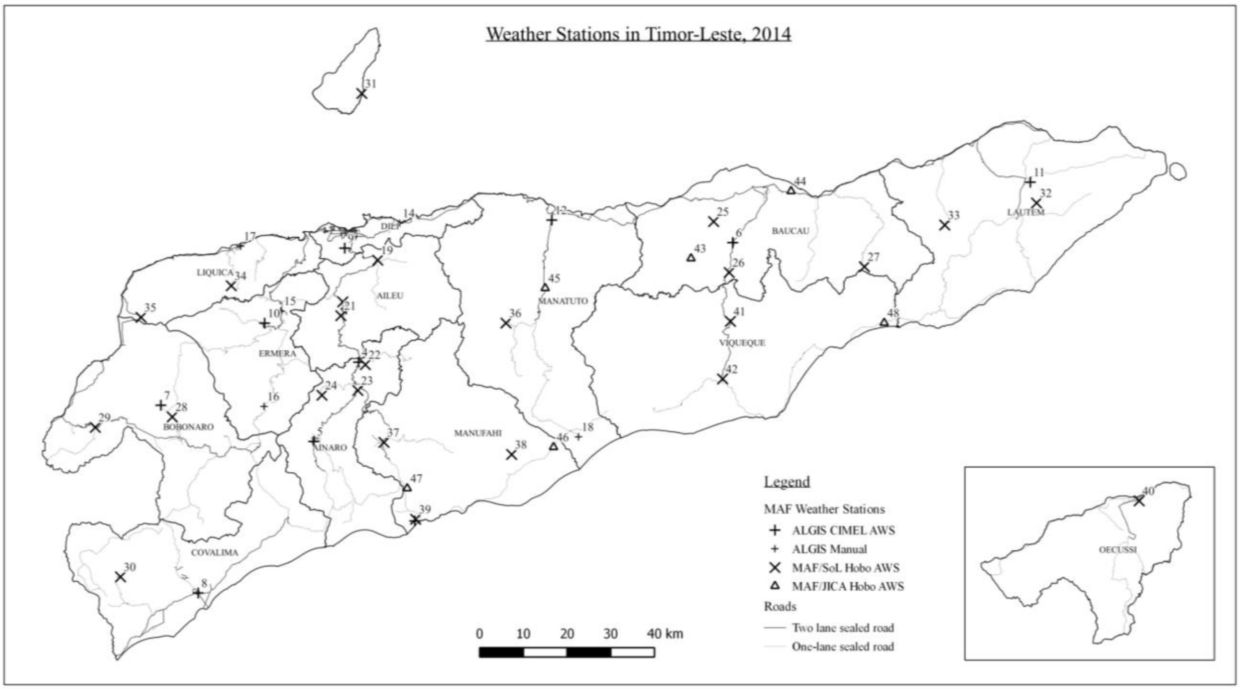


Figure 26. Location of weather stations in Timor-Leste.

Table 95. Daily averages at automatic weather stations (Nov., 2012, - Aug., 2014)

Station location					*Daily average/total*							
Station	*District*	*Latitude*	*Longitude*	*Alt (m)*	*Daily Rain (mm)*	*Temp Max (°C)*	*Temp Min (°C)*	*RH Max (%)*	*RH Min (%)*	*Solar Radiation (MJ/m^2/day)*	*Wind Speed (m/s)*	*Gust Max (m/s)*
Acumau	Aileu	-8.617	125.638	975	4.5	25.9	18.8	94.9	68.4	14.3	0.5	5.3
Quintal Portugal	Aileu	-8.704	125.565	980	4.4	27.8	15.8	99.1	58.0	16.5	0.4	6.1
Seloi Malere	Aileu	-8.734	125.561	925	5.9	28.8	16.0	98.6	55.6	16.4	0.2	5.6
Aituto	Ainaro	-8.891	125.596	1667	6.3	21.8	14.7	97.4	64.7	14.4	1.0	8.0
Urulefa	Ainaro	-8.837	125.612	1316	5.3	24.4	13.4	99.5	63.5	16.0	0.5	6.5
Darasula	Baucau	-8.535	126.346	690	4.5	28.4	18.6	94.2	66.5	16.2	0.5	5.8
Fatulia	Baucau	-8.656	126.361	854	5.3	26.7	19.2	96.7	68.9	16.0	1.3	7.2
Ostico	Baucau	-8.535	126.330	695	5.3	26.7	19.2	94.6	61.8	14.3	1.8	7.3
Balibo	Bobonaro	-8.984	125.040	529	6.0	28.4	19.6	97.2	68.5	16.2	0.4	4.8
Ritabou	Bobonaro	-8.947	125.205	163	8.0	32.7	21.9	90.8	60.7	17.6	0.2	5.2
Atauro	Dili	-8.264	125.607	4	3.6	32.2	24.6	92.1	68.2	18.7	0.2	3.9
Fuiloro	Lautem	-8.496	127.027	358	7.1	29.3	21.2	98.9	69.2	16.2	1.8	8.2
Fazenda Algarve	Liquiça	-8.671	125.330	1130	4.3	25.5	18.3	95.5	73.3	14.6	0.4	5.3
Loes	Liquiça	-8.737	125.140	22	4.4	32.3	22.5	97.1	62.3	19.7	0.9	6.3
Betano	Manufahi	-9.163	125.718	9	4.4	31.3	22.8	95.2	67.0	17.7	1.0	6.2
Dotik	Manufahi	-9.026	125.921	101	5.4	31.5	21.4	92.3	63.8	16.7	0.5	5.9
Holarua	Manufahi	-8.935	125.629	1033	10.5	26.7	16.1	86.5	61.4	15.5	0.2	4.5
Same	Manufahi	-9.001	125.652	550	3.4	16.5	11.9	53.3	35.7	16.2	0.1	1.9
Pante Macasar	Oecusse	-9.200	124.349	7	2.4	32.6	24.0	86.4	57.3	19.7	0.4	5.3
Bahalara-uain	Viqueque	-8.950	126.274	21	5.1	32.1	22.6	94.6	67.7	17.8	0.3	5.1
Ossu De Cima	Viqueque	-8.689	126.373	950	7.6	26.1	18.9	97.6	67.1	15.5	1.6	8.3
Ossu	Viqueque	-8.745	126.381	667	7.6	26.1	18.9	97.6	67.1	15.5	1.6	8.3

7.2 Analysis of Weather Data by AEZs for 2013-2014

7.2.1 Rainfall

Good rains were experienced throughout the country during the cropping season of 2013-2014 without the extreme flooding that affected farmers during mid-2013. Southern slopes received the most rainfall overall (Table 96) due to the bi-modal wet season. In AEZ 4 and 5, (AEZ defintitions found in Table 13) eight out of twelve months were classified as wet months where more than 100 mm of rain falls each month. AEZ 4 received the most rain of 2057 mm which is almost double the amount of rain received by AEZ 1. The heaviest rainfall of 166mm in one 24 hour period occurred at Ossu De Cima. Other sites such as Fuiloro and Ritabou also experienced heavy rain resulting in minor flooding. (Far less than the 277 mm experience in Bahalara-Uain in June, 2013).

Table 96. Monthly rainfall (mm) averaged over AEZ, 2013-2014

Month	*AEZ 1*	*AEZ 2*	*AEZ 3*	*AEZ 4*	*AEZ 5*	*AEZ 6*
September	3.7		2.3	21.7	6.2	14.9
October	8.1	89.7	35.3	45.5	26.6	34.4
November	103.0	185.8	176.9	243.4	123.8	109.9
December	182.6	430.7	373.5	397.9	298.4	162.6
January	313.9	542.3	186.6	144.0	149.6	119.8
February	232.5	313.8	249.1	150.4	138.4	134.9
March	44.3	109.6	185.7	262.2	263.2	73.6
April	146.9	257.1	239.3	190.0	288.0	97.5
May	16.7	40.9	43.4	188.8	285.6	249.6
June	35.3	3.5	71.9	362.9	405.8	232.2
July	42.8	43.7	21.8	42.5	48.0	33.4
August	0.1	2.7	0.3	8.0	11.2	7.5
Annual total	*1130.0*	*2019.8*	*1585.9*	*2057.3*	*2044.8*	*1270.4*
Wet months >100 mm)	*5*	*6*	*6*	*8*	*8*	*6*
Daily max (mm)	*83.4*	*111.0*	*95.8*	*166.0*	*111.2*	*84.0*
Location	*Maumeta*	*Ritabou*	*Darasula*	*Ossu De Cima*	*Fuiloro*	*Betano*

The northern slopes received the highest intensity of rainfall. On 6 occasions, AEZ 2 received over 150 mm in a 10 day period (Figure 27). By comparison, this only occurred twice in AEZ 4 and 5 on the southern slopes. All AEZs except AEZ 1 received their first rains in late October followed by a dry period of 1 to 2 weeks or more. It is important for farmers to manage this risk by reserving seed or ensuring a solid start to the wet season. AEZ 1 and 2 experienced an unusual dry period during March and April which may have impacts on the grain filling period of maize especially for those farmers who planted late. This dry period was followed by a peak of heavy rainfall allowing opportunity for a short horticultural crop such as lettuce or green beans. Farmers with technology to capture these late rains would be able to extend their cropping season further into the dry season.

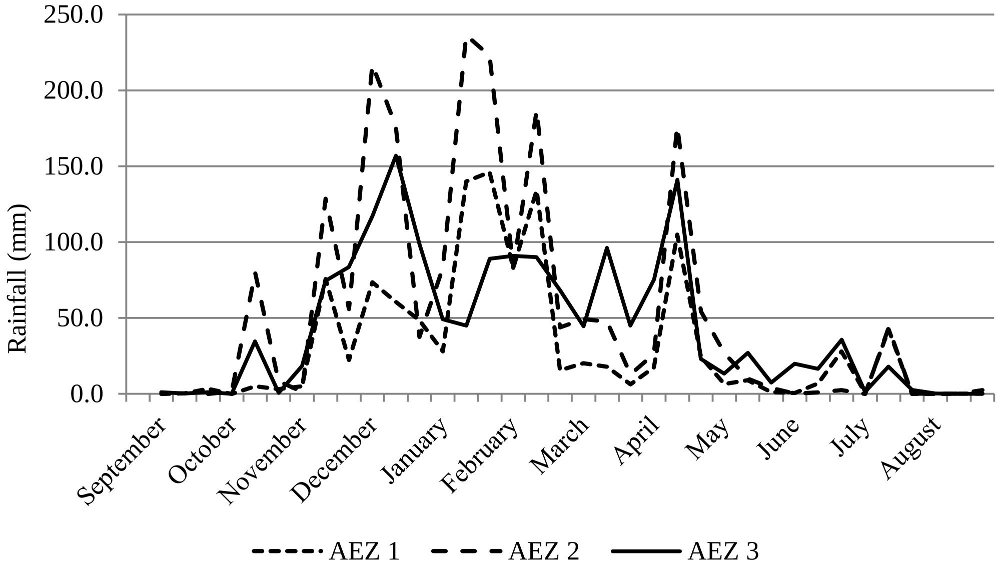


Figure 27. Decadal rainfall on the northern side of Timor-Leste by AEZ

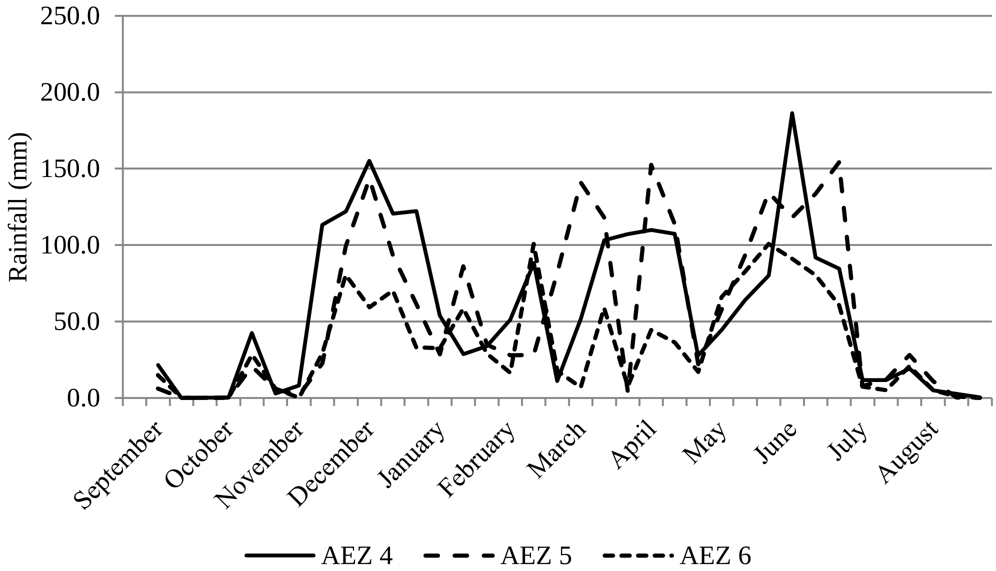


Figure 28. Decadal rainfall on the southern side of Timor-Leste by AEZ

On the south coast, farmers experienced a drier season than last year with the lowest cumulative rainfall figures from January to May. (Figure 29) This is in contrast to farmers on the north coast who received comparatively good rains throughout the first cropping season until March. This localised, temporal high variability is a challenge for farmers to develop resiliency. Careful planting combined with good soil organic matter to retain moisture will assist in producing a successful crop.

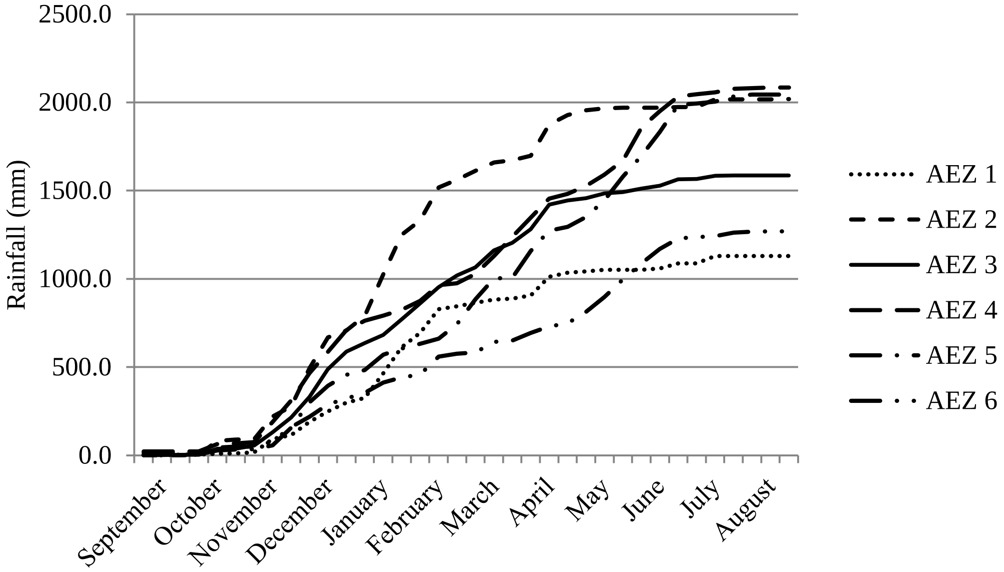


Figure 29. Cumulative rainfall by AEZ, 2013-2014

7.2.2 Temperature

Timor-Leste experiences a wide range in temperature. Most of the risk is related to high temperatures especially along the coast. In the higher altitudes, farmers can take advantage of cooler temperatures for farming wheat, citrus and cool climate horticulture crops. Ritabou, in the Maliana basin, recorded the highest temperature of 37.2°C in late October. Other coastal sites such as Maumeta (Atauro), Loes, Pante Maccassar, Betano, Bahalara-Uain, and Dotik also experienced temperatures above 35°C. This was particularly concerning in Bahalara-Uain, Ritabou and Pante Maccassar where high temperatures were experienced in late February and early March where the risk of impact on flowering is higher. Very cool temperatures were experienced in August in Maubisse with records as low as 4.8°C. This was recorded at the Urulefa research station located down in a valley at high altitude.

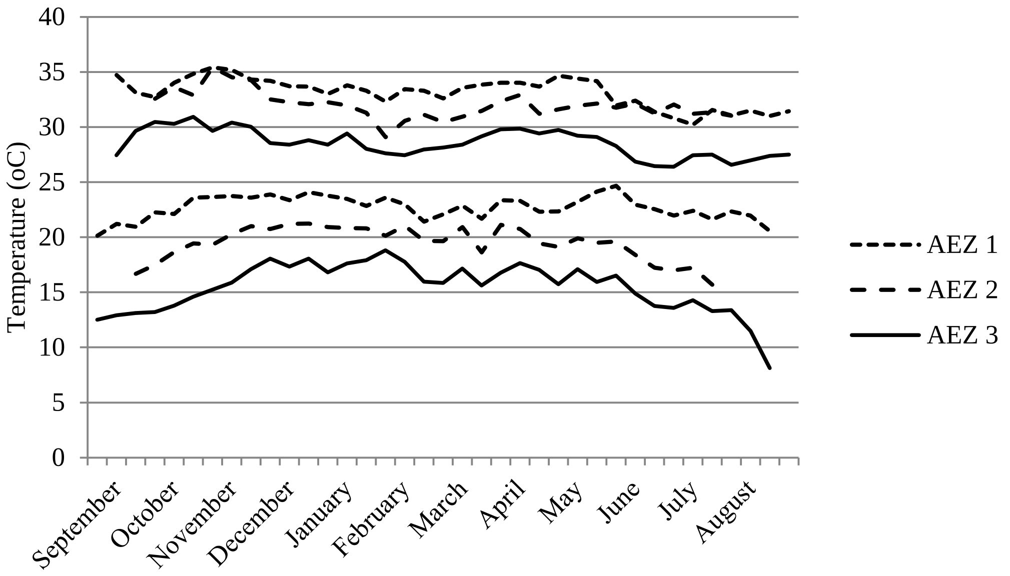


Figure 30. Decadal maximum (upper) and minimum (lower) temperatures (N side of T-L)

Figure 31. Decadal maximum (upper) and minimum (lower) temperatures (S side of T-L)

7.2.3 Radiation

A comparison of solar radiation across the agro-ecological zones shows that coastal areas in AEZ 1 and AEZ 6 received the highest radiation. Mountainous areas generally receive less radiation due to increased cloud cover. During the period of December to April, mountainous areas of AEZ 3 and 4 received 25% less solar radiation than the coastal areas of AEZ 1 and 6. During the same period the northern and southern slopes of AEZ 2 and 5 received 14% less radiation. Aspect appears to have minimal impact when comparing data across the AEZs with only minor differences in cumulative radiation between AEZ 2 and 5 during February. The southern slopes receive slightly higher radiation as the sun passes to the south of Timor-Leste during the cropping period.

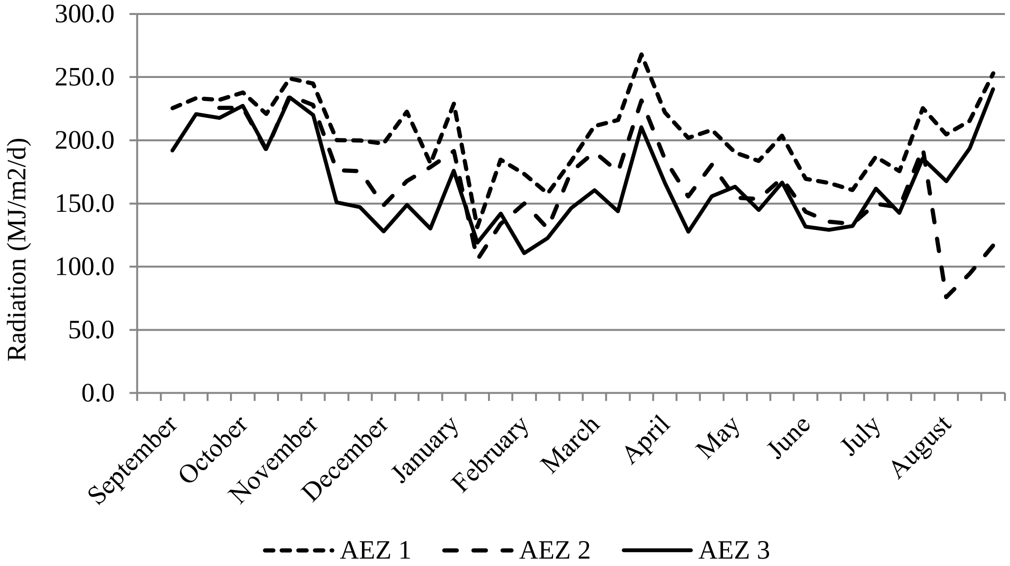


Figure 32. Decadal solar radiation on N side of Timor-Leste by AEZ

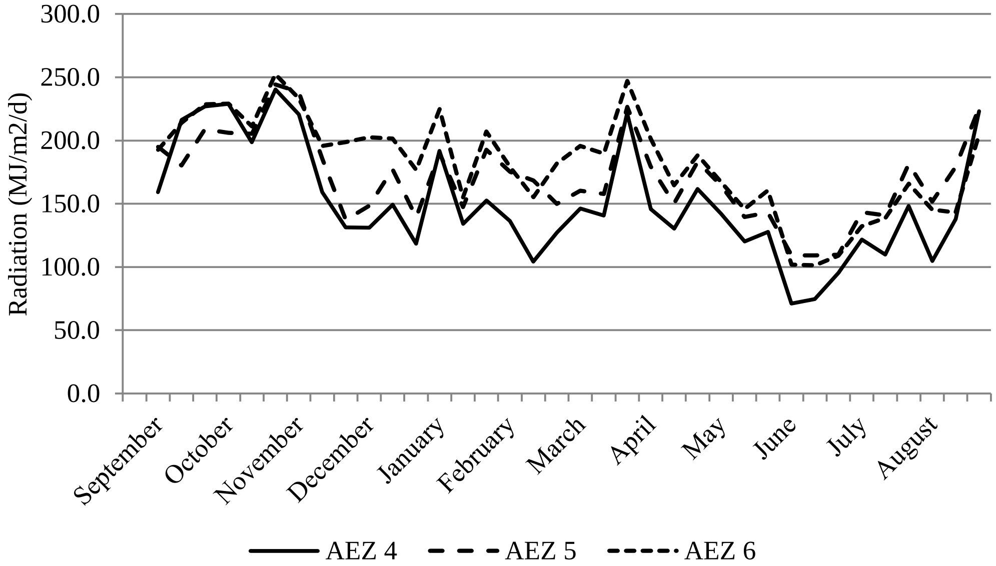


Figure 33. Decadal solar radiation on the S side of Timor-Leste by AEZ

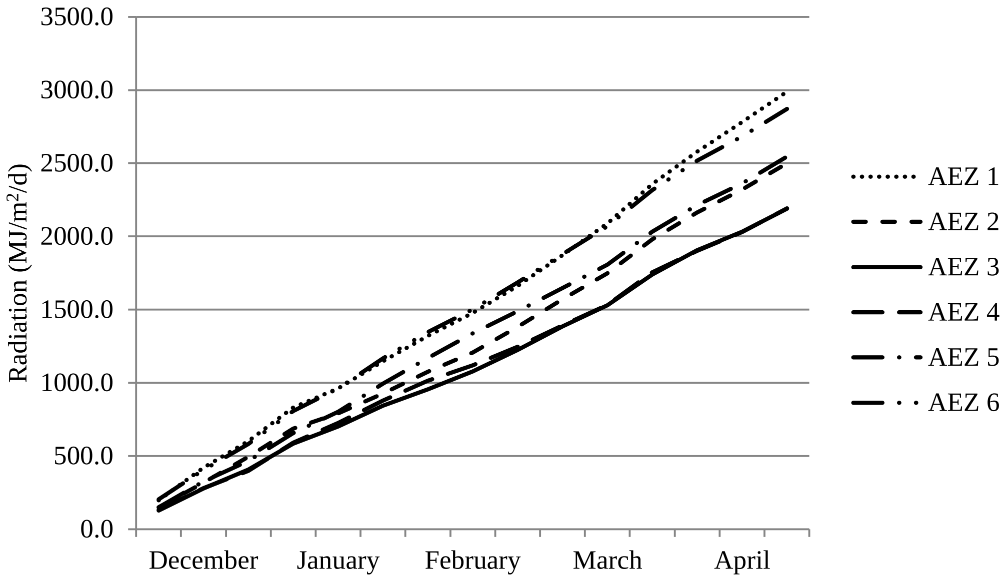


Figure 34. Cumulative graph of solar radiation (Dec. – Apr.) by AEZ

7.2.4 Damaging winds

High winds including brief gusts can reduce maize yields due to root lodging or green snap. Root lodging occurs when the plant bends at ground level and roots are partially pulled up or broken. Green snap occurs when the corn stalk snaps off above the ground. Although wind speed is the direct cause, resistance to wind damage can be influenced by soil potassium levels and plant density. Potassium contributes to development vascular stem cellulose providing the stalk with its strength. If plants are too close together, root development is inhibited leading to greater risk of lodging. In areas at risk of high winds during the vegetative stage, farmers should avoid plant densities over 7 plants/m^2. (Mi, Liu, & Zhang, 2014)

During the early growth stages, the maize is not tall enough to be affected by high winds. The period of risk is generally from late January through to early March. Table 95 shows a selection of sites across Timor-Leste including 4 research stations and other sites at risk of wind damage. Wind damage also depends on local factors such as the time of planting, slope, aspect and protection from other vegetation. Gust speeds over 15 m/s (54km/hr) during late January and February can be particularly damaging.

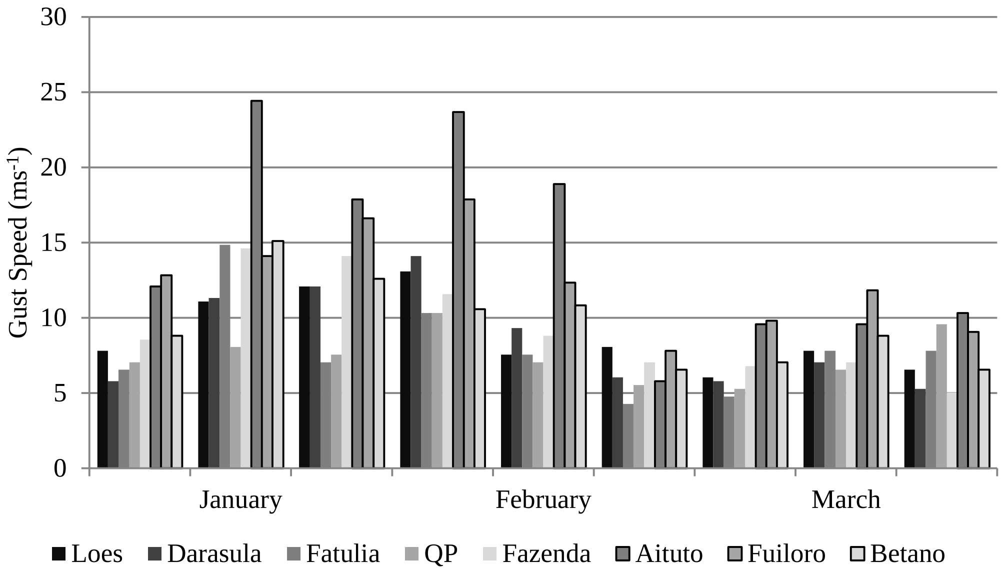


Figure 35. Comparison of decadal maximum gust speeds, Timor-Leste.

As an example, farmers on the Los Palos plateau experienced wind damage in late January and early February due to wind speeds as shown in Figure 36. During 3 days of winds gusting over 15 m/s some maize within the field was knocked over. High altitude sites exposed to prevailing winds are particularly at risk such as Aituto with wind speeds over 85 km/hr being recorded in January. The risk of adverse impacts from wind may be reduced by site selection, growing wind breaks such as tall grasses, ensuring adequate soil potassium and avoiding high plant densities.

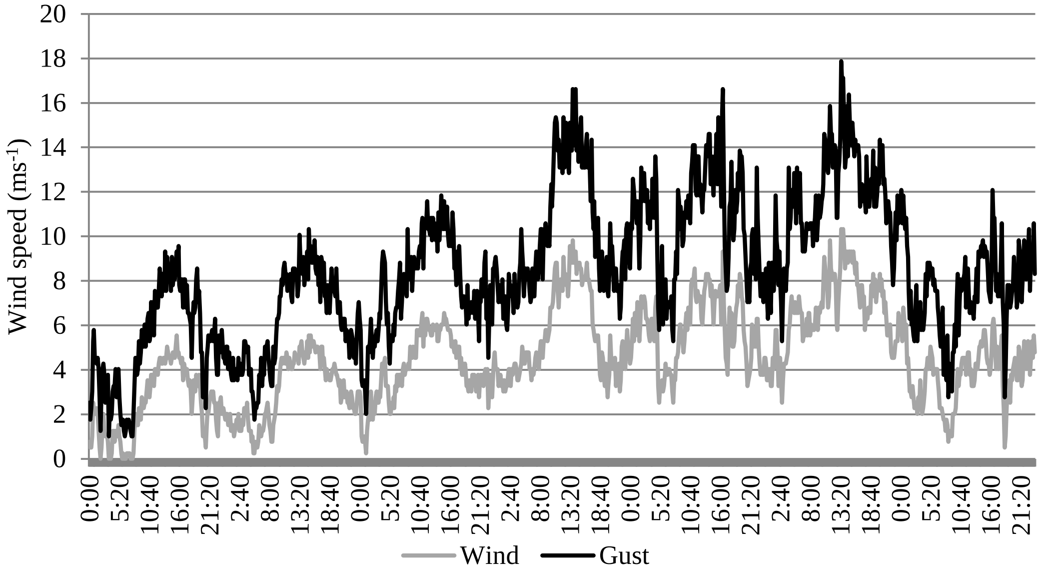


Figure 36. Damaging wind gusts above 15 ms^{-1}, Fuiloro, Lautem, 28/1/2014 to 3/2/2014.

7.3 Historical Weather Stations

The first record of the operation of a meteorological station in Timor-Leste is for a short period from July, 1861, until January, 1863. It was not until 1914 that a dedicated meteorological service for the nation was initiated. This began with the procurement of four rain gauges that were installed in Dili, Ermera, Hato-lia and Raimera. By 1916, the network of rain gauges across the country had been increased to 20. These were mainly installed at religious missions and military posts. In 1917, further upgrades led to the establishment of 15 meteorological stations and 15 rain gauges. By 1941, there were 16 meteorological stations and 11 rain gauges still in operation. In 1941, the operation of stations was interrupted due to the impact of World War II and were not re-established for another 10 years. Baucau recommenced recordings in October, 1950, but most records do not begin until the mid-1950's. During this time a decree was made for the colonies to combine the technical services of meteorology, geophysics and astronomy into one directorate. By 1955, the meteorological network was operational with 26 meteorological stations and 26 rain gauges. This service was again interrupted in 1975 with the withdrawal of Portugal from Timor-Leste and the occupation of Indonesia. The Indonesian government re-established meteorological services across the country but as of 2014 there are only records available for Dili, Baucau and Pante-Maccassar in Oecusse.

The National Archives in Dili holds some manuscripts for daily weather data has been digitised during 2013 and 2014 managed by the National Directorate of Meteorology and Geophysics with some advisory support provided by Seeds of Life. Unfortunately, information on the exact locations of the weather stations was problematic. Past readings of latitude and longitude assigned to stations were found to be inaccurate in the order of several kilometres and in some cases completely misplaced in a different region. Work was carried out to accurately locate the historical weather station sites. This began first with the name of the station, a consideration of any latitude, longitude and altitude data available starting with the Santika research (Santika, 2004). Historical documents and maps were also considered including O Clima De Portugal (Ferreira, 1965), O Clima E O Solo De Timor (Soares, 1957) and various agricultural bulletins from the early 1900's (Agriculture, 1920). Reference was also made to aerial photography in consultation with MAF staff that were local to the area. Finally, in some cases, onsite visits were conducted to confirm with elderly locals and Government officials about the location of the station. The location of a few stations such as "Granja E. Marques" and Suro are still unknown.

7.4 Validation of the crop growth model APSIM-maize variety "Sele"

The crop modelling program, Agriculture Production Simulation (APSIM), allows investigation into the development and yield of maize in Timor-Leste. Crop sites in Timor-Leste can vary widely in temperature due to the mountainous terrain which ranges from sea level to 2963 m over a distance of 40 km. Latitude has very minimal impact on the temperature range as the country is aligned east west and spans just 1.4^{o} of latitude.

A maize variety was developed in APSIM to match the growth duration of LYDMR (CYMMIT, India) researched and released in Timor-Leste under the name "Sele". Simulations were run with weather data from 9 locations for one cropping season and compared with the observed growth duration of approximately 100 trials close to the weather station locations. The weather stations ranged in altitude from 21 m to 1667 masl. All phenology parameters for the variety SC623 from APSIM-Maize were initially used to estimate phenological development. The thermal time from emergence to the end of the juvenile period needed to be lengthened to 273 ^{o}C days to simulate the phenological development observed in 'Sele' in Timor-Leste. There were no further changes to phenological parameters. A linear regression of the observed days to maturity with the simulated days to maturity resulted in an r^2 value of 0.88.

APSIM-Maize Sele was then tested for response to nitrogen using field trials at Betano, Urulefa and Loes research stations. Yield calibration simulations were run for the 3 sites with nitrogen added at rates of: 0, 15, 30, 60, 120 kg of N/ha.

Soil Organic Matter in the simulation was calibrated using the 0 kg of N trial so that the yield of the simulation matched the observed yield in the field. The increased N rates were then applied to the model and compared with field results. (Figure 37)

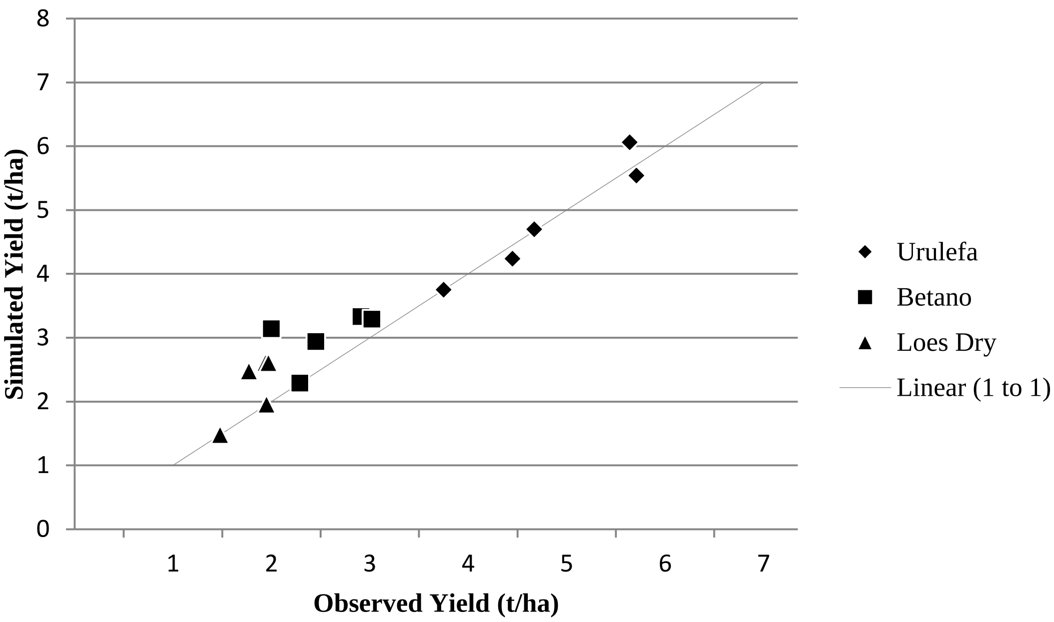


Figure 37. Maize yield in the APSIM model compared to observed maize yield

7.5 APSIM simulation of maize

Methodology

Detailed simulation impact experiments were carried out with APSIM-Maize (Keating et al., 2003) at four locations in Timor-Leste for which 8 years (2004-2012) of detailed meteorological data were available (Table 97) to determine the effects of increasing temperature on the development and yield of maize. APSIM-Maize was run for each location using the measured climate conditions for the 8-year period (referred to as current climate), then re-run with a 1.5 °C and 3.0 °C increase in temperature on each day during the growth of the maize crop and with no additional N, 40 and 80 kg ha-1 of N fertilizer each year at sowing.

Table 97. Location of 4 sites with average data from 2004-2012

Location	*Latitude*	*Longitude*	*Elev. (m)*	*Aspect*	*Max temp (°C)*	*Min temp (°C)*	*Rainfall Dec-Mar (mm)*	*Solar Radiation (MJ m^{-2})*	*AEZ*
Betano	9.148°S	125.696°E	20	Flat	25.2	18.1	594	14.9	Southern coast
Dare	8.591°S	125.568°E	440	Northern slope (80%)	21.2	16.0	628	9.4	Northern lowlands
Aileu	8.719°S	125.572°E	940	South west slope (5%)	22.5	14.2	925	12.4	Northern highlands
Maubisse	8.832°S	125.598°E	1480	South east slope (40%)	17.4	11.3	593	11.6	Southern highlands

APSIM-Maize was run for each location using the measured climate conditions for the 8-year period (referred to as current climate), then re-run with a 1.5 °C and 3.0 °C increase in temperature on each day during the growth of the maize crop and with no additional N, 40 and 80 kg ha-1 of N fertilizer each year at sowing. The major runs were initiated with N levels and soil organic carbon levels for each site and were not re-initialized each year. The organic carbon (Org. C) fractions given are the total biomass fraction (FBiom) and inert fraction (FInert); the difference between the total and the sum of the biomass and the inert fractions is the humic fraction. A second simulation was run with the standard 'Sele' duration, but with soil organic carbon rates of 1.2%, 1.9% and 3.8%.

To simulate increased growth duration of this variety, the thermal time was changed from emergence to the end of the juvenile period by +50oC days1 and +100oC days1.

Results and discussion

The results of this simulation are fully presented and discussed in a paper currently being prepared for publication. In general terms, the results indicate that increasing the duration of the vegetative phase significantly decreased the overall mean yield from 3350 kg ha-1 for the phenology of the 'Sele' cultivar to 3170 kg ha-1 when the vegetative phase was increased by 50 °C days1 and to 2900 kg ha-1 when increased by 100 °C days.

When the temperature was increased by 1.5 °C and 3.0 °C to simulate global warming, the yield with no added fertiliser decreased at Betano and Dare, but increased at the cooler sites of Aileu and Maubisse. This trend was maintained even with the application of 40kg ha^{-1} of N except at Aileu where yields stabilised. With the addition of 80kg ha^{-1} of N, all sites experienced a decrease in yield when temperature increased.

This simulation supports the hypothesis that as temperatures rise, maize yields are likely to rise in locations where N is very limiting and where there is generally low water stress. In addition, the simulations demonstrate that supplying additional N will benefit yields more at higher elevations where temperatures are lower and organic turnover is slower than at lower elevations where temperatures are higher and turnover is quicker.

7.6 Soil tests

During 2014, 195 soil tests were prepared for testing phosphorus (P), pH and electrical conductivity (EC).

Methodology

Olsen available phosphorus

Olsen available phosphorus is based on the phosphorus (P) extraction method of Olsen et al. (Olsen, Cole, Watanabe, & Dean, 1954), which uses an extraction with bicarbonate to estimate plant-available P in soil. Phosphate-P in solution is determined colorimetrically using the Murphy and Riley (Murphy & Riley, 1962) method as described by Blakemore et al. (Blakemore, Searle, & Daly, 1987). The term water used in this method refers to distilled water or equivalent P free water. Assistance and technical monitoring was established using Australian Soils Lab standards with oversight by David Lyons.

Electrical conductivity (EC) of 1:5 soil/water extract

Electrical conductivity was measured with an EC electrode using an updated method from 3A1 in Rayment and Lyons (Rayment & Lyons, 2011). This was based on a 1:5 w/v soil/water extract with air dry (40°C) soil. This soil/water ratio has been widely used in Australia and considerable data has accumulated. When the same suspension was to be used for the determination of Cl and pH, the EC was determined first to reduce risk of Cl– contamination from the calomel pH reference electrode (or similar).

If soils contain more than about 1% of gypsum, the soil suspension will approach saturation and have an EC of about 2.2 dS/m. When much gypsum is present it will not be dissolved completely in a 1:5 soil/water suspension. However, a precise indication of soluble salts loses significance in such soils.

pH of 1:5 soil/water suspension

This method (Rayment and Lyons, 2011) is the most widely used in Australia, and is based on a soil/water ratio of 1:5 at 25°C. The pH is determined with an electrode after shaking for 1 h. The suspension is stirred during measurement to minimise changes in electrode potential associated with suspension effects and positioning of electrodes.

Results

The soil test results can be categorised according to Table 98 set out below as a guide to understanding the results of the soil tests shown in Table 99. A map indicating how variable the phosphorus levels are across Timor Leste is presented in Figure 38.

Table 98. Guide to understanding results of soil tests

Olsen P	*<5*	*5~10*	*10~17*	*17~25*	*>25*
	very low	low	marginal	optimal	high
EC(ms/cm)	*<0.15*	*0.15-0.4*	*0.4-0.8*	*0.8-2*	*>2*
	very low	low	medium	high	very high
pH	*<5*	*5.0-6.0*	*6.1-7.8*	*7.9-8.5*	*>8.5*
	strongly acid	moderately acid	Neutral range	moderately alkaline	strongly alkaline

The soils across the Districts were found to be low in P with 73% of soils having an Olsen P result less than 10. Only 15% of soils tested were found to have adequate phosphorus levels in the optimal and high ranges. There few cases of soils with adequate levels of P which were found to be in scattered locations on the Baucau plateau, along the south coast around Betano and in AEZ 3 region of Liquiça. Electrical conductivity is low to very low across all soils tested.

Along the coastal plains, both north and south, soils are generally more alkaline. Mountainous areas are generally more acidic especially in the districts of Ermera, Liquiça and Aileu. In high altitude areas around Maubisse and Ossu De Cima higher levels of pH were again observed. However, pH is a localised attribute that can vary widely within a small area.

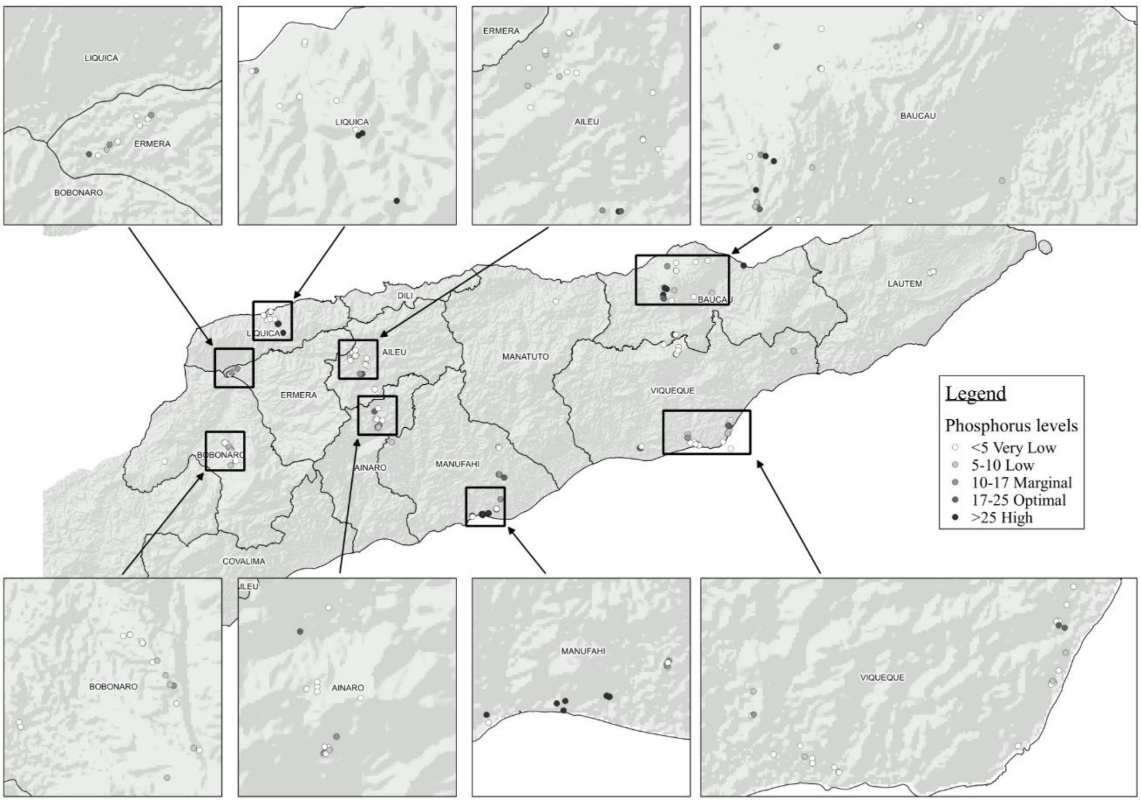


Figure 38. Soil P levels across Timor-Leste

Table 99. Soil test results by suco for pH, electrical conductivity (EC) and Phosphorus

District	*Suco*	*Elev. (m)*	*pH*	*EC (ms/cm)*	*Phosphorus (Olsen)*
Aileu	Aisirimou	930	4.9	0.05	3.0
Aileu	Liurai	941	6.0	0.06	24.4
Aileu	Seloi-Kraik	1103	5.0	0.06	4.0
Aileu	Seloi-Malere	1007	5.6	0.06	5.2
Ainaro	Aituto	1614	7.2	0.13	6.1
Ainaro	Hohorae-Kiik	1704	7.4	0.13	3.8
Ainaro	Maubisse	1420	6.9	0.06	11.1
Baucau	Bahu	513	7.4	0.17	3.7
Baucau	Fatulia	893	6.9	0.10	3.0
Baucau	Gariuai	508	7.7	0.09	4.9
Baucau	Loilubo	727	6.1	0.04	9.2
Baucau	Osso-Ala	709	6.5	0.09	43.0
Baucau	Ostico	696	5.6	0.10	16.5
Baucau	Seisal	8	8.1	0.17	15.3
Baucau	Triloca	556	6.9	0.10	5.8
Baucau	Uatulari	750	5.7	0.06	14.5
Bobonaro	Balibo	529	6.8	0.10	3.0
Bobonaro	Holsa	163	6.5	0.05	3.0
Bobonaro	Odomau	251	7.2	0.02	5.8
Bobonaro	Rai-fun	226	7.3	0.18	5.5
Bobonaro	Ritabou	179	6.5	0.07	4.5
Bobonaro	Tapo-Memo	167	5.5	0.03	3.0
Dili	Atauro Vila	13	7.8	0.23	23.0
Ermera	Asu-Lau	59	6.6	0.16	7.5
Lautem	Fuiloro	364	7.4	0.08	3.2
Liquiça	Darulete	1130	5.5	0.07	61.0
Liquiça	Dato	291	6.5	0.09	13.2
Liquiça	Loidahar	399	6.6	0.05	3.0
Manufahi	Dotik	94	7.0	0.12	13.8
Manufahi	Holarua	163	6.5	0.05	
Manufahi	Mahaguidan	59	6.6	0.16	7.5
Manufahi	Uma-Berloik	8	7.0	0.06	3.0
Viqueque	Bahalara-uain	1614	7.2	0.13	6.1
Viqueque	Boilale	513	7.4	0.17	3.7
Viqueque	Carau-Balu	893	6.9	0.10	3.0
Viqueque	Fatudere	696	5.6	0.10	16.5
Viqueque	Karaubalu	226	7.3	0.18	5.5
Viqueque	Maluru	364	7.4	0.08	3.2
Viqueque	Ossu - Desima	94	7.0	0.12	13.8
Viqueque	Uma Uain craic	959	7.3	0.14	4.0
Viqueque	Uma Uain Leten	11	7.9	0.15	7.4

8. Communication and technology dissemination

8.1 Promotional materials

Over the calendar year, some 52 technical and promotional materials were designed and printed in Tetun and English. These were distributed to key stakeholders including Ministry staff, development partners, and farmers; made available on the SoL website; and displayed in MAF and SoL offices (both in Dili and the districts). Many of the brochures, posters and banners continue to be distributed and used at MAF-SoL events to promote the varieties and National Seed System.

Materials developed include:

- 24-page glossy booklet explaining the National Seed System for Released Varieties
- Banners promoting the agricultural shops in the district, World Food Day and released varieties
- Labels for Sele, Noi Mutin and Nakroma commercial and certified seed 500 g, 1 kg and 5 kg packets
- Posters to promote existence of CSPs and CSPGs in each suco, and to display a CSP's business plan
- Radio play consisting of 6 x 10 minute episodes explaining the good agricultural practices for maize
- Report covers for the 2013 Annual Research Report and 2014 Adoption Survey
- Wall calendar for 2015.

8.2 Communications

MAF-SoL received 64 mentions during 2014 in local media (51) and international media (13). Mentions were typically positive (19) or neutral (39), with six negative mentions.

In the second half of the year, MAF-SoL was mentioned in 13 articles and stories in local media (10 mentions) and international media (3 mentions). The majority of mentions were positive (9) or neutral (3), with one negative mention. The most common theme was weather and climate with articles on SoL's maps (4), weather stations (1) and suco information sheets (1). Other topics included SoL's support of CSPGs, the fieldwork visit by University of New South Wales students, discussion of hybrid seeds, seed distribution and the maize animation.

ACIAR and the Australian Broadcasting Corporation (ABC) collaborated for the production of the "Food Bowl", a series of television programs about how agriculture, science and farming come together to lift lives out of poverty ensuring a safe food future. The ACIAR activities in Timor-Leste, with a particular focus on Seeds of Life and on the livestock program, were selected for one of the episodes. The Food Bowl team came to Timor-Leste in mid-May 2014 for 3½ days of shooting, with the final 25-minute program screened on Australia Plus TV on 24 December.

From August to October, the communication team put a strong focus on engaging with community radio stations:

- The Communication Coordinator met with 14 community radio stations in 12 districts – Aileu, Bucoly Sahe, Ermera, Liquiça, Los Palos, Maliana, Manatuto, Matebian, Maubisse, Oecusse, Same, Suai, Tatmailau (Ainaro) and Viqueque radio stations. These visits were designed to strengthen SoL's relationships with community radio stations and discuss future opportunities to work together.
- SoL paid for its two radio plays on maize and sweet potato (6 x 10 minutes each) to be broadcast on 14 community radio stations and one national station. At a typical cost of $2-$2.50/minute of broadcast, this equated to around $4,800. Due to the lack of content available to radio stations, it's often the case that they repeat the radio dramas at no extra cost to SoL.
- SoL requested community radio stations to organise and broadcast 30-minute talk shows where farmers could call in and have their questions answered by MAF or SoL representatives such as suco extension officers. Each station was asked to broadcast five talk shows, with each focusing on a different crop species (maize, rice, peanut, sweet potato and cassava). The average cost for a station to organise and broadcast the five shows is $375; therefore the estimated total cost of these talk shows for 13 stations is $4,875. Four stations (Viqueque, Bucoly-Baucau, Aileu and Maubisse) have broadcast talk shows to date, with very positive responses from callers, and this activity will continue in 2015.

The 20-minute NSSRV film was shown twice on national television in October. This was shown during MAF's hour-long agriculture segment on Sunday afternoons, at no cost to SoL.

Seeds of Life signed a one-year sponsorship agreement with local NGO Cinema Lorosa'e for $5,000 in October. This agreement involves Cinema Lorosa'e screening SoL's short films including the gender film, NSSRV film or maize animation and surveying up to five attendees about the SoL film at each event. This partnership provides an affordable and effective way to share key messages with rural communities in an engaging manner.

During 2014, information about Seeds of Life and its activities were shared with audiences through a range of channels (Table 100).

Table 100. Communication types, 2014

Audience	*Communication medium*
Farmers	Face to face communication with SoL OFDT staff Farmer field days Research results meetings Seed production workshops Socialisation workshops Printed materials (posters, banners, brochures, etc) Community radio Community theatre
MAF district staff	Ongoing liaison with SoL district staff and leaders Trainings Farmer field days Printed materials (booklets, brochures, etc) Research results meetings
NGO & agency partners	Ongoing liaison with SoL district staff and leaders Research results meetings Website Publications Social media networks Printed materials (brochures, banners, etc)
Timorese public	Conferences Tetun-language publications Local media Information distribution at local and national events Website Social media networks
Australian & international public	Website Printed and radio stories International conferences English-language publications Social media networks

International journal publications during 2014

Jensen, L.P., Picozzi, K., Almeida, O.C.M., Costa, M.J., Spyckerelle, L., Erskine, W. (2014). Social relationships impact adoption of agricultural technologies: the case of food crop varieties in Timor-Leste. Food Security, 3:397-409.

Website **http://www.seedsoflifetimor.org/**

9. Capacity building

In 2014, one MAF staff member was granted a John Allwright scholarships to pursue post-graduate studies at The University of Western Australia. This makes the total of five MAF staff members studying for Master's degree qualifications overseas during the year. (Table 101).

In terms of short-term courses, significant focus was given to strengthening the financial skills of the members of the Commercial Seed Producers (CSPs). They were provided with training on preparing business plans as well as understanding the mechanism of Savings and Loans (these trainings are categorized as Admin and Management in Table 102. The extension staff working with the CSPs received the same training. Similarly, farmers involved in Community Seed Production Groups (CSPG) received substantial training on harvest and post-harvest techniques, basics of community seed production and were provided cross-visits to learn from each other. Select CSPG members in Aileu, Lautem and Oecusse also received training on nutrition.

Staff involved in seed quality control received overseas training on seed technology and seed testing while newly assigned seed officers were provided with training on harvest and post-harvest technology.

Important technical courses such as data analysis, statistics, survey data collection and analysis, agronomy, and soils were organized for the researchers. General courses such as mathematics, IT, English, gender, computer application and photography were organized for all staff.

Some SoL staff received training on admin and finance management from Indonesia while some SoL advisors together with local staff had the chance to participate in international conference in Australia and Malaysia.

The total training opportunities for short-term courses during the year was 5162 or equivalent to 19 training opportunities per working day which means that a total of 19 MAF staff were attending training every working day of the year (Table 102). In terms of numbers, most of the trainees during 2014 were farmers. SEOs also attended training courses multiple times as did researchers, administrative staff and seed production staff (Figure 39). The program also provided the opportunity for collaborating NGOs to attend training courses.

The program also provided technical assistance to 7 students of the Faculty of Agriculture in Universidade Nacional Timor Lorosa'e (UNTL) in preparing their Bachelor's research paper.

Table 101. Master's degree scholars during 2014

Start Date	End Date	Course Title	Participants		
			M	F	Total
29/08/2012	30/04/2015	Agronomy- Plant Breeding	1	0	1
29/08/2012	30/04/2015	Agronomy- Plant Breeding	0	1	1
08/03/2013	07/03/2016	Agronomy- Tissue Culture	0	1	1
02/07/2013	02/07/2016	Agronomy- Plant Breeding	0	1	1
10/02/2014	25/12/2016	Agricultural Economics, Plant and Soil Science	1	0	1

Table 102. Training courses during 2014 (excluding Master's degree)

Course category	Participants M	F	Total	Training opportunities
Seed Production	732	160	892	1211
Admin & Management	418	320	738	1082
Statistics	119	14	133	611
Nutrition	111	125	236	568
Computer Application	142	53	195	483
English	211	42	253	441
Communication	68	18	86	165
Gender	74	23	97	157
Mathematics	56	10	66	156
Survey Data Collection & Analysis	5	10	15	120
Soils	3	2	5	85
Agronomy	19	1	20	43
Information Technology (IT)	31	9	40	40
Total	1989	787	2776	5162

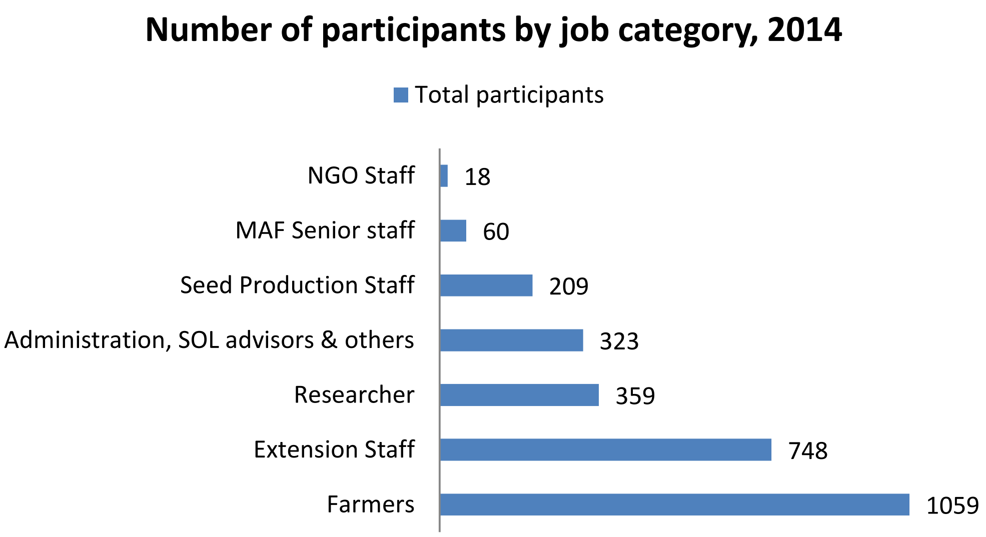


Figure 39. Number of training participants by job category, 2014

10. Technology recommendations

10.1 Released and potential varieties

Eleven improved crop varieties identified by SoL/MAF had been released by the MAF at the end of 2014. The first seven varieties identified by SoL were released by the Variety Release Committee on 8 March 2007. Two of the seven varieties are yellow maize, three sweet potato, one rice and one peanut. All released varieties had undergone evaluation under on-station conditions over the period 2000-2005 and in later years. Their evaluations are fully described in the Seeds of Life Annual Research Report for 2008.

Two cassava varieties were released by the MAF on 27 August, 2009 and multiplied in 2009-2010 for distribution to seed producers. These varieties were released as Ai-Luka 2 and Ai-Luka 4. A description of the evaluations leading to the release of these varieties including the variety release documents is presented SoL, 2009.

A high yielding white variety, Noi Mutin evaluated years from 2009 to 2012 was released on 27 July, 2012 with the name Noi Mutin (white darling). Details of the evaluation of this variety leading to it being recommended to the Variety Release Committee are included in the 2011 SoL Annual Research Report.

A third, bitter cassava variety for starch production was released in May, 2014. This variety was at the time, being extensively promoted by Cooperative Café Timor (CCT) as a second cash crop for farmers but demonstrated to have high levels of starch in SoL trials.

Most of the ten released varieties were included in replicated and on-farm trial after their official release. Details of these are included under the species names below.

10.1.1 Maize

Sele, Suwan 5 and Noi Mutin

Of the two released yellow maize varieties, Sele and Suwan 5, Sele is by far the most popular with farmers and seed multiplication and distribution has been concentrated on this variety in the period from 2007 to 2012. Sele is yellow grained and, for yellow maize, possesses characteristics preferred by most of the population. It is high yielding, possesses good pounding characteristics and is sweet to eat. It also appears to perform particularly well in drought conditions. Descriptions of these characteristics and farmers reactions to Sele are summarized in SoL, 2008.

Sele continued to perform well in replicated trials and in OFDTs during 2012 (See SoL, 2012) as it did in earlier years (Table 103, Table 104). As the preferred released variety, it was also used as a standard against which other varieties were measured. Most of the entries in the replicated trials in 2011-2012 were white grained as these varieties are preferred by farmers in many parts of Timor-Leste. A comparison of the yield of Sele and P07 (released as Noi Mutin in 2012) with the controls during replicated trials conducted over a six year period is presented in Table 103. Sele out yielded the locals by an average of 50% over this period and P07 (Noi Mutin) by 46%.

White grained Noi Mutin was included in OFDTs for the fourth year in 2011-2012. This variety continued to out yield local varieties as did Sele. Sele out yielded the locals by an average of 43% and Noi Mutin by 27% over 662 sites between 2009 and 2012 (Table 104).

Four other white maize varieties (V11, V15, V41 and S07) performing well in replicated trials in 2010-2011 and 2011-2012 were initially being considered for inclusion in OFDTs for

2012-2013 but were rejected due to weevil damage and downy mildew susceptibility during dry season trials.

Table 103. Sele and Noi Mutin maize yields and yield, advantages res. stns, 2007-2012

Year	*Yield (t/ha)*			*Yield advantage (%)*	
	Sele	*Noi Mutin*	*Local*	*Sele*	*Noi Mutin*
2007 (Six sites)	2.6	2.6	1.5	73	73
2008 (Four sites)	1.5	1.3	1.0	53	33
2009 (Five sites)	1.8	1.6	1.0	81	58
2010 (Four sites)	1.7	2.1	1.2	42	75
2011 (Four sites)	2.2	2.3	1.5	47	53
2012 (Six sites)	2.5	2.2	2.0	25	5
Mean (2007-2012)	2.1	2.0	1.4	50	46

Table 104. Sele and Noi Mutin maize yields and yield advantages, OFDTs, 2009-2012

Year	*Yield (t/ha)*			*Yield advantage (%)*	
	Sele	*Noi Mutin*	*Local*	*Sele*	*Noi Mutin*
2009 (235 sites)	2.2	1.7	1.4	57	21
2010 (188 sites)	2.7	2.5	1.8	51	40
2011 (86 sites)	2.1	1.9	1.5	34	21
2012 (153 sites)	2.6	2.4	2	31	23
Mean (2009-2012)	2.4	2.1	1.7	43	27

10.1.2 Peanuts

Utamua

The released peanut variety, Utamua, continued to average good yields during 2012. However, the results were very variable with some sites failing. (Table 105). No peanut on-farm trials were conducted during the 2011-2012 wet season but in previous years performed well against the test entries in OFDTs (Table 106).

Table 105. Utamua peanut yields and yield advantages, research stations, 2001-2012

	Yield (t/ha)					*Yield advantage (%)*			
Year	*Utamua*	*Pt14*	*Pt15*	*Pt16*	*Local*	*Utamua*	*Pt14*	*Pt15*	Pt16
2001-2005	2.1	na	na		2.0	7	na	na	
2006 (Two sites)	1.1	1.8	1.3	1.6	1.2	-9	50	8	33
2007 (Five sites)	2.0	2.4	2.3	1.8	1.7	17	40	34	6
2008 (Four sites)	1.3	1.1	1.1	0.7	0.9	43	26	23	-22
2009 (Six sites)	1.5	1.2	1.5	1.8	1.1	32	5	32	58
2010 (Four sites)*	1.2	0.7	0.8	0.9	0.8	71	-1	10	14
2011 (Four sites)	1.1				0.4	86			
2012 (Two sites)	1.2				0.9	27			
Mean (2006-2012)	1.3	1.6	1.5		0.9	38	24	21	18

* Only two sites for Utamua and only respective controls considered for this evaluation

Table 106. Utamua peanut yields and yield advantages, OFDTs, 2006-2010

Year	*Yield (t/ha)*					*Yield advantage (%)*			
	Utamua	*Pt14*	*Pt15*	*Pt16*	*Local*	*Utamua*	*Pt14*	*Pt15*	Pt16
2006 (168 sites)	1.8	na	na	na	1.2	50	na	na	na
2007 (138 sites)	2.0	na	na	na	1.6	24	na	na	na
2008 (175 sites)	2.0	na	na	na	1.5	33	na	na	na
2009 (166 sites)	2.0	1.1	1.4	na	1.1	82	0	27	na
2010 (132 sites)	3.5	na	2.3	2.3	2.4	43	na	-6	-7
Mean (2006-2010)	2.3	1.1	1.9	2.3	1.6	47	0	3	-7

10.1.3 Sweet potato

Hohrae 1, Hohrae 2 and Hohrae 3

The three released varieties, Hohrae 1-3 (Table 107) continued to perform well in replicated trials during 2012. All three varieties are highly popular with the farmers, particularly Hohrae 3 which is an orange coloured flesh variety bringing extra vitamin D into the diet of consumers. The results of trials conducted in 2011 also indicated that both CIP 83 and CIP 72 performed well. The yield results of these entries from replicated trials are presented in Table 108. Hohrae continued to be included in OFDTs during 2012 as the best performer to date for comparison purposes.

Table 107. Sweet potato yields and yield advantages, research stations, 2001-2010

Year	*Yield (t/ha)*				*Yield advantage (%)*		
	Hohrae 1	*Hohrae 2*	*Hohrae 3*	*Local*	*Hohrae 1*	*Hohrae 2*	*Hohrae 3*
2001-2005	12.7	13.2	13.3	5.6	128	137	138
2006 (One site)	2.8	4.8	1.3	0.6	367	700	117
2007 (One site)	29.6	23.9	26.5	9.8	202	144	170
2008 (Two sites)	22.2	15.9	21.9	8.9	149	79	146
2009 (Five sites)	9.2	13.8	19.6	8.9	3	55	121
2010 (Five sites)	5.0	6.6	9.5	5.9	-15	12	61
Mean (2006-2010)	13.8	13.0	15.8	6.8	102	91	131

Table 108. Sweet potato yields and yield advantages, research stations, 2011 and 2012

Year	*Yield (t/ha)*				*Yield advantage (%)*		
	Hohrae 3	*CIP83*	*CIP72*	*Local*	*Hohrae 3*	*CIP83*	*CIP72*
2011 (Four sites)	10.2	9.1	14.8	4.2	145	118	254
2012 (Five sites)	14.0	7.9	12.7	7.2	95	10	76

OFDTs conducted between 2007 and 2010 demonstrated the capacity of the Hohrae varieties to perform on-farm under a range of conditions (Table 109). Hohrae 3 was included in 41 OFDTs in 2012 and was the equal best performer with CIP83 (Table 110).

Table 109. Sweet potato yields and yield advantages, OFDTs, 2007-2010

Year	*Yield (t/ha)*				*Yield advantage (%)*		
	Hohrae 1	*Hohrae 2*	*Hohrae 3*	*Local*	*Hohrae 1*	*Hohrae 2*	*Hohrae 3*
2001-2005	na	na	na		na	na	na
2006 (None harvested)	na	na	na		na	na	na
2007 (83 sites)	4.0	4.7	4.5	3.1	29	52	45
2008 (115 sites)	6.1	6.3	6.5	3.0	103	110	117
2009 (76 sites)	na	na	15.6	3.8	na	na	311
2010 (109 sites)	na	na	15.8	6.5	na	na	143
Mean (2006-2010)	5.1	5.5	10.6	4.1	66	80	159

Table 110. Select sweet potato yields and yield advantages, OFDTs, 2011 and 2012

Year	*Yield (t/ha)*				*Yield advantage (%)*		
	Hohrae 3	*CIP83*	*CIP72*	*Local*	*Hohrae 3*	*CIP83*	*CIP72*
2011 (44 sites)	13.4	9.3	4.0	4.0	235	127	0
2012 (41 sites)	10.6	10.9	7.4	4.6	130	137	61

10.1.4 Rice

Nakroma

Nakroma (released in 2007) performed extremely well in farmers' fields between 2005 and 2010 averaging 31% more yield on 51 sites (Table 111). This variety was selected by MAF personnel and farmers in trials conducted in 2005 for targeting to release in Timor-Leste. It remains a popular variety amongst the rice farming population and is spreading rapidly in the rice growing areas. PSB RC 80 is another variety which has also performed extremely well in some rice areas and is favourably received by farmers. This variety and PSB RC 82, Matatag 2 and Angelica were included in OFDTs during 2011 and with Matatag 2 in 2012 (Table 112) but not released.

Table 111. Rice yields of OFDT, all Districts, 2005 - 2010

Variety	*Mean yield (t/ha)*			*Yield advantage (%)*		*LSD*
	Local	Nakroma	PSBRC 80	Nakroma	PSBRC 80	*(p=0.05)*
2005/06 (47 sites)	2.9	3.3	na	17	na	
2006/07 (52 sites)	3.0	3.7	na	20	na	0.5
2007/08 (76 sites)	3.6	4.8	na	30	na	0.6
2008/09 (71 sites)	3.2	3.8	3.3	18	4	0.5*
2009/10 (51 sites)	2.9	3.8	3.5	31	21	0.7
Total (297 sites)	3.1	3.9	3.4	24	11	

Table 112. Rice yields of OFDT varieties 2010-2011 and 2011-2012

	Mean predicted yield (t/ha)						
	Significance	Local	Nakroma	PSBRC 80	PSBRC 82	Matatag 2	Angelica
2010-2011 (17 sites)	ns	2.4	3.3	3.0	2.5	4.2	2.1
2011-2012 (29 sites)	ns	2.1	2.7			2.6	

10.1.5 Cassava

Ai-luka 2 and Ai-luka 4 were released in August, 2009 as new high-yielding, sweet cassava varieties. These two varieties were identified after passing through the rigorous SoL evaluation process. Ai-luka 2 and 4 were chosen because of their high yield and good flavour, and the positive response from farmers. They produce a yield 51-65% higher than local varieties, based on replicated and on-farm trials.

On May 23, 2014, the bitter cassava variety KU50 (Ca109) was released with the name **Ai-Luka 1.** This cassava variety has been promoted by the Cooperativa Café Timor (CCT) as a second cash crop for coffee farmers. In 2010, 205 CCT coffee farmers started to grow it on 50 ha in the districts Baucau, Bobonaro, Covalima and Manufahi. The expansion of the cultivation over a four year period is given in Table 113.

Table 113. Bitter cassava cultivation by CCT farmers

Year	No. of farmers	Area planted (ha)	Amount bought from farmers (t)
2010-2011	205	50	102
2011-2012	787	180	307
2012-2013	2,192	501	833
2013-2014	2,306	1,703	

Note: CCT estimates that the amount harvested by the farmers is double the amount bought from the farmers.

The benefit for the farmers is that they can obtain $ 500 – 1,500 per ha. The harvested roots/chips can be processed into modified cassava flour at a plant in Tibar that has a capacity to produce 3 t per hour.

The cassava variety is originally from Thailand and was suggested to CCT based on research conducted at the research centres. It has a high yield and high starch content, but also a high level of cyanide. The cyanide content and bitter taste discourages rats and other animals from eating the stored roots/chips.

Figure 40. Signing of the release form for the Ai-Luka 1 variety
From left to right: HE Marcos da Cruz, Vice Minister of Agriculture and Fisheries; Lourenço Borges Fontes, Director-General MAF; Francez Suni

Prior to the release, the Variety Release Committee had met and indicated its support for the release of the variety by the Ministry.

10.2 Farming systems recommendations

Maize

Agro-ecological zone (AEZ). Research conducted during the year did not reveal a variety by AEZ interaction. This indicates that Sele and Noi Mutin are well adapted over all testing regions. There is no indication that Sele or Noi Mutin should be recommended in some areas and not others. However Sele is often reported by farmers to show significant drought resistance.

Soil pH. The growth of all maize varieties was reduced when grown in either acidic or basic soils. Of all maize production sites, 18% had a soil pH acidic enough to reduce maize yield. Future research could evaluate different varieties to see if it is possible to expand the pH tolerance of maize varieties, or ameliorate the soils to increase grain yields. There may also be a role for extension staff to work with farmers to identify acid soils. Once identified, farmers could avoid the acid soil sites, and produce higher yields at other locations.

Seeds per hill. Research results indicate that the optimum number of seeds per hole is three or less and that farmers who plant more than this suffer significant yield reductions. Farmers will be encouraged to maintain their hill seeding density at below 4 for local and new varieties.

Plant density. Grain yields are not influenced by whether the maize is planted in rows or randomly. Although there is no yield advantage in plant densities exceeding four plants per square metre, there is a yield reduction when plants/m^2 drops below four. Maize crops should be managed to achieve at least four plants/m^2 at harvest time.

Weeding. Two weedings, preferably early in the season are recommended for maize. More than three weedings do not increase yields. The first weeding, within 4 weeks after planting, is critical in achieving high yields.

Fertilizer. Farmers in Timor-Leste currently do not use fertilizers, either organic or chemical, on maize, although soil improvement could significantly increase yields.

Insect pests and diseases. Maize crops were not significantly affected by insect pests and diseases during the year. However downy mildew can sometimes devastate susceptible crops, so varieties that are resistant to downy mildew are essential.

Rice

Plant density. Grain yields are not influenced by planting either in rows or randomly in the OFDT data set. However for ease of weeding, especially with mechanical weeders, planting should be at approximately 20-25cm intervals in lines.

Weeding. A second weeding was shown to be very beneficial to rice yield. At least two weedings – preferably early in the season are recommended for rice.

Peanuts

Seeds per hill. Planting two seeds per hill increases yields in both Utamua and local varieties.

Replanting. Replanting poorly germinated hills will increase plant population and subsequent yields.

Weeding. Research in 2007 indicated that pod yields are higher with an increased number of weedings. Peanuts may need to be weeded up to four times to maximize yields.

General

Grain storage Weevils are a renowned problem in stored grain in Timor-Leste. Techniques for improving storage life of maize includes storing grain in air tight containers (plastic containers and bags) or selecting varieties with known weevil resistance. The trials conducted during the year confirm that weevil tolerance is partially due to sheath characteristics but also on characteristics of the grain itself. Further research will focus on investigating both improved storage techniques and releasing varieties with better resistance.

Velvet bean The use of velvet bean (*Mucuna pruriens*) to both suppress weeds and improve soil nutrition through mulching is well known in other parts of the world. This technology was used by Timor-Leste farmers in the past and can be extended to farmers during future on-farm evaluation. Research conducted between 2006 and 2012 indicated that velvet bean will need to be planted after maize to avoid smothering the crop during the wet season. Planting velvet bean the same time as the maize crop leads to velvet bean dominating the maize crop, reducing maize yield. It is recommended that Velvet bean be used as a technology to increase maize yield and reduce the weed burden of farmers.

On the south coast where farmers plant 2 crops a year, velvet bean grown in the main wet season has been shown to significantly increase maize yields in the second season crop (planted May-June).

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Seeds of Life
Fini ba Moris

Seeds of Life activities form a program within Timor-Leste’s Ministry of Agriculture and Fisheries (MAF). Funding for the program is provided collaboratively by the Ministry for Agriculture and Fisheries and the Australian Government through the Department of Foreign Affair and Trade (DFAT) and the Australian Centre for International Agricultural Research (ACIAR). The Centre for Plant Genetics and Breeding (PGB) within The University of Western Australia (UWA) is commissioned to coordinate the Australian funded activities.

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