Annual Research Report
2012

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 Agency for International Development (AusAID) plus the Australian Centre for International Agricultural Research (ACIAR) and is managed by ACIAR. The Centre for Legumes in Mediterranean Agriculture (CLIMA) within The University of Western Australia (UWA) coordinates the Australian funded activities.

Table of Contents

List of tables and figures

Tables

Figures

Foreword

It is such a great pleasure for me to release the 2012 Annual Research Report prepared by the Seeds of Life (SoL) program. SoL is now in its third phase (2011-2016) of operating within the Ministry of Agriculture and Fisheries (MAF). In this phase, the program is expanding its activities into Informal Seed Production (IFSP). This component is aimed to strengthen the mechanism of seed production amongst farmers through informal networks, market channels and empowerment. This is the seventh research report to be issued since 2006. The report focuses on the research activities conducted by SoL/MAF and summarizes training, communications and seed production activities within the program during 2012.

As in previous years, seed adaptation research activities were conducted in the Districts of Aileu, Ainaro, Baucau, Bobonaro, Liquiça, Manufahi, and Viqueque. These Districts were selected to represent the characteristics of the six Agro Ecological Zones in Timor-Leste. High yielding and good quality varieties were tested in both research centres and in farmers' fields. Researchers effectively install and manage, collect the data, analyse, and present the results of over one thousand field trials each year. The results are evaluated over a number of years prior to the MAF recommending them for farmers to cultivate.

The results presented in this report are representative of the hard work MAF researchers have done over a number of years. One major output in 2012 was when MAF released a new white maize variety named "Noi Mutin". This variety has achieved a 27% yield advantage over local varieties in more than 650 on-farm trials conducted over a four-year period. The grain is also sweet and soft to eat and the plant is resistant to disease and drought conditions.

Seed of released varieties will be multiplied under the supervision of MAF through the certified seed system within the Formal Seed Production (FSP) program, so that these seeds can be ready for distribution to the farmers through IFSPs in 11 Districts in 2012-2013.

In ensuring smooth operation in the research centres, the SoL Program continues to renovate and construct necessary infrastructure. This can be seen on the inauguration of Loes Research Centre in May 2012. Meanwhile, in the area of capacity building, SoL continues to provide MAF staff members with training, courses, comparative studies, access to national and international conferences, as well as upgrading three researchers’ education to the Master level.

Finally, on behalf of the Ministry of Agriculture and Fisheries, I would like to extend our gratitude to the Australian Government, especially Australian Centre for International Agricultural Research (ACIAR) and the Australian Agency for International Development (AusAID) who have made financial support available for the implementation of the SoL program. My high appreciation also, to all parties who have collaborated in the SoL Program for the agricultural development in Timor-Leste to eradicate hunger, food insecurity, and poverty.

May, 2013

H.E Mariano ASSANAMI Sabino
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
AP	Annual Plan
APC	Australian Program Coordinator
ATL	Australian Team Leader
AusAID	Australian Agency for International Development
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Centre for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Centre
CIP	International Potato Centre
CLIMA	Centre for Legumes in Mediterranean Agriculture
CSPG	Community Seed Production Group
DSO	District Seed Officer
EoPOs	End-of-Program Outcomes
FAO	Food and Agriculture Organization
FSMG	Farmer Seed Marketing Group
FSPA	Formal Seed Production Advisor
GIS	Geographic Information Systems
ICRISAT	International Centre for Research in the Semi-Arid Tropics
IELTS	International English Language Testing System
IFSP	Informal Seed Production
ILETRI	Indonesian Legumes and Tuber Crops Research Institute
IRRI	International Rice Research Institute
ISPA	Informal Seed Production Advisor
M&E	Monitoring and Evaluation
MAF	Ministry of Agriculture and Fisheries
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
OJT	On the Job Training
OM	Office Manager
PDD	Program Design Document
PMT	Program Management Team
PSC	Program Steering Committee
RA	Regional Advisor
SEOs	Suco Extension Officer (MAF extension officer)
SoL	Seeds of Life
SoL3	Seeds of Life 3
SOSEK	Social Science and Economics (Sosial Ekonami)
SPC	Seed Production Coordinator
SPO	Seed Production Officer
STA	Short-Term Advisor
TAG	Technical Advisory Group
TL	Timor-Leste
UNTL	University of Timor Lorosae
UWA	University of Western Australia

Personnel

Ministry of Agriculture and Fisheries

H.E Mariano ASSANAMI Sabino	Minister, Ministry of Agriculture and Fisheries
Mr. Marços da Cruz	Secretary of State for Agriculture & Forestry (until July 2012) Vice Minister, Ministry of Agriculture and Fisheries (from August 2012)
Mr. Lourenço Borges Fontes	Director General and SoL Co- Leader
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Mr. Adalfredo do Rosario Ferreira	Director of Research and Special Services
Mr. Octávio da Costa Monteiro	National Director Policy and Planning
Mr. Januário Marçal de Araujo	National Director Community Agriculture Development
Mr. Manuel Xavier	Chief of Department for Research and Special Services
Mr. Moises Lobato Pereira	Research Manager, Darasula
Mr. Abril Fatima Soares	Research Manager, Aileu (until May 2012)
Ms. Deonisia Raquela Soares Brito	Research Manager, Aileu (from June 2012)
Mr. Rafael Feliciano	Research Manager, Betano
Mr. Telesforo Fernandes Moniz	Research Manager, Loes

Name	*District*	*Sub-District*
Ms. Armandina Marçal	Dili	
Ms. Anita Ximenes	Dili	
Ms. Octaviana Ferreira Agostinho	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	Betano
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Mr. Antonio Pereira do Rego	Baucau	Venilale
Mr. Rojino Da Cunha	Baucau	Vemasse
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	Betano
Mr. Felisberto Amaral Soares	Manufahi	Betano
Mr. Jose da Costa Freygen	Liquiça	Maubara
Mr. Jorge Amaral	Manufahi	Alas
Mr. Armindo Moises	Manufahi, Ainaro	Turiscai, Maubisse
Mr. Leandro C.R Pereira	Liquiça	Maubara
Mr. Mario Tavares Gonçalves	Liquiça	Liquiça Villa
Mr. Luis da Costa Patrocinio	Bobonaro	Balibo
Mr. Luis Pereira	Dili	
Mr. Paulo Soares	Liquiça	Liquiça Villa
Mr. Mario da Costa	Viqueque	Viqueque
Ms. Maria Martins	Aileu	Aileu Villa
Ms. Isabel Soares Pereira	Dili	
Ms. Julieta Lidia	Dili	

Mr. Luis Fernandes	Baucau	
Mr. Amandio da Costa Ximenes	Viqueque	Ossu
Mr. Inácio Sávio Pereira	Viqueque	Uatulari
Mr. Tobias Monis Vicente L. Agm	Liquiça	Maubara
Mr. João Paulo	Dili	
Mr. Agostinho Alves	Manufahi	Betano, Same, Alas
Mr. Laurentino Ximenes	Dili	
Mr. Sabilio dos Santos	Dili	
Mr. Fernando Soares	Liquiça	Maubara
Mr. Leão Mauleto	Bobonaro	Maliana
Mr. Julio Filipe	Baucau	Vemasse
Mr. Florindo Morais Neto	Dili	
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. Francisco Gama	Dili	
Mr. Rui Amaral Pereira	Dili	
Mr. Antonio de Jesus	Aileu	
Mr. Pedro da Costa de Jesus	Baucau	
Mr. Orlando dos Santos da Lux	Ainaro	
Mr. Floriano de Fatima	Manufahi	
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Mr. Silvester Sarmento	Liquiça	

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Mr. Robert Williams	Research Advisor
Dr. Asep Setiawan	Seed Production Advisor
Mr. Buddhi Kunwar	Informal Seed Production Advisor
Mr. I Wayan Tambun	Assistant Informal Seed Production Advisor (From July 2012)
Mr. Martin Browne	Regional Advisor for Eastern Region
Mr. Nick Molyneux	Climate Change Advisor (Until March 2012)
Mr. Samuel Bacon	Climate Change Advisor (From April 2012)
Mr. Luc Spyckerelle	Monitoring and Evaluation Advisor
Mr. Joseph Freach	Regional Advisor for Western Region
Mr. Luis Aguilar	Regional Advisor for Central Region
Mr. Rijk Jacobsen	Short Term Communication Advisor (From April-October 2012)
Mr. Nick Appleby	Short Term Multimedia Advisor (From June 2012)
Mr. Augusto Soares Barreto	Short Term Planning and Budgeting Adviser (From July 2012)
Mrs. Carla Da Silva	Office Manager
Ms. Ines Alves	Finance Officer
Ms. Cecilia da Silva Pires	Finance Assistant (from November 2011)
Mr. Apolinário Ximenes	OFDT Officer (from October 2011)
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Ms. Alexandra Araujo	Administrative Officer
Mr. Filomeno Cardoso	Logistics Officer
Mr. Jeronimo Ribeiro	Logistics Officer
Mr. Jonas Amaral	IT Officer
Mr. Francedes Suni	Communications Officer (from October 2011)
Mr. Anibal da Costa	Training Coordinator (from December 2011)
Mr. Jose Maria Alves Ornai	Formal Seed Production Coordinator (from January 2012)
Ms. Teresa Maria Pires	Admin Officer Eastern Region (Until June 2012)
Ms. Liliana da Costa Cruz	Admin Officer Western Region
Mr. Egas Vong	Finance Assistant
Mrs. Chona P. Binuya	English Teacher
Ms. Yane Andriana	Admin Officer Central Region (From August 2012)
Mr. Edmundus Fahik	Mathematics Teacher (From June 2012)

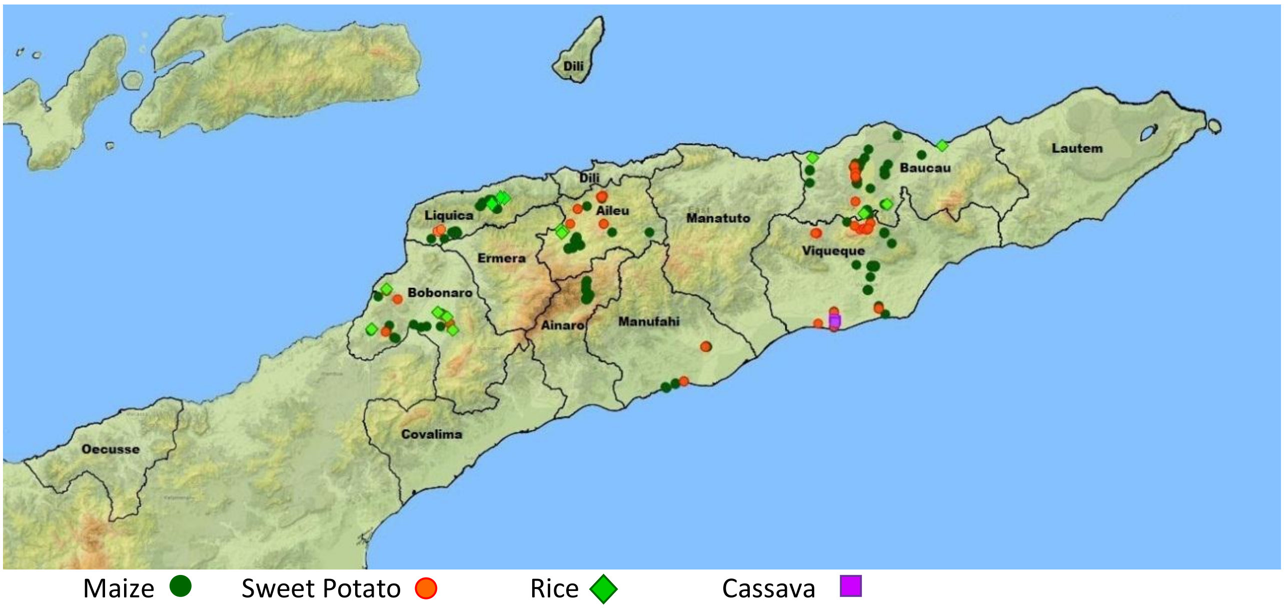


Figure 1. Selected research/demonstration sites in Timor-Leste, 2011-2012

1. Overview of the Seeds of Life program

1.1 Introduction

The Seeds of Life (SoL) program in the Ministry of Agriculture and Fisheries (MAF) addresses the underlying causes of food insecurity in Timor-Leste. These include low yields of staple crops, vulnerability of unfavourable seasons and natural disasters, lack of cash incomes to purchase food during periods of shortfall, post-harvest losses and low market distributional capacities.

SoL3 builds on the success of previous phases (SoL1 and SoL2) and maintains a core focus on increasing yields by selecting and distributing improved varieties of superior genetic quality. It also has a secondary focus on analysing and developing strategies to overcome climate variability and change; improving agronomic practices to reduce weed burdens and increase soil fertility; reducing post-harvest storage losses and improving input supply arrangements for seed.

The program concentrates on evaluating higher yielding varieties of crops currently cultivated by farmers in Timor-Leste. These are maize, sweet potato, cassava, rice and peanuts. A small amount of work is also conducted on some minor crops such as wheat, barley, potato and various bean crops.

SoL3 is being implemented over a five year period (01 February, 2011-31 January, 2016). During 2012, research activities were concentrated in the Districts of Aileu, Baucau, Viqueque, Bononaro, Manufahi, Ainaro and Liquica. However, training, seed multiplication and seed distribution were also conducted in the remaining six Districts.

This is the seventh Annual Research Report prepared by Seeds of Life. The report details the results of the research conducted by the research component (Component 1) trials completed after August, 2011, during the 2011-2012 wet season and into the dry season of 2012. The report also summarizes the formal and informal seed production programs (Component 2 and Component 3 respectively) plus management activities (Component 4) and outlines progress made with communications and capacity building within Seeds of Life.

1.2 Program summary

The third phase of SoL was designed with four components possessing specific activities for each. These are 1) Evaluation of improved food crop varieties, 2) Formal seed production and distribution, 3) Informal seed production and distribution and 4) Seed system management. Capacity building is an integral part of the program and is imbedded in each component but a summary of the year’s training activities is presented separately.

The activities and progress of each component for 2011-2012 are presented below:

1.2.1 Component 1: Evaluation of improved food crop varieties

Component objective: Improved varieties of food crops identified 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
- Sufficient foundation seed being produced

- Capacity of MAF staff to manage the identification and release of new varieties strengthened

Major construction on research stations during the year was primarily on Loes Research Station where roads and drainage were installed to facilitate access to crops and improve crop growing conditions. At this station, a pump was installed on the bore and a 110,000 l tank installed for irrigation. Other infrastructure developments during 2012 include the erection of a temporary service and storage shed at Kintal Portugal (Aileu) and water bore development at Darasula Research Station.

Most genetic material evaluated during 2012 had been imported during earlier years of the program. The only new material imported was a QPM (Quality Protein Maize) white maize variety imported from Indonesia.

Improved genetic material of fourteen crops imported during earlier years were compared with locally grown varieties. Potential new varieties were evaluated on-station in 43 wet season trials conducted over the 2011-2012 wet season and 17 trials in the 2012 dry season. The number of entries in each trial varied from 13 to 106 depending on the crop. Two promising maize varieties were identified in the wet season replicated trials but when evaluated further during the dry season were found to be susceptible to downy mildew and eliminated. The direction for selecting white maize varieties has been modified as a result. Three new sweet potatoes were identified for inclusion in 2011-2012 and 2012-2013 on-farm trials.

Potential new varieties found to show some promise in replicated on-station trials were evaluated on farmers' fields under farmer conditions. Approximately 430 on-farm demonstration trials (OFDTs) were installed over the 2011-2012 wet season and data collection extended through to July 2012. The OFDTs were installed across 7 Districts and 19 Sub Districts. Farmers were particularly pleased with the released varieties. When asked to compare released varieties with locals in the baseline survey, 87.5% of the MAF/SoL variety growers considered that these varieties yielded better or much better than the local varieties, and only 1.4% of the MAF/SoL variety growers thought they yielded worse or much worse than the local variety (Table 1).

Table 1 Comparison of productivity of MAF/SoL varieties with local varieties

Crop, variety	*# of farmers reporting on productivity*	*Much better than local variety*	*Better than local variety*	*Same as local variety*	*Worse than local variety*	*Much worse than local variety*	*Don't know/ remember*
Maize, Sele	138	102	8	25	2		1
Rice, Nakroma	55	31	20	4			
Peanut, Utamua	46	31	10	2		2	1
Cassava, Ai-luka 2	35	21	9	5			
Cassava, Ai-luka 4	15	9	6				
Sweet potato, Hohrae 1	40	27	11		1		1
Sweet potato, Hohrae 2	16	8	7	1			
Sweet potato, Hohrae 3	15	6	9				
MAF/SoL varieties, combined	360	235	80	37	3	2	3
Percentage of total		65.3%	22.2%	10.3%	0.8%	0.6%	

As a result of four years of on-farm trials, a new white maize variety (tested as P07) was released by the Minister of MAF on 27 July 2012 with the name Noi Mutin (white darling in English). Data of other crops are also being closely examined as prospective releases. Sufficient foundation seed of this release and other SoL/MAF varieties was multiplied and made available for the various seed production programs and for research purposes in 2012 and into 2013. Small areas of sweet potato multiplication were also established close to farmers requiring cuttings. Watering of these sites was supported by micro-trickle irrigation systems. One hectare of cassava plants for cuttings was established at both Loes and Corluli for further multiplication by farmer groups.

Capacity building within the Ministry of Agriculture and Fisheries included formal and informal training. MAF personnel received training on statistics, data analysis, report writing and presentation of research results. Many also had the opportunity of attending or presenting research papers at international conferences. These events are recorded in the Training Summary presented in Section 9 of this report. SoL advisers and MAF staff were also involved with supervising university students with their final year theses or “skripsis”. Two agronomy “skripsis” were supervised – both on maize agronomy. In addition, one MSc thesis was supervised in Australia and two MAF personnel were sponsored to fulfil the requirements for a MSc in Indonesia.

1.2.2 Component 2. Formal seed production and distribution

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

Activities in this component include:

- Formal seed being produced through farmer contracts
- 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
- Capacity of MAF staff to manage the production and distribution of formal seed strengthened

Seed production officers (SPOs) contracted farmers in Aileu, Baucau, Liquica, Viqueque, Bobonaro and Manufahi to produce seed (and planting material) of maize, rice and sweet potato during the year. All cassava multiplication for the program was at Betano or Loes research stations. By the end of 2012 the amount of clean seed produced for the 2012-2013 planting season was as follows: 17.3 t Nakroma rice seed; 42.5 t Sele and Noi Mutin maize seed; 3.7 t Utamua peanut seed.

The program was on target to plant 20 ha of Sele and Noi Mutin maize , 5-10 ha of Utamua peanuts, 5-10 ha of Nakroma rice, 6000 m^2 of Hohrae sweet potato and 5 ha of Ai-Luka cassava in 2012-2013.

Seed Production Officers and Seed Production Coordinators continued to monitor the quality of seed produced during the year. Quality was maintained by rejecting up to 20% of that harvested and one technician was dedicated to laboratory analysis of seed quality. Quality equipment purchased in the previous year was used for quality control purposes. New seed sampling equipment and techniques have been implemented in the program.

Technical extension support was provided to contracted seed producers throughout the year. Most of the field inspections done by District Seed Officers was conducted in the presence of the Suco Extension Officer (SEO) and farmer. In addition, seed producers received regular visits from seed production officers.

Seed grading, packing and storage facilities established during earlier years of the program continued to clean, grade and pack seed for various programs. 20 t rice, 4.6 t maize and 1.7 t peanut seed was processed at Baucau 7.5 t maize and 3.6 t peanut in

Bobonaro; 37.6 t maize at Betano; 1 t maize at Aileu and 6t at Loes. Each warehouse is capable of storing 30t of seed and cleaning/grading rice at 1 t/hr and maize seed at 0.2-0.3 t/hr. Fifteen persons were assigned by MAF to the seed production program. Three are women.

Formal seed was distributed through preferred distribution channels. Included in the distribution was 39.2 t of Nakroma rice seed, 23.8 t of Sele maize and 2.6 t Utamua peanut seed which was distributed to MAF, SoL components and NGOs over the year. Some cost recovery was possible by selling seed to international organizations. These funds were re-invested into the seed production program.

The Capacity of MAF staff to manage the production and distribution of formal seed was enhanced through a series of short training courses and a visit to another seed technology program in Indonesia (See Section 9).

1.2.3 Component 3. Informal seed production and distribution

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

Activities in the component include:

- Community Seed Production Groups (CSPGs) established
- Farmer Seed Marketing Groups established
- Focal seed merchants in local markets established
- Access to seed for vulnerable groups improved through seed fairs
- Systems linking informal seed producers with potential buyers enhanced
- Capacity of MAF extension staff to establish CSPGs strengthened

Seven hundred and twenty six Community Seed Production Groups (CSPGs) were established over the 2011-2012 wet season (280 SoL and 446 NGO groups) and underwent training during the year. The number of SoL sponsored groups in the original 7 Districts will increase to approximately 560 in 2012-2013 and these were contacted by the end of August 2012. An additional 24 groups were established in each of the new Districts of Lautem, Ermera and Manatutu. The cumulative total number of CSPGs in MAF/SOL for the ten Districts is 632 groups. The number of NGO groups is also expected to expand during 2012-2013.

Farmer Seed Marketing Groups (FSMGs) are being established to enhance the sale of farmer-grown seed. Three FSMGs (two in Baucau and one in Liquica) were formed during the year. Within these groups are 15 CSPGs. The three FSMGs produced 2.6 t of maize of which 1.87 t of Sele was sold to NGOs at $1.50/kg . The total sales value of this maize was $2,817 which directly benefitted the farmers. The plan is to develop 5-7 FSMGs in 2013-2014.

It is planned that focal seed merchants in local markets be supported to assist merchandise farmer produced seed. Two seed merchants, one in Baucau and other in Maliana have been identified with support from MAF District offices. A seed marketing training course is planned for April 2013 to assist the farmers with their marketing plan.

A simple, inexpensive farmer to farmer seed exchange approach will be piloted in the Districts to support vulnerable households. The seed exchange scheme is planned to be implemented from January 2013 in Liquica and will be replicated in 6 of the original 7 Districts where CSPGs have sufficient reserves of seeds and planting material.

Systems are being developed linking informal seed producers with potential buyers. These activities commenced during 2012 with discussions between SoL and Losconi in Manufahi/Manatutu for Losconi to consider commercially growing seed for sale to SoL and NGO informal seed producers. SoL then further facilitated a linkage support system between FSMGs/CSPGs and potential seed buyers later in the year. As a result 6.6 t of maize, 2.3 t of paddy was sold at $1.50/kg. The value of these sales was $12,994. The two main buyers were the NGOs World Vision and CRS. The purchases were made from 34 CSPGs (includes 3 FSMGs).

SoL supported fourteen training courses on informal seed production during the 2012 calendar year (Section 9). The courses covered a total of 481 participants of whom 58 (12%) were women. Training courses included a range of subjects including seed production, post harvest and quality control, gender, communication and facilitation skills, English language skills, mathematics, rice post production to market course, report writing and presentation skills, understanding national seed systems (from the Nepal study visit). The participants were: national seed production coordinators, District informal seed production coordinators, chief of the extension departments from 7 Districts, Suco extension officers and Sub-District Extension Coordinators.

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
- M&E systems established
- Seed system gender strategy implemented
- Improved-variety technical and promotional materials developed
- Awareness of improved varieties increased
- Environmental and climate change impacts addressed
- Capacity of MAF staff to manage the national seed system enhanced

SoL coordinated the formulation of a National Seed Policy during 2012. A policy will be drafted at the beginning of 2013 and finalized by mid year. A National Seed Policy Working Group with representatives from Government (MAF), Non-Governmental Organizations (NGOs), development organizations and farmers was formed. Representatives from these groups took a draft policy for discussion to each of the 13 Districts to gather feedback. Forty to seventy farmers, SEOs and other District personnel were involved in each of the meetings. Feedback from the discussion groups was being collated at the end of the year.

Forward planning systems are being implemented in SoL but these still need to be integrated with MAF planning. An inventory system for SoL seed is established and will be expanded to encompass the national seed program as the policy is fully developed. Training is being provided to help MAF staff with the initial design.

The Monitoring and Evaluation/Social Science (M&E/SOSEK) Unit increased in number to five at the end of December 2012 with the assignment of a MSc graduate from Australia. The 2011 Baseline Survey Report was finalized and published during the year and competency assessments of SoL personnel completed. The information from this survey was being collated at the end of the year. The M&E/SOSEK team also started a study of maize growing CSPGs in one suco in Aileu, and conducted a feedback survey of CSPGs and SEOs on their year 1. The M&E manual was updated during the year.

A seed system gender strategy was drafted during the year. The short-term gender advisor spent two months developing a work plan for Gender in SoL. An action plan for each component has been developed and personnel trained on Gender in Agriculture perspectives. The MAF assigned two persons to work on gender activities in MAF/SoL.

SoL personnel published 4 refereed papers in scientific journals and four other were edited for inclusion in conference proceedings and an ACIAR publication. Two more papers were drafted and submitted to scientific journals. Program reports were also printed for distribution. These include the 2011 Annual Research Report, Baseline Survey, and others. In addition there were three conference presentations, and printed material including banners, information booklets, brochures maps and brochures. A list of these are presented in Section 8 of this report.

SoL activities received considerable publicity during the year both on local and international TV in addition to publicity in local press. A list of these is presented in Section 8. Included were visits by the MAF Minister and Secretary of State to SoL activities and his publically expressed support for the program on local TV.

Educational climate information posters were produced during 2012. Included in the posters were recommendations for 5 key farming adaptations. An analysis of ENSO cycle impact on the climate of each of 13 Districts was also completed and a terracing report released. There was also a mapping analysis of pH and Fe & Zn deficiencies in the nation. The state of the nations' weather stations and Ag-met data was developed in collaboration with Agricultural Land Geographical Information System (ALGIS) staff.

MAF staff received considerable training during the year (Section 9). One Masters' degree student in Australia was also studying participatory plant breeding and seed distribution systems and two other students studied agronomy – plant breeding. Two MSc students graduated from The University of Western Australia during the year. One in social science and the other in plant breeding. This makes a total of four MSc graduates sponsored or partially sponsored by SoL.

1.2.5 Program management

SoL personnel dedicated a considerable part of their time during 2012 establishing sustainable systems within MAF. The Program Management Team (PMT) composed of four directors, seven District directors, the SoL ATL and chaired by the MAF DG met on a quarterly basis and directors were fully involved with program activities. All meetings with farmers were organized through the District offices and Suco Extension Officers arranged the CSPGs.

Physical and financial management systems were established at the SoL office in Dili and in the three Districts with the assistance of extra logistical and financial staff members. A communications strategy developed during 2011 was acted upon by a small communications team. Administrative guidelines were developed and the M&E Framework was reviewed and being implemented. The second TAG visit in April completed its report in July 2012 and its recommendations are being acted upon.

1.2.6 Capacity building

SoL invested considerable resources in capacity building of seed industry personnel during the year. MAF personnel were the main recipients attending most of the short term courses and joined conferences and international study tour visits. For example, four Directors and MAF staff members attended gender workshops, statistics, report writing courses and joined trips to Indonesia, Philippines and India. Training opportunities (number of training days multiplied by the number of participants) amounted to 15.75 per working day during 2012. In addition, four persons completed Masters degree courses and three are in the process. These are all presented in Section 9. The impact that this training is having on the capacity of the MAF to sustain a national seed system is being measured by competency assessments. The results of this evaluation will be available in 2013.

1.3 Rainfall

Introduction

Rainfall data were collected at a number of sites in the near proximity of replicated agronomic trial sites and some On-Farm Demonstration Trials (OFTDs) during 2011-2012. This annual data can be compared to the long-term average rainfall calculated from data collected during the Portuguese period and from previous SoL years. Data presented here are from seven Districts across Timor-Leste that are representative of the different elevations and agro-ecological zones across the country. The climate of Timor-Leste can be broken into two seasons: the wet/rainy season and the dry season. There was less rainfall in 2011-2012 when compared with 2010-2011 which indicates a shift to more average rainfall (see Figure 2). More land was used for cropping during 2011-2012 leading to increased production. At most sites it is possible to cultivate maize, sweet potato and cassava during November, whereas rice in rain-fed areas is planted in early January. Some areas such as Manufahi have a bimodal wet season allowing two crops to be planted.

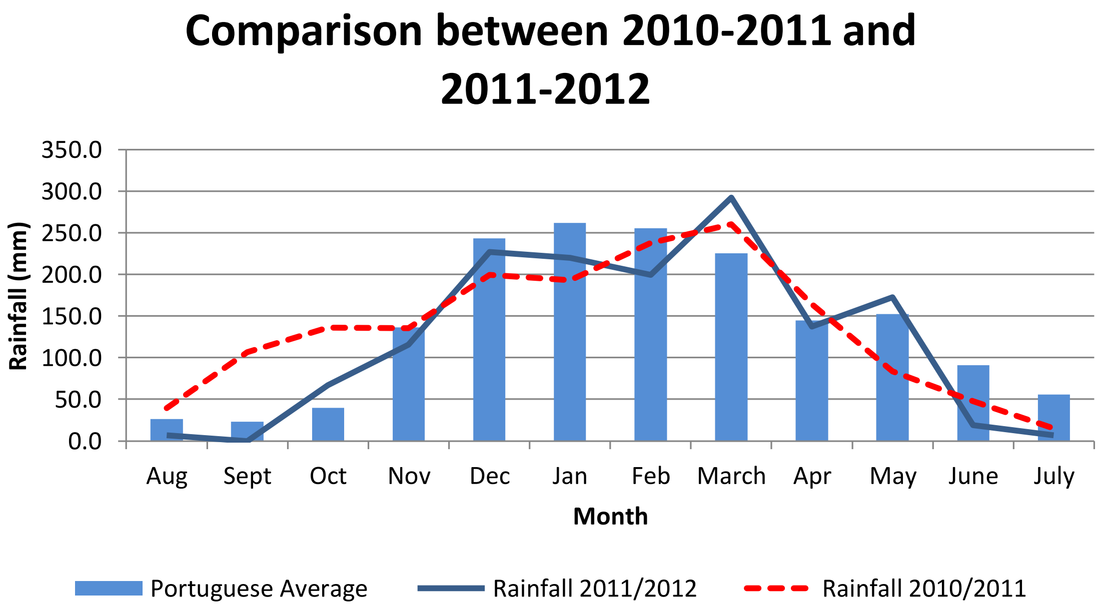


Figure 2. Comparison of rainfall in 2010-2011 with 2011-2012

Rainfall data at select sites

At Aileu, very little rainfall was recorded in August and September of 2011 (Figure 3). The wet season started in October with above average rainfall allowing farmers to plant their crops. A steady period of rainfall continued through until March when very high rainfall was experienced. This may have impacted on farmer ability to adequately dry their harvest for storage. Rainfall returned to normal levels in April and May leading to the start of the dry season in June.

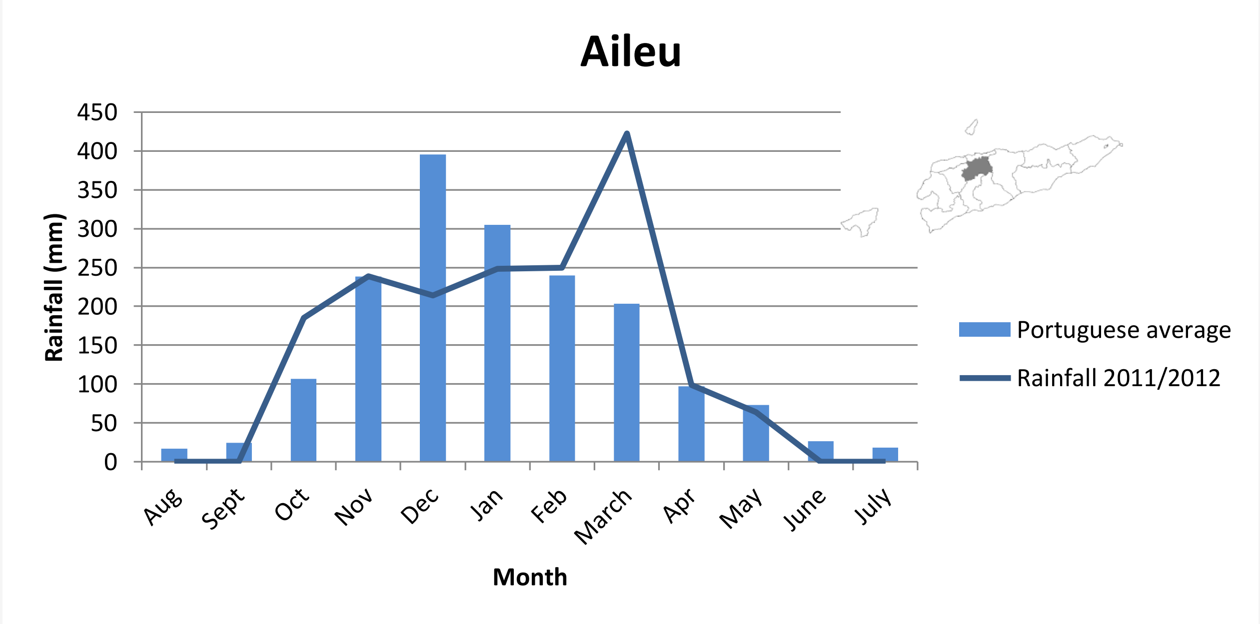


Figure 3. Rainfall (mm) at Mantane, Aileu, 2011-2012. Map shows district location

In Alas, Manufahi, farmers experienced below average levels of rainfall (Figure 4) for all months of the cropping season excepting for December, 2011. The good rains in December allowed crops to be planted after a long dry season. There was a sharp decline in rainfall after December where farmers experienced abnormally low rainfall for the rest of the season. The bimodal pattern of rainfall was still evident, though, allowing a second crop to be planted in May.

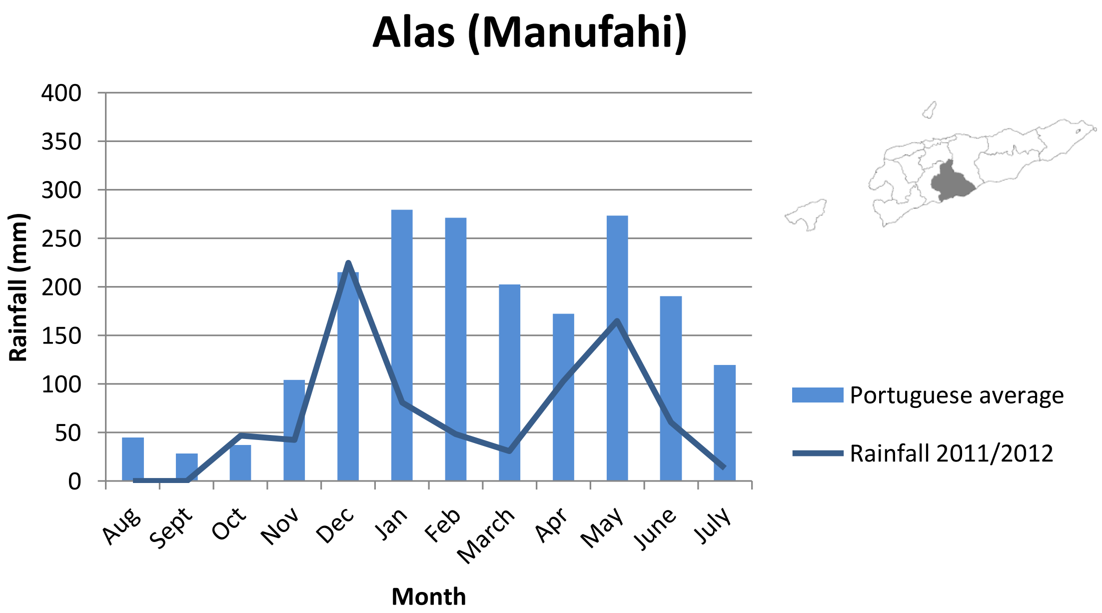


Figure 4. Rainfall (mm) at Alas, Manufahi 2011-2012. Map shows district location

In Maubisse, farmers experienced an early start to the wet season with strong rainfall continuing throughout the season from October until March (Figure 5). Abnormally high rainfall was experienced during February and March followed by a sharp decline to less than 50% of average rainfall during April. This abrupt finish may have affected late maturing crops. This erratic rainfall makes it difficult for farmers to adequately plan the planting season. Rainfall patterns returned again to normal late in the wet season.

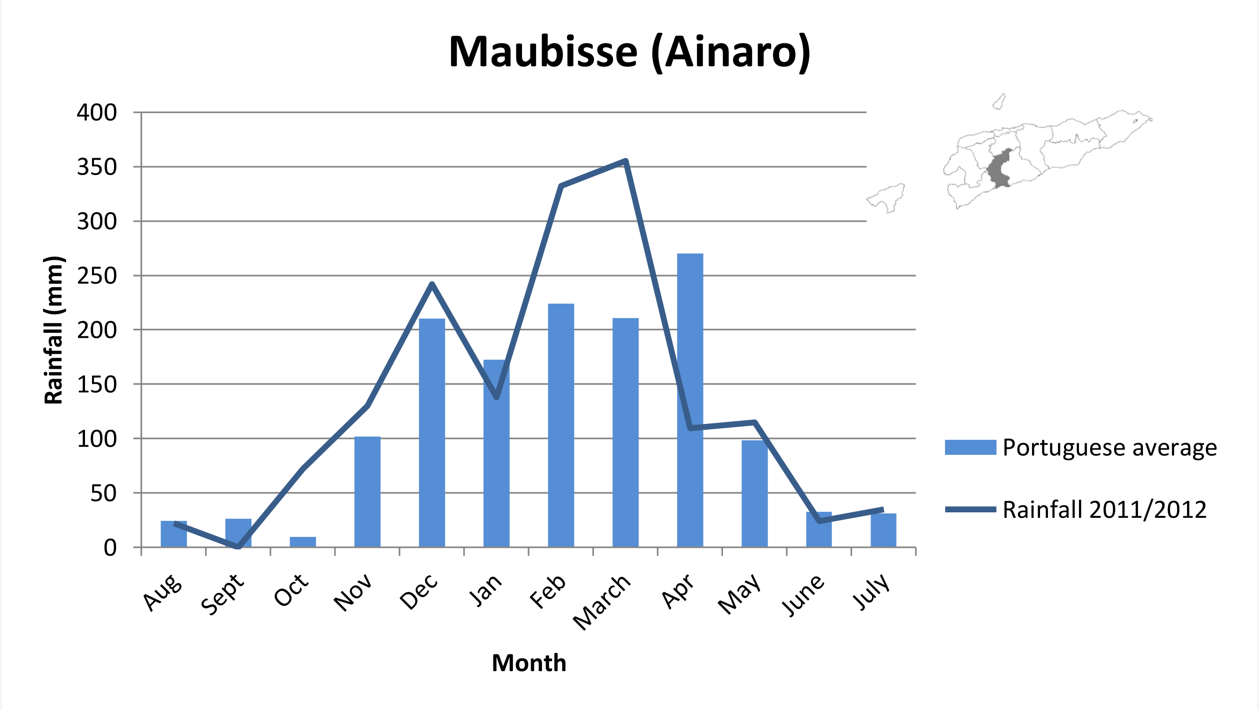


Figure 5. Rainfall (mm) at Maubisse, Ainaro, 2011-2012. Map shows district location

Venilale is an area with high elevation in the eastern Districts. This area experienced a strong start to the wet season in 2011 (Figure 6). Rainfall peaked in December and then dropped to below average levels. A steady rainfall pattern continued through until May resulting in an extended growing period. A sharp drop followed in June leading to the start of the dry season.

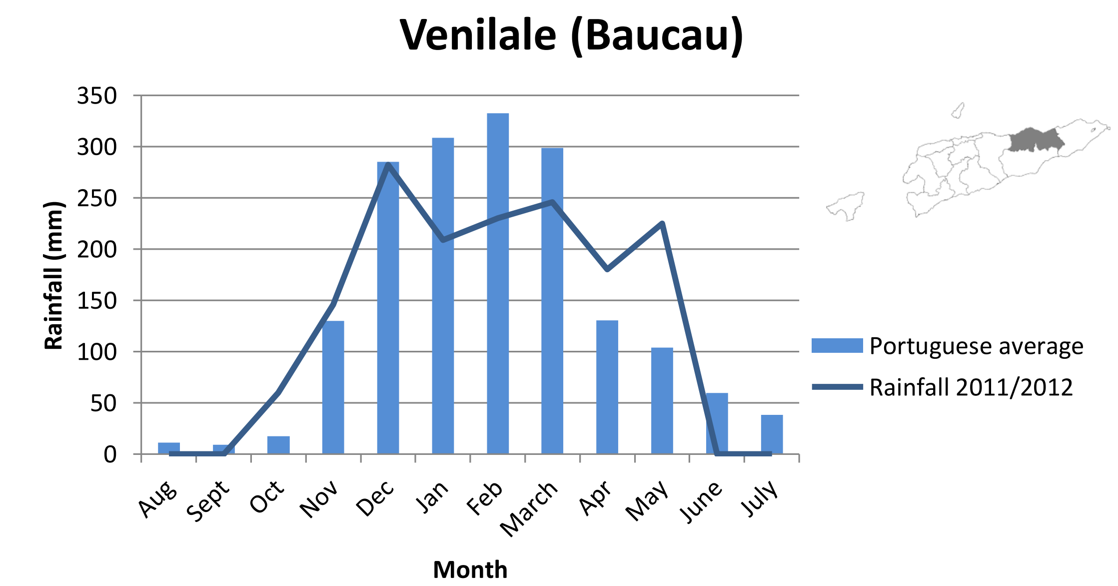


Figure 6. Rainfall (mm) at Venilale, Baucau, 2011-2012. Map shows district location

Maliana has very high average annual rainfall allowing farmers to plant many different crops. During 2011-2012, the rainfall was below average (Figure 7). In March and April farmers experienced above average rainfall. A sharp decline in May/June indicated the start of the dry season. This rainfall pattern resulted in a peak in rainfall for the area being delayed by 2 months.

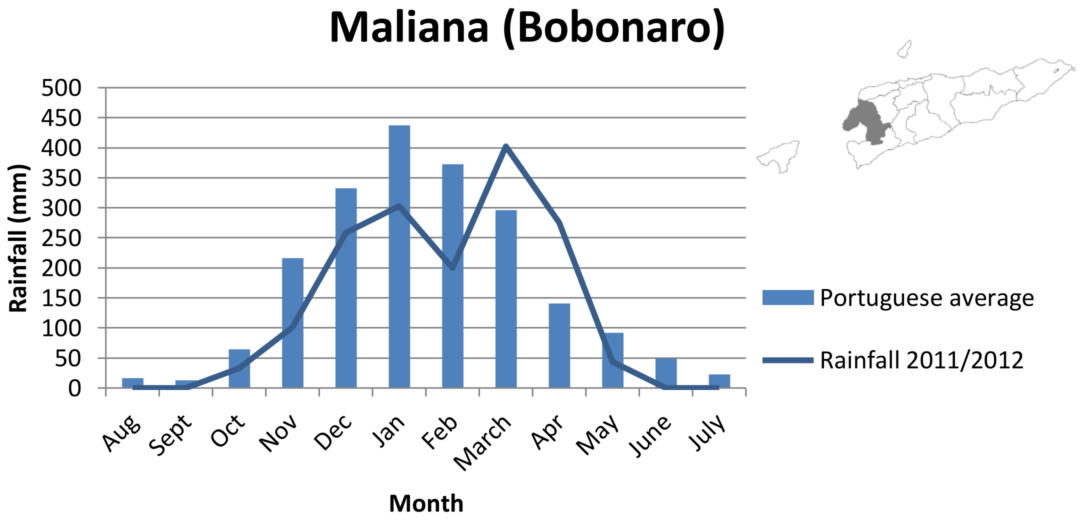


Figure 7. Rainfall (mm) at Maliana, Bobonaro, 2011-2012. Map shows district location

Like other areas on the north coast, Liquica also experienced above average rainfall compared with the long term rainfall data from the Portuguese period (Figure 8). After a very dry period in August and September, farmers experienced a strong start to the wet season with above average rainfalls. An unusual peak of rainfall occurred in March before returning to average levels. The wet season ended abruptly in June with very little rainfall and remained dry through July.

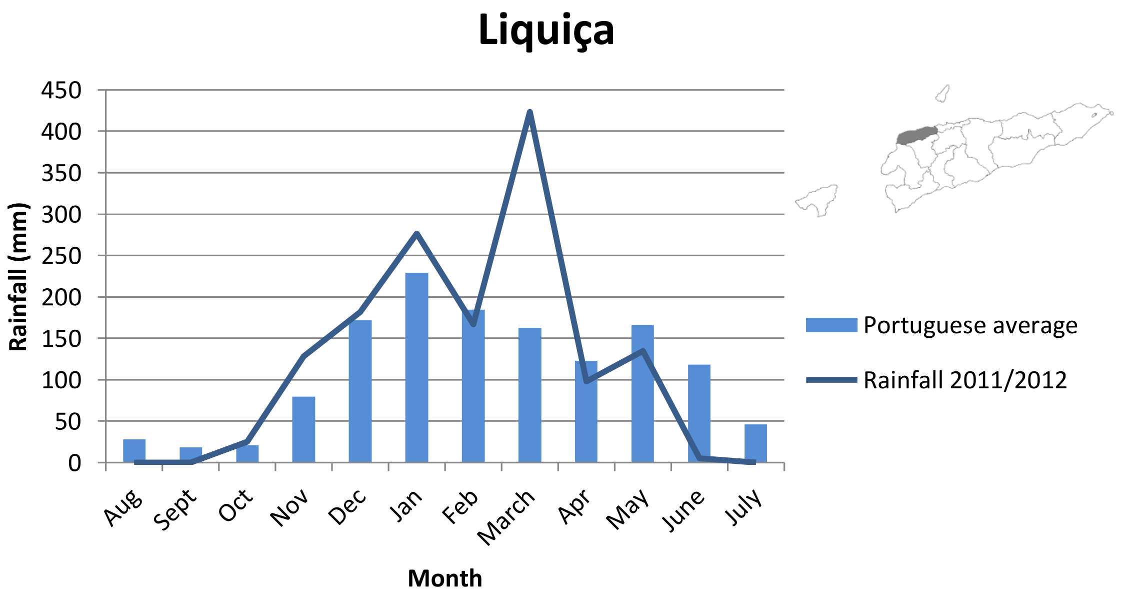


Figure 8. Rainfall (mm) at Liquica, 2011-2012. Map shows district location

In the District of Viqueque, the wet season had a strong start in December with above average rainfall (Figure 9). This continued with a strong peak in rainfall during January. Rainfall then returned to average levels through February and March. The second half of the bimodal wet season received extremely high rainfall with double the average during May. This was followed by a sharp decline in rainfall during June and July.

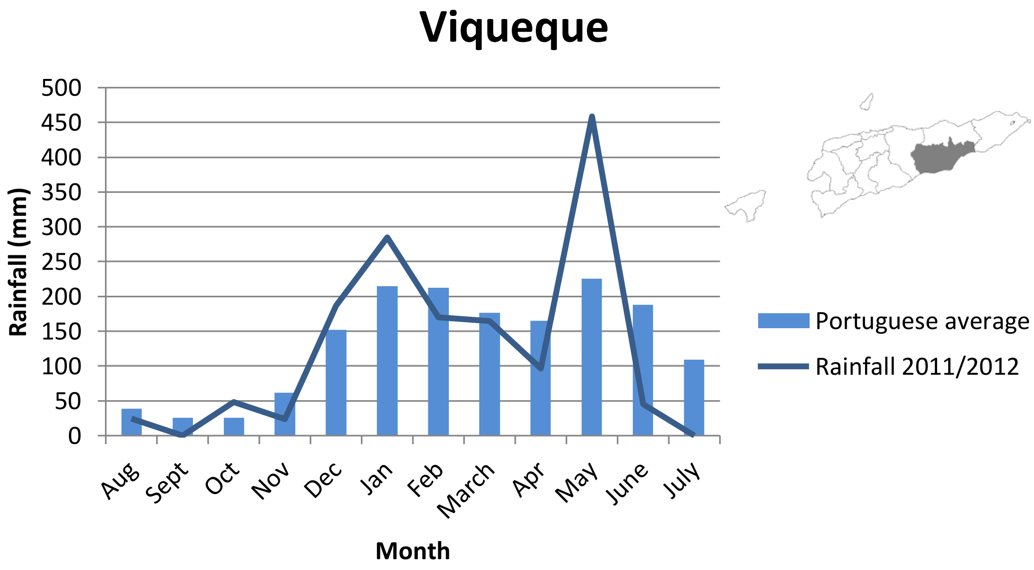


Figure 9. Rainfall (mm) at Viqueque, 2011-2012. Map shows district location

In Summary

Most of the rainfall data presented in the seven figures above, indicate that farmers experienced large and unpredictable rainfall patterns during 2011-2012. These rainfall patterns may follow average conditions for three to four months before an unexpected peak or drop in rainfall is experienced, making farming difficult. The erratic rainfall affects farmer's ability to maintain soil moisture and control erosion. Increasing soil organic matter may assist in maintaining soil moisture content and extend the growing season. The use of cover crops such as velvet bean may also protect the soil during high rainfall events.

2. Evaluation of new germplasm

2.1 Maize

2.1.1 Replicated maize trials, wet season 2011-2012

Fifteen maize (*Zea mays* L.) varieties evaluated first in observational trials and then in replicated trials in 2010-2011 were further evaluated in the wet season of 2011-2012. Most of the fifteen entries were from a set of 36 white maize populations imported from Africa (see SoL, 2011) representing a wide range of genetic material with potential for use in Timor-Leste. The code name and source of material used in the 2011-2012 trials are presented in Table 2. All populations are open pollinated and free for multiplication and cultivation in Timor-Leste if suitable material can be identified. Twelve of the entries were white grained. One of the local checks (Fatulurik) and the high yielding Sele and Suwan 5 are yellow grained.

Table 2. Name, code and source of 15 entries used in six trials, 2011-2012

Code	*Full name*	*Source*
Har12	V036=PopDMRSRE(MOZ)F2	CIMMYT Zimbabwe
*M45**	*Local Fatulurik*	*Timor-Leste*
M47	*Local Kakatua*	*Timor-Leste*
P07 (Noi Mutin)	CMU Var 12	Philippines
P11	CMU Var 10	Philippines
P7H12	Cross of P 07 and Har 12	Timor-Leste
S07	07SADVE3	CIMMYT Zimbabwe
S08	08SADVE2	CIMMYT Zimbabwe
S09	09SADVE-F2	CIMMYT Zimbabwe
Sele*	LYDMR	CIMMYT India
Suwan 5*	Suwan 5	Thailand
V11	VP0711	CIMMYT Zimbabwe
V15	VP0715	CIMMYT Zimbabwe
V41	VP0741	CIMMYT Zimbabwe
V83	VP083	CIMMYT Zimbabwe

* Yellow grained varieties in use in Timor-Leste

Methods and materials

Replicated trials on the 15 varieties presented in Table 2 were conducted during the 2011-2012 wet season at Aileu, Betano, Loes, Darasula and Ululefa research stations (Table 3). These research stations are located in four of the six distinctly different agro-ecosystems of Timor-Leste. Each trial was installed as a randomized complete block with three replicates, the plots being 5m x 5m in size.

Table 3. Planting and harvest dates, maize variety trials, 2011-2012

Location	*Season*	*No. of varieties*	*No. of reps*	*Date planted*	*Date harvested*	*Days to maturity*	*Rainfall during trial (mm)*	*Grain yield (t/ha)*
Aileu (K. Portu)	Wet	15	3	11/08/2011	4/02/2012	146	1491	0.7
Betano (Same)	Wet	15	3	13/12/2011	18/04/2012	128	na	1.3
Loes (Maubara)	Wet	15	3	27/11/2011	27/02/2012	94	607	3
Darasula (Baucau)	Wet	15	3	11/08/2011	13/03/2012	127	1182	0.9
Ululefa (Maubisse)	Wet	15	3	11/09/2011	29/03/2012	141	799	3.5

Seven rows were planted in each plot with 75 cm row spacing and 25 cm between hills. Two or three seeds were planted per hill, which if required, were later thinned to one plant per hill. Gaps were resown to improve plant stand. None of the trials were either fertilized or irrigated, with the exception of Aileu which had 15 kg N/ha and 15 kg P/ha applied to the trial at the three-leaf stage. The trials were planted from August to December, 2011.

A number of parameters were recorded during plant growth, starting with emergence rates at 2-3 weeks. At harvest, the cobs of the two outside rows were dried separately and put aside for taste and weevil tolerance testing. Yield and yield components were evaluated from the five central rows. The numbers of plants and cobs were counted and the fresh weight of the latter measured. After drying, cobs were weighed again with and without sheathes. Total grain weights (after threshing) were recorded to calculate final yields and the weight of a random sample of 100 seeds recorded for seed weight.

The data of each trial were analysed separately using GenStat Discovery 4 in order to determine varietal effects. Yield advantages were calculated from the resulting predicted means over the average of the locals. All trial data was examined for row effects, and if significant, analysed with REML as at Betano.

Results

Maize yields and yield components

Data on the plant population, number of cobs/plant, seed weight and weight of seeds per cob for each site were recorded at each research station site and are available for comparison. Grain yields at each site are presented in Table 4. Plant populations were variable due to periods of high rainfall and/or drought during the growing period. As a result, significant yield differences were observed in only four of the five sites. Mean yields and mean yield advantages presented in Table 4 excluded the reported yields from Aileu. Within the remaining four sites yields were highly variable, ranging from a low of 0.2 t/ha in Baucau to 4.2 t/ha in Maubisse. These differences are reflective of the agro-ecological conditions at each site and climatic variability during the year.

Mean yield advantages across four of the five sites (excluding Aileu) presented in Table 4 indicate the success of the selection criteria in earlier years showing that the two released yellow maize varieties, Sele and Suwan 5 were the highest yielding entries in 2011-2012. The two local varieties, Fatululik (yellow grained) and Kakatua (white grained) both had similar mean yields across four sites at 2.04t/ha. HAR12 and V83 performed particularly poorly on the acid soils at Darasula station. The newly released white variety Noi Mutin (P07) yielded approximately 5% more than the locals across the compared sites.

Three white entries (V11, V15 and V41) which performed well during 2010-2011 also performed well during 2011-2012. As a white variety, V11 was particularly impressive with a yield advantage over locals of approximately 22% compared with 24% for the yellow grained Sele. V15 and V41 also out yielded the local controls by 9-10%. All three were reasonably consistent with the yields of Noi Mutin (Figure 10) at each site across the two years (2010-2011 and 2011-2012). The potential for this material (and S07 which performed well over the two years) on farmers fields needs to be further examined.

Table 4. Maize yields and yield advantages, 2011-2012

	Yield (t/ha)					*Mean*[a]		*Mean for 2010 and 2011*[b]
Variety	*Aileu (K. Portugal)*	*Betano (Same)*	*Loes (Maubara)*	*Baucau (Darasula)*	*Urulefa (Maubisse)*	*Yield (t/ha)*	*Yield advantage (%)*	*Yield (t/ha)*
HAR12	0.74	1.52	2.84	0.23	2.48	1.56	-23.59	1.30
V83	0.82	1.16	2.39	0.09	3.91	1.89	-7.50	1.47
P11	0.99	1.33	2.71	1.04	2.96	2.01	-1.58	1.59
L.Fatulurik	*0.76*	*1.46*	*2.66*	*0.48*	*3.58*	*2.04*	*0.00*	*1.38*
L.Kakatua	*0.23*	*1.36*	*2.55*	*0.70*	*3.53*	*2.04*	*0.00*	*1.40*
S09	0.72	1.21	2.71	0.88	3.65	2.11	3.44	1.48
Noi Mutin	0.30	1.14	3.76	0.67	3.04	2.15	5.49	1.64
S08	0.59	1.19	2.57	1.31	3.76	2.21	8.14	1.45
V15	0.67	1.19	3.22	0.34	4.15	2.22	9.03	1.66
V41	0.62	1.54	2.88	1.20	3.32	2.23	9.55	1.63
P7H12	0.74	1.57	3.45	0.61	3.61	2.31	13.13	1.53
S07	0.85	1.41	2.06	1.90	4.21	2.40	17.41	1.61
V11	0.71	1.54	2.82	1.78	3.82	2.49	22.07	1.73
Sele	0.68	1.15	3.95	1.31	3.74	2.54	24.45	1.83
Suwan 5	0.57	1.24	4.27	2.71	3.26	2.87	40.69	1.93
Mean	0.66	1.33	2.99	1.02	3.53	2.20		
F pr.	ns	0.28	<.001	93.93	<.001			
LSD	0.84	0.50	1.04	0.00	0.75			
%CV	71.80	23.40	29.05	21.22	12.20			

a Does not include non significant data from Aileu. b Includes data from four of six trials sites

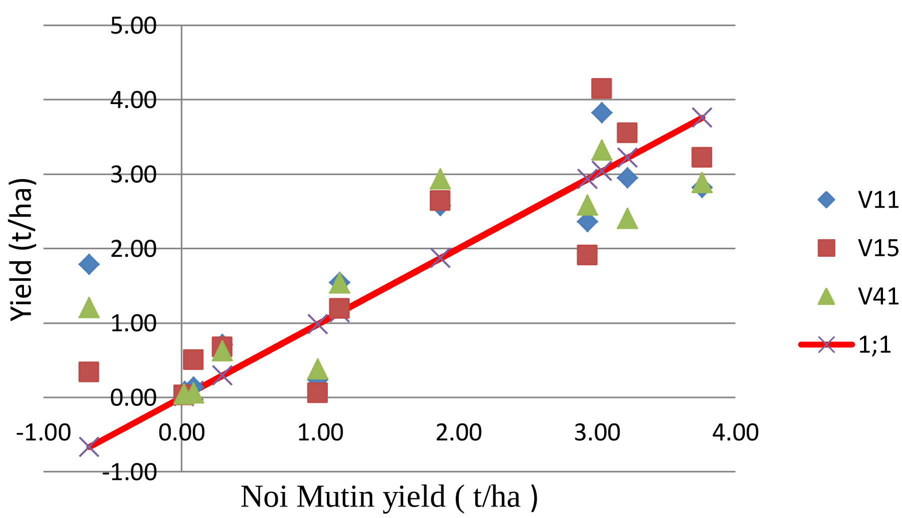


Figure 10. Yield of V11, V15 and V41 compared with Noi Mutin, 2011-2012

Farmers' preferences

Field days were held at Urulefa and Betano stations during the year to evaluate farmers' reactions to a select number of varieties. The test entries were similar at both sites with the exception of replacing Har12 for Kakatua at Betano (Table 5 and Table 6). Twenty five to 30 farmers attended each field day, examined the research sites and discussed the trial results with the researchers. The quality of the maize grain was then examined. The farmers examined the grain, pounded it and consumed some cooked grits. Twenty seven farmers at Urulefa completed the forms and ten responded at Betano. At Urulefa station, the farmers preferred the pounding qualities of Noi Mutin, V11 and P11 and liked the taste of Noi Mutin, V11 and S09 (Table 5). By far their overall preferred choice would be for cultivation of Noi Mutin. Other popular choices were Sele, their local white Kakatua variety and V11.

Table 5. Taste test at Urulefa station (% farmers' preference)

Variety	Easy to pound	Full cobs	Tasty	Overall choice
S09	48	59	67	4
L. Fatulurik	*74*	*52*	*30*	*7*
P11	81	37	52	7
V15	4	78	44	15
V41	78	33	48	15
V 83	26	74	74	15
V11	96	26	67	19
L. Kakatua	*7*	*96*	*41*	*22*
Sele	70	52	56	22
Noi Mutin	96	48	74	67

At Betano, farmers thought that S07 was easy to pound and was good to eat (Table 6). Sele, Noi Mutin and V41 were also considered easy to pound with Sele and Noi Mutin with preferred eating characteristics. As at Urulefa, the farmers at Betano gave a high overall preference for Noi Mutin and Sele but also liked V41 and their local variety, Fatulurik.

Table 6. Taste test at Betano (% farmers' preference)

Variety	Easy to pound	Full cobs	Tasty	Overall choice
Har12	0	60	40	0
M02	40	80	20	0
P11	20	60	40	0
P7H12	0	60	0	0
S07	80	0	60	0
V11	0	60	40	0
L. Fatalurik	*0*	*80*	*20*	*20*
V41	40	60	20	20
Noi Mutin	40	20	80	80
Sele	60	0	60	80

Weevil damage resistance

Farmer's selection criteria for maize varieties embrace a number of characters including yield, grain colour, taste, yield consistency and ability to store for long periods in the presence of high weevil populations and other pests. Resistance to weevil infestation is a particularly important character if farmers do not have good on-farm storage. The traditional method is for farmers to tie the ends of the maize cob husks together and store bundles in dry places. This may be above the fireplace, in storage areas, hanging from ceilings or even trees. To examine the test material resistance to weevil damage, 15 cobs of each were stored for 9 months after the 2011 harvest in a shed at Betano research station and for nearly 10 months at Loes Research Station. At the conclusion of the period, weevil damage to the grain in each cob was assessed.

At Betano, little weevil damage was noticeable in the two local varieties, Fatulurik and Kakatua (Table 7) but it was extremely high in S07. The released varieties Noi Mutin and Sele possessed medium resistance to weevil infestation while V11 appeared to have considerable resistance. The other high yielding V15 and V41 were slightly more susceptible than Sele. For these varieties, it would be best that they are stored in sealed air tight containers such as drums or screw-top plastic bottles.

Table 7. Weevil damage of stored cobs, Betano, 2011

Variety	% Weevil damage
L. Fatulurik	*16.0*
L. Kakatua	*18.0*
V11	24.0
M02	26.3
P7H12	28.3
V83	31.7
Noi Mutin	39.4
P11	40.0
Sele	43.0
V15	43.0
V41	51.3
S08	52.0
S09	56.3
S07	82.5
F pr.	0.032
LSD	35.61
% CV	56.6

At Loes, there was no significant difference in the weevil damage of different varieties after nearly ten months of storage (Table 8). However, in this trial, the percentage of cob damage was compared across sheath types. Some sheaths were tight and could be tied off at the end to form “rings” of cobs reflecting traditional storage methods. Other cobs (loose sheaths) project from the sheaths and are open to weevil infestation. Although there was little difference between varieties, weevil infestation of loose sheathed cobs was almost twice that of tight sheathed cobs.

Table 8. Weevil damage of stored cobs, Loes, 2011

Variety	*% Weevil Damage*	*% tight sheathed cobs affected by weevils*	*% loose sheathed cobs affected by weevils*
HAR12	63	52	78
M02	58	43	71
M03	61	46	90
L. Fatulurik	*39*	*33*	*79*
L. Kakatua	*60*	*54*	*81*
Noi Mutin	64	46	90
P07H12	45	33	90
P11	66	52	86
S07	42	29	65
S08	75	75	90
S09	64	35	81
V11	61	17	85
V15	64	52	77
V41	70	39	90
V83	80	6	88
Mean	61	45	83
F.Prob	*ns*	*ns*	*ns*
LSD	*31*	*42*	*31*
%CV	*31*	*57*	*23*

2.1.2 Replicated maize trials, dry season 2012

Methods and materials

A further replicated trial was conducted on the 15 varieties presented in Table 2 during the dry season of 2012 at Loes Research Station. Details of the trial are presented in Table 9. The trial was installed as a randomized complete block with three replicates, the plots being 5m x 5m in size.

Table 9. Planting and harvest dates, maize variety trials, 2011-2012

Location	*Season*	*Number of varieties*	*No. of reps*	*Date planted*	*Date harvested*	*Days to maturity*	*Grain yield (t/ha)*
Loes (Maubara)	Dry	15	3	3/5/2012	5/09/2012	125	3

Results

Maize yields and yield components

The two released yellow maize varieties (Sele and Suwan 5) continued to yield well during the dry season trial at Loes Research Station (Table 10). The white released variety Noi Mutin also yielded well as did Har 12 and the cross between Har12 and Noi Mutin, Po7H12. Three varieties showing promise during the wet season trials, V11, V15 and V41, however, were badly affected by downy mildew over a three month period (Table 10). This is the first time that downy mildew has been observed in the trials and is a sound reason for not including these varieties in further trials.

Table 10. Maize yield and yield components, Loes, 2012

Variety	*Yield (t/ha)*	*Plant density plants/m²*	*Seeds per cob*	*Cob weight (g)*	*100 Seed weight (g)*	*Downy mildew % at 2 months*	*Downy mildew % at 3 months*
Har12	3.5	3.7	273	876	32	13	15
L.Fatulurik	2.5	3.6	242	697	28	14	27
L.Kakatua	2.2	3.6	205	814	30	16	43
Noi Mutin	3.3	3.4	328	889	31	12	10
P07H12	3.4	4.1	320	840	33	12	17
P11	1.8	3.6	205	818	30	13	30
S07	2.7	3.6	287	835	34	16	27
S08	1.8	3.3	226	838	32	28	53
S09	2.8	3.9	252	695	33	20	25
Sele	3.7	3.5	278	709	34	8	8
Suwan 5	3.8	4.3	263	732	29	10	7
V11	2.4	3.7	289	729	31	24	60
V15	2.0	3.5	290	855	31	32	70
V41	2.0	3.3	205	881	31	25	67
V83	1.4	3.3	230	821	32	23	70
Mean	*2.6*	*3.6*	*260*	*802*	*31*	*18*	*35*
F.prob	*<.001*	*ns*	*ns*	*ns*	*ns*	*<.001*	*<.001*
L.S.D	*0.97*	*0.99*	*103*	*270*	*4.5*	*8*	*18*
% CV	*22.2*	*16.3*	*23.8*	*20.2*	*8.7*	*27*	*30*

Conclusions

From the results presented in this section, it is clear that the selection criteria for releasing new varieties MAF/SoL has employed in the past are a proven process. The yields of the released Sele, Suwan 5 and P07 (Noi Mutin) are outstanding compared with traditional farmer varieties and much of the introduced germplasm. Sele and Noi Mutin are also considered by farmers to possess high processing and eating qualities. These varieties are more susceptible to post harvest storage problems if stored in the traditional manner and should not be stored for long periods under these conditions but stored in sealed containers such as drums.

There is a need to diversify the genetic base of released white varieties and from this year's research, the four test composites V11, V15, V41 and S07 appeared to be worthy of further examination. The fact that S07 proved to be highly susceptible to weevil damage in Betano during 2011 reduced the urgency to examine this population. The white composites from CIMMYT in Zimbabwe, V11, V15 and V41 are all high yielding and possess preferred eating qualities. However, they proved to be susceptible to downy mildew during the dry season trials at Loes. Downy mildew commonly limits crop yields in Timor-Leste and resistance to this disease needs to be an included character of all released varieties. MAF/SoL shall continue to source downy mildew resistant maize material internationally. It will also commence conducting trials on the highest yielding local white, downy mildew resistant varieties with the view of possibly enriching these with HYV characters from other sources.

2.1.3 Maize On-Farm Demonstration Trials (OFDTs) 2011-2012

On farm demonstration trials (OFDTs) are conducted to evaluate improved varieties that have performed well in replicated trials on research stations against previously released varieties and local maize populations. These trials are established on farmers' fields and receive the same agronomic treatment that the farmer normally applies to the rest of the crop. As the new varieties are still being evaluated, only small quantities of seed are provided in these trials but extra seed of a MAF released variety is sometimes given to farmers as an incentive for hosting the trials. This limits the farmer's risk while allowing him/her to test the suitability of new varieties. The purpose of the 2012 maize OFDTs was to test *Noi Mutin*, a white maize variety from Central Mindanao University in the Philippines, against local maize and the MAF released variety *Sele*. *Noi Mutin* performed well in research station trials in the previous four years and met the criteria of being white, open pollinated, downy mildew resistant, and weevil resistant. Referred to by its code P07 in previous reports, *Noi Mutin* was accepted as a MAF released variety in November 2011.

Materials and methods

OFDTs were established in all Agro-ecological zones of Timor-Leste during the 2011/12 growing season. A total of 158 trials were planted across 15 Sub-Districts in the Districts of Aileu, Ainaro, Baucau, Bobonaro, Manufahi, Liquiça, and Viqueque. Researchers worked within each Sub District to identify farmers to host the trials via the Chefe de Suco, MAF extensionists and other workers, and their own contacts.

The researchers explained the OFDT process to interested farmers and emphasized that this was a research activity and not a seed give-away. Farmers were made aware that it was not known how well the varieties would perform as they were still being tested, and that only 200 g of the new variety seed would be given for each trial. The hosting farmer supplied the local seed for each trial, which usually matched what would be planted on the rest of the farm. This resulted in different varieties being classed as the local at different locations, but provided an accurate representation of what the farmer would normally plant. In some areas, improved varieties may have been planted as local maize.

The trials were laid out with 5 m x 5 m plots marked with string or bamboo. Researchers made sure that the plots followed a contour line but the allocation of the varieties to the plots was random and there was no replication. Researchers were present for planting at as many sites as was possible and for the majority of sites this was realized. The OFDT sites were visited an average of 6 times from planting to harvest.

A data collection protocol, developed and refined through several years of SoL OFDTs, was used to record data on the trial at each visit. The protocols included measurements of plant height, identification of pests and diseases, geographic data, soil information, agronomic methods, harvest data etc. Data was collected in such a way that many columns could be cross checked which helped to eliminate errors before the final data was analyzed.

At harvest, staff recorded the fresh weight of cobs from the whole plot (25 m^2). A sub-sample of 5 cobs was taken from the fresh cobs at harvest time, and only grain from these cobs were threshed and dried. The ratio of dried grain to the cob fresh weight was used to convert the total fresh weight of cobs to amount of grain weight per plot, and then converted to tons per hectare. Farmers kept the produce from each OFDT, except for the small sample taken for analysis.

Site characterization

Latitude, longitude, and elevation were recorded at all sites using a 12 channel GPS receiver (Garmin ETrex) to an accuracy of ± 6 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 11).

Table 11. Definition of the 6 agro-ecological zones in Timor-Leste.

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

All sites for OFDTs in the 2011-2012 cropping season were tested for soil pH using 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 rocks, 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 (Table 12) 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.

Analysis

Data from the protocols was first entered into an MS Excel spreadsheet database before being transferred for further analysis to GenStat Discovery Edition 3. Yield data were analyzed by ANOVA (Unbalanced Model) in a range of methods. The model of the analysis always included variety and AEZ as factors in the model once the other location factors of District and Sub-District had been tested. As elevation was shown to have an impact on crop yield between sites, elevation was included as a co-variate in testing across factors in the analyses.

The influence of a wide range of factors on maize yield was tested. In turn, each factor was added to the model, one at a time. If they were significant, the factor was kept in the model, and if they were non-significant the factor was discarded. Once a significant factor was identified, the interaction of that factor and variety was also tested for significance at the $p = 0.05$ level.

MAF researchers have taken an increased responsibility for analysis and write up of the data this year. This is an important step towards handing over full responsibility for reporting, which should see the annual research report being completed in Tetun by researchers in 2013.

Table 12. Determining soil texture characteristics.

Texture	*Description*	*Length of soil ribbon*
Sandy	The soil stays loose and separated, and can only be accumulated in the form of a pyramid.	Nil
Sandy Loam	The soil contains enough silt and clay to become sticky, and can be made into the shape of a fragile ball.	15-25 mm
Silty Loam	Similar to the sandy loam, but the soil can be shaped by rolling it into a small, short cylinder. Soil has a 'silky' feel.	25 mm
Loam	Contains almost the same amount of sand, silt and clay. Can be rolled into a 15 cm long (approximately) cylinder that breaks when bent.	25 mm
Clay Loam	Similar to loam, although the cylinder can be bent into a U shape (without forcing it) and does not break.	40-50 mm
Fine Clay	The soil cylinder can be made into the shape of a circle, but shows some cracks.	50-75 mm
Heavy Clay	The soil cylinder can be shaped into a circle, without showing any cracks.	>75 mm

From: Agricultural Compendium for Rural Development in the Tropics and Subtropics' (1989) and B McDonald et al. (1990).

Results

Testing environments

Timor-Leste has a wide range of growing environments due to differences in elevation, soil pH, and soil texture. Each year's OFDT testing seeks to cover as much of this diversity as possible. In the 2011-2012 growing season, sites ranged from 1 masl in Alas to 1739 masl in Maubisse (Table 13).

Table 13. Distribution of maize OFDT sites by elevation, 2008 to 2012.

Elevation (m)	*Locations 2008-2009 (%)*	*Locations 2009-2010 (%)*	*Locations 2010-2011 (%)*	*Locations 2011-2012 (%)*
0-150	27	28	34	32
150-350	15	14	6	11
350-550	12	10	4	7
550-750	12	11	12	13
750-950	12	15	13	16
950-1150	10	11	16	6
1150-1350	7	4	7	4
1350-1550	3	5	7	5
>1550	2	2	0	6

Soil pH at the testing sites represented the entire range normally encountered in Timor-Leste (Table 14). Average pH across all sites was 6.9 with the majority of sites falling in the 6 – 7.5 range. Few sites represented the more extreme ends of the scale, unlike the earliest years of testing where the sites fell more evenly across the range. In the last three years of testing, the majority of sites have been centered around the most desirable pH range.

Table 14. Distribution of soil pH across maize OFDT sites 2008 to 2012.

Soil pH	*Locations 2007-2008 (%)*	*Locations 2008-2009 (%)*	*Locations 2009-2010 (%)*	*Locations 2010-2011 (%)*	*Locations 2011-2012 (%)*
4.5	2	1	0	0	1
5.0	3	2	2	0	1
5.5	9	12	6	10	6
6.0	11	18	18	19	15
6.5	13	18	30	22	20
7.0	24	14	19	25	22
7.5	9	14	16	19	23
8.0	15	16	7	5	6
8.5	12	9	1	0	6
9.0	3	2	0	0	1

Both soil pH and elevation differed statistically (Fprob <.001) among Sub-Districts, (Table 15) as has been the case for the last several years.

Table 15. Soil pH and elevation of maize OFDT locations, 2008 to 2012.

District	*Sub-District*	*Average elevation over all previous years*	*Elevation 2011-12*	*Average soil pH over all previous years*	*Soil pH 2011-12*
Aileu	Aileu	1012	926	6.3	6.0
Aileu	Laulara	1269	1259	6.4	7.0
Aileu	Liquidoe	1133	1230	6.2	6.3
Aileu	Remexio	985	1045	5.9	7.3
Ainaro	Maubisse	1508	1635	7.0	7.9
Baucau	Baucau	462	488	7.3	7.6
Baucau	Vemasse	425	556	7.1	5.9
Baucau	Venilale	665	861	7.3	7.7
Bobonaro	Balibo	564	267	6.5	7.4
Bobonaro	Maliana	268	166	7.5	6.9
Liquica	Liquica	471	717	6.7	6.3
Liquica	Maubara	315	113	6.5	6.7
Manufahi	Alas	107	45	7.7	7.3
Viqueque	Ossu	610	395	6.1	6.8
Viqueque	Viqueque	19	21	7.1	7.2

All soil textures were represented in this year's trials, with the exception of sandy soil (Table 16). Sandy Loam was the most commonly encountered soil type.

Trial losses

Only 3% of trials planted during the 2011-2012 wet season were reported as losses and unharvested. This is far lower than the usual number of losses which have ranged from 17% to 25% over the last 5 years. Reasons for trials not to be harvested include damage by animals and farmers not waiting for the researcher to be present to measure yields. Drought has also been the cause of trial failure. The season in 2011-2012 received reasonably good rainfall during the wet season reducing drought-affected losses.

Table 16. Distribution of soil texture of maize OFDT, 2008-2011.

Soil texture	*Locations 2009-10 (%)*	*Locations 2010-11 (%)*	*Locations 2011-12 (%)*
Sandy	0	1	0
Sandy Loam	20	27	35
Silty Loam	11	13	9
Loam	14	14	8
Clay Loam	23	22	20
Fine Clay	23	15	22
Heavy Clay	8	8	6

Variety

Yields of both the released varieties Sele and Noi Mutin were significantly higher than local maize populations. (Table 17) This was due to these varieties having larger cobs. Noi Mutin's performance continued to support its status as a released variety and its colour and taste proved to be popular at field days.

Table 17. Yield components for OFDT maize varieties over all OFDTs, 2011-2012.

Variety	*Yield (t/ha)*	*Density (plants/m^2)*	*Cobs/plant*	*Seeds/cob*	*Seed weight/cob (g)*	*Seed weight (g/100)*
Sele	2.57	4.38	0.94	232	68.8	29.3
Noi Mutin	2.41	4.51	0.88	236	68.1	29.3
Local	1.96	4.56	0.88	197	53.2	30.1
LSD ($P \leq 0.05$)	*0.29*	*ns*	*ns*	*21.3*	*6.0*	*ns*
*Variety*AEZ LSD*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
*Variety*District LSD*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*

No interaction was found in 2011-2012 for yield or any yield component with AEZ or District. As with all released varieties, there is no reason to alter recommendations about the variety based on locational factors in Timor-Leste.

Figure 11 demonstrates graphically the yield relationship between the local and released varieties at each site. Each data point that lies above the 1:1 line represents a site where the released variety outperformed the local check. With both varieties the majority of the points lie above the line, a fact borne out in the ANOVA analysis where the released varieties achieved a statistically significant advantage over local maize.

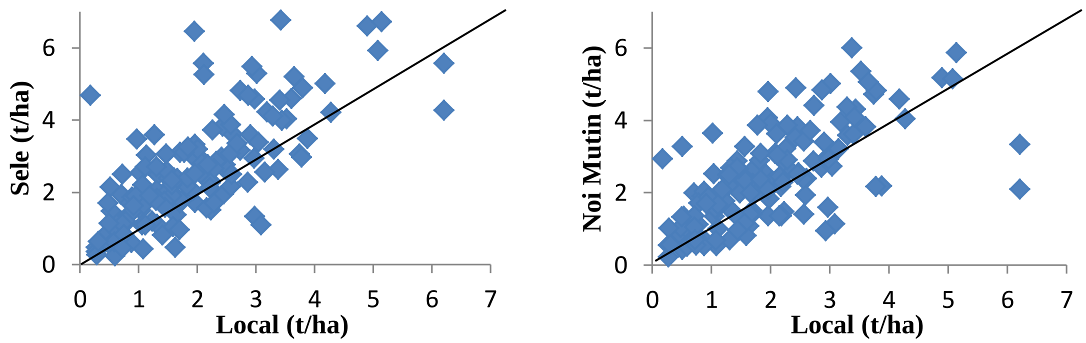


Figure 11. Yield of 2 test populations vs. local populations at all sites 2011/12.

Maize yields for all varieties tended to increase as plant densities rose to around 5 plants/m^2, and then plateaued thereafter (Table 18 and Figure 12). There was no statistically significant interaction between plant density and variety for grain yield, with the released varieties outperforming the local at most plant density ranges. In both this and previous year's testing, there is no indication that recommending a different planting density for the released varieties is necessary.

Table 18. Effect of crop density on yield for OFDT maize varieties, 2011-2012.

Plant density (plants/m^2)	*Local (t/ha)*		*Noi Mutin (t/ha)*		*Sele (t/ha)*	
< 1	0.8	(0)	0.2	(2)	1.0	(2)
1 – 2	1.2	(5)	1.1	(6)	1.1	(8)
2 – 3	1.5	(19)	1.7	(17)	1.9	(17)
3 – 4	2.0	(21)	2.1	(24)	2.5	(21)
4 – 5	2.2	(29)	2.2	(25)	2.3	(31)
5 – 6	2.6	(37)	2.8	(36)	2.9	(29)
6 – 7	2.3	(15)	3.1	(21)	3.2	(25)
7 – 8	2.5	(9)	3.2	(11)	3.3	(12)
> 8	2.5	(14)	2.7	(10)	3.3	(7)

* Figures in brackets indicate the number of observations.

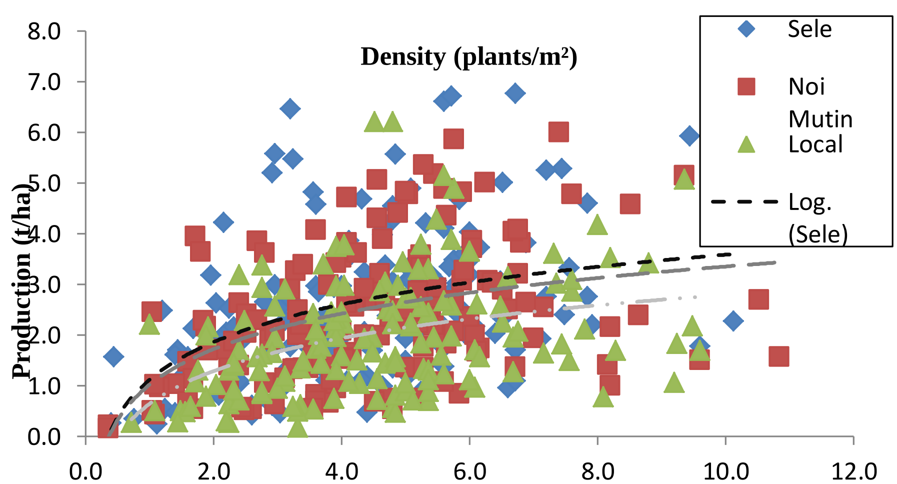


Figure 12. Regression graph comparing plant density and yield.

Districts

Both Sele and local maize yielded highest in Maubara, Liquiça, while Noi Mutin produced the highest yields in Balibo, Bobonaro. Due to the widespread distribution of Sele in Liquiça District over a number of years, it is likely that improved variety seed was being planted as a local in at least some of the sites. A similar situation also occurred in Baucau District last year where Sele and the Indonesian variety Arjuna were widely distributed. This may partially explain the lack of yield advantage in Noi Mutin in these areas. As Sol varieties are accessed by an increasing number of farmers, the incidence of improved varieties being planted as locals is likely to increase. To date this seems to be limited to isolated areas as there is no trend of local yield increasing in OFDT testing over the last 6 years, but the yields recorded for local maize in 2012 were the highest in the history of the program. Sele out-yielded local maize in all areas.

Table 19. Maize OFDT grain yield and yield advantage by Sub-District 2011-2012.

District	*Sub-District*	*Local (t/ha)*	*Noi Mutin (t/ha)*	*Sele (t/ha)*	*Yield advantage Sele over local*	*Yield advantage Noi Mutin over local*
Aileu	Aileu	1.3	2.2	2.2	69%	69%
Aileu	Laulara	1.2	2.0	1.7	42%	67%
Aileu	Liquidoe	2.0	2.9	3.0	50%	45%
Aileu	Remexio	1.9	2.4	3.3	74%	26%
Ainaro	Maubisse	1.6	1.7	1.8	13%	6%
Baucau	Baucau	1.3	2.1	2.6	100%	62%
Baucau	Vemasse	2.2	3.0	2.7	23%	36%
Baucau	Venilale	2.5	2.1	2.9	16%	-16%
Bobonaro	Balibo	2.4	3.7	2.9	21%	54%
Bobonaro	Maliana	1.4	1.5	1.6	14%	7%
Liquica	Liquica	2.9	2.8	3.3	14%	-3%
Liquica	Maubara	3.6	3.0	3.9	8%	-17%
Manufahi	Alas	2.3	3.0	3.1	35%	30%
Viqueque	Ossu	1.2	1.6	1.6	33%	33%
Viqueque	Viqueque	2.1	2.7	3.0	43%	29%
Average		*1.96*	*2.41*	*2.57*	*31%*	*23%*

Agro Ecological Zones (AEZ) and yield

Average yields for all varieties in each AEZ are outlined in Table 20. Both Sele and Noi Mutin produced a yield advantage over local maize in all AEZs. All varieties performed the best on the northern coast and the worst in the Southern uplands.

Table 20. Maize OFDT mean yield by AEZ, 2011-2012

AEZ Class (See Table 11)	*Local (t/ha)*	*Noi Mutin (t/ha)*	*Sele (t/ha)*	*Yield advantage Noi Mutin over local*	*Yield advantage Sele over local*	*Number of trials harvested*
1 Northern coast	2.57	3.62	3.42	41%	33%	11
2 Northern slopes	2.08	2.12	2.50	2%	20%	25
3 Northern uplands	1.86	2.36	2.45	27%	32%	64
4 Southern uplands	1.74	1.88	2.07	8%	19%	24
5 Southern slopes	2.02	3.08	3.38	52%	67%	4
6 Southern coast	2.02	2.68	2.88	33%	43%	29

Elevation and yield

The regression graph (Figure 13) below compares elevation of the three varieties and yield. The inverse relationship between yield and elevation has been clearly demonstrated over several years of trials. Sele and Noi Mutin outperform the local at all elevations, though by a slightly lesser margin at high altitudes.

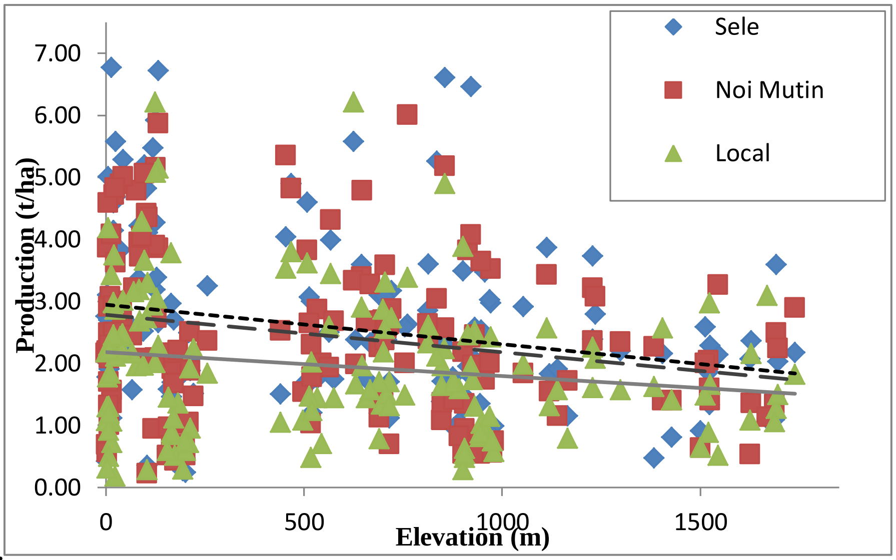


Figure 13. Regression graph comparing elevation and yield.

While the main purpose of OFDT testing is to evaluate the performance of new and released varieties against local maize on farms, it also provides the opportunity to collect data on a number of agronomic factors and their effects on yield. This data provides insight as to how Timorese farmers manage their maize crops, and what factors limit their ability to produce higher yields. Many of these factors have been evaluated over a number of years as presented in Table 21. Similar data is also presented in Williams *et al*, 2012.

Table 21. Various factors affecting maize OFDT yields, 2007-2012.

Factor	*F pr.*	*Significant 2011-2012*	*Significant 2010-2011*	*Significant 2009-2010*	*Significant 2008-2009*	*Significant 2007-2008*
Variety	<0.001	✓	✓	✓	✓	✓
AEZ	<0.001	✓	✓	✓	✓	✓
Sub-District	<0.001	✓	✓	✓	✓	✓
Number of seeds per hill	<0.001	✓	✓	✓	✓	✗
Planting distance	ns	✗	✓	✗	✗	✓
Soil pH	0.050	✓	✗	✓	✓	✓
Soil colour	0.004	✓	✓	✓	✓	✓
Soil texture	<0.001	✓	✓	✓	✓	✗
Number of staff visits	<0.001	✓	✓	✓	✗	✓
Random or line planting	<0.001	✓	✗	✓	✓	✗
Slope class	0.005	✓	✓	✓	✗	✗
Number of weeding events	-	-	✓	✓	✗	✗
Mixed planting or monoculture	ns	✗	✗	✓	✗	✗
Gender of the head of household	ns	✗	✓	✗	✗	✗
Tools used for land preparation	<0.001	✓	✓	✗	-	-

Fields marked with a hyphen (-) represent unavailable data.

Seeds per hill

The number of seeds planted per hill significantly affected maize yields with higher densities of 4 seeds per hill out yielding less dense plantings. (Table 22) No farmers were observed planting only one seed per hill in 2011-2012.

Table 22. Influence of seeds per hill on OFDT maize yields, 2011-2012.

Seeds per hill at planting	*Average yield of four tested varieties (t/ha)*	*Number of plots*
2	2.15	168
3	2.38	297
4	3.75	9
LSD (P<0.05)	*0.67*	

Soil pH

Soil pH had a significant effect on maize yields (Table 23) with the sites representing a wider range than in last year’s trials. The majority of sites fell in the 6 to 7.5 pH range.

Table 23. OFDT yield by soil pH for all maize varieties, 2011-2012.

Soil pH	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0
Number of plots	3	3	27	72	93	105	108	30	30	3
Mean yield (t/ha)	0.77	2.52	2.80	2.27	2.58	2.10	2.33	2.50	1.96	2.87
LSD (P<0.05)	*1.12*									

Soil colour

Soil colour had a significant effect on maize yields (Table 24) with black soils being the most commonly encountered and producing the highest yields.

Table 24. Effect of soil colour of maize yield 2011-2012.

Soil colour	*Yield (t/ha)*	*Number of plots*
Yellow	2.33	6
Red	2.21	78
Black	2.72	147
Dark brown	2.48	81
Light Brown	2.12	123
LSD (P<0.05)	*0.66*	

Soil texture

Soil texture had a significant effect on maize yields (Table 25) with sandy loam being the most widely encountered and producing the highest yields.

Table 25. Impact of soil texture on maize yield 2011-2012.

Soil texture	*Yield (t/ha)*	*Number of plots*
Sandy Loam	2.81	150
Silty Loam	2.10	39
Loam	2.16	33
Clay Loam	1.87	84
Fine Clay	2.32	93
Heavy Clay	2.75	24
LSD (P<0.05)	*0.54*	

Researcher visits to OFDTs

The number of researcher visits to OFDT plots has again proved to be significant as is the case in all but one previous year (Table 26). Researchers visited the sites an average of 6 times from planting to harvest.

Table 26. Effect of number of researcher visits on farm maize yield 2011-2012.

Number of visits	*Average yield (t/ha)*	*Percent of observations*
1	2.13	2
2	2.52	8
3	1.88	3
4	2.06	6
5	1.53	6
6	2.63	18
7	2.35	44
8	1.62	4
9	2.82	8
LSD (P<0.05)	*0.72*	

Farmer's preference for maize populations

A total of 328 farmers participated in taste test field days during the 2011-2012 harvest season, 35% of whom were female. Sele and Noi Mutin far outperformed local maize for yield and yield components in the opinion of the vast majority of farmers. Both released varieties rated highly for colour, despite their obvious difference. Sele maintained a small advantage over Noi Mutin in most categories, though the difference was negligible which suggests that the varieties are equally well perceived by farmers.

Table 27. Farmer responses (%)* to maize varieties 2011-2012.

Characteristic	*Local*	*Noi Mutin*	*Sele*
Big cobs	6	95	100
Big kernels	4	21	93
High yield	5	97	100
Full cobs	13	92	100
Colour	22	100	100
Tight sheaths	15	92	89
Taste	90	95	100
Weevil resistant	98	92	88
Wind resistant	79	95	99

* Many farmers made more than one choice from each criterion.

Conclusions

The 2011-2012 trials provided further support for the released varieties Sele and Noi Mutin. The varieties performed well regardless of locational factors and maintained a significant yield advantage over local maize regardless of elevation or other locational factors. 2011-2012 saw the highest yields among local maize in seven years of OFDT testing, though no trend towards higher local yields can yet be identified. This warrants attention in the coming years, however, because as SoL improved varieties become more accessible it is likely that the occurrence of them being planted as locals will increase.

2.2 Sweet potato

2.2.1 Sweet potato replicated trials, 2011-2012

Sweet potato (*Ipomoea batatas (*L.) Lamb.) clones tested by SoL have been introduced from the International Potato Centre (CIP) regional office in Indonesia over the past 10 years. Sweet potato variety trials have been conducted on a set of 12 clones (including 2 local checks) for a number of years, allowing the selection of three varieties for release in 2007 (CIP 01, 06 and 07 under the names of Hohrae 1, 2, 3 respectively).

Since the 2008-2009 wet season, additional sweet potato clones are being investigated in replicated trials and compared with local checks and with the Hohrae released varieties. Clones which performed well in previous observational trials are also being included, depending on the quantity of available planting material (see SoL 2010 for clone details)

Methods and materials

The 2012 replicated trials were conducted at Betano, Baucau, Aileu, Maubisse and Loes research stations. Each consisted of a randomized complete block design with three replicates, the plots being 5 x 5 m in size except in Maubisse where plots were 3 x 3 m. Stems for planting were sourced from Loes. One cutting per hill was planted with a 100 x 50 cm spacing (i.e. 2 plants/m²). The trials were neither fertilized nor irrigated except in Aileu (15 kg/ha of N and P) where the lack of station area does not allow for fallow. Trials were planted between November 2011 and January 2012 and harvested between April and August 2012 (Table 28).

Table 28. Planting and harvest details of sweet potato varietal trials, wet season 2011-2012

Location	*Season*	*No. of entries*	*Number of replicates*	*Planting date*	*Harvest date*	*Days to maturity*	*Rainfall (mm)**	*Mean yield (t/ha)*
Aileu (K.Portugal.)	Wet	15	3	11/11/2011	25/06/2012	227	1697	7.5
Betano (Same)	Wet	15	3	16/12/2011	04/06/2012	171	1123	12.4
Loes (Maubara)	Wet	15	3	13/01/2012	18/06/2012	157	787	8.1
Baucau (Darsula)	Wet	15	3	18/11/2011	23/04/2012	157	937	4
Maubisse (Ure Lefa)	Wet	15	3	21/12/2011	11/08/2012	234	1236	10.8

* Total rainfall from planting to harvest dates for each research station.

Yields, yield components and yield advantages

At harvest, the number of plants, the number of tubers and the total production were recorded for each plot. Additional parameters were measured in some stations such as ground cover and disease impact, marketable and non-marketable tubers (small or damaged), average weight of big and small tubers, production from the main root or from secondary roots.

In order to determine varietal effects, the data of each trial were analysed separately using spatial analysis modules under GenStat Edition 15. Depending on the presence of row and/or column effect in the yields, different tests were performed (Table 29).

Table 29. Statistical analyses of the 2011-2012 sweet potato varietal trials

Station	*Row/col effects*	*Test*	*Type*
Aileu	No	ANOVA	One-way in Randomized blocks
Betano	Yes, Column	REML	AR1 Random on Column
Loes	No	ANOVA	One-way in Randomized blocks
Baucau	Yes, Column	REML	AR1 Random on Column
Maubisse	No	ANOVA	One-way in Randomized blocks

Yield advantages were calculated over the local averages. The existence and degree of correlation between the predicted means of the yields and of the other parameters were then identified using Simple Linear Regressions. As yield ranges differed greatly from one trial to another, individual regressions were run (as opposed to running regression over all data sets) in order to determine whether correlations were significant. The percentage of variability accounted for is then equivalent to an adjusted R^2.

Farmers' preferences

Farmers' field days were conducted in all stations except Aileu at harvest time in order to assess the farmers preferences of sweet potato varieties and to determine the traits that farmers value. The numbers of tested varieties and participants are detailed in Table 30.

Table 30. Sweet potato taste tests during farmers' field days, 2012

Station	*No. of varieties tested*	*No. of participants*	*Proportion of women (%)*
Betano	10	54	9
Loes	10	14	14
Baucau	8	39	23
Maubisse	10	38	24
Total	15	145	17

Farmers were presented with boiled samples and asked to evaluate taste characteristics. Farmers were asked whether they generally liked the varieties and how sweet they were, this criterion being highly regarded to define the eating quality of sweet potato. Finally, all the participants were asked whether they were willing to plant the varieties.

To analyse farmers' preferences, unbalanced ANOVAs were run with Station, Variety and Gender as the treatment factors. Correlations with Simple Linear Regressions were then calculated over the varieties predicted means.

Results

Yields and yield advantages

Table 31 presents the yields achieved at each site for all tested varieties as well as the corresponding yield advantages over the local checks.

Variation among sites was noticeable with the second year's harvest at the new Baucau site, while an improvement on the initial year remaining the lowest yielding trial. Large site differences were found within various research trials conducted at this site. Within site differences also proved significant at Betano with differences in production going across the research block. REML analysis rather than ANOVA was therefore used on data from these sites, which better accounted for differences in productive capacity within these sites.

Betano's overall yield however proved the opposite of Baucau with it being the highest yielding site (12.4 t/ha against 8.5 t/ha on average) for a second consecutive year. Betano, usually a drought prone site, received abundant rainfall again in 2011-2012 between planting and harvest (Table 28). Aileu in contrast recorded a second consecutive year with average yield below 10 t/ha in contrast to previous years. Maubisse produced an exceptional performance from its local variety, out-yielding all others on site.

Hohrae 3 regained the top overall yielding spot in 2012 with 14 t/ha, representing an overall yield advantage of 95% over the local varieties. CIP 72 and CIP 71 were second and third in line with their 1st and 2nd billing from the previous year. There was very little difference in yield between these two varieties in either year with yield advantages over local varieties of 76% and 73% respectively in 2012. CIP 72 was by far the best yielding variety in Loes as it was the previous year while it was second behind Hohrae 3 in Betano. CIP 72 gave more disappointing results at the other sites. CIP 71 tended to be more consistently high yielding across sites (Table 31).

Yield components and other parameters

The predicted means for the yield components and other parameters associated with the yields are detailed in Table 32.

Yield was divided into marketable and non-marketable roots. Non-marketable usually included roots which were small or grew from secondary roots. The quantity of the latter tends to vary between varieties. Though not very saleable a sizeable proportion of the non-marketable component can still be consumed. What becomes apparent when examining the table above is that local varieties tend to have a much greater proportion of production in this category compared with the introduced lines. Locals not only lose out to test varieties on production but also on the value of the product.

Loes had a relatively low percentage of 61% marketable yield with Betano, Aileu and Maubisse having 83%, 80% and 74% respectively of their tuber weight deemed marketable. There was good correlation between overall yield and the proportion of marketable tubers with the overall figure having an R^2 value of 0.91 showing that total production was a good approximation of the marketable tubers.

Table 31. Sweet potato yields and yield advantages, 2011-2012

Variety	*Yield (t/ha)*					*Average*			*Yield advantage (%) within site*				
	Aileu	*Betano*	*Loes*	*Baucau*	*Maubisse*	*St. dev.*	*Yield (t/ha)*	*Yield adv.(%)*	*Aileu*	*Betano*	*Loes*	*Baucau*	*Maubisse*
Hohrae 3	10.7	24.2	17.1	8.0	10.2	6.6	14.0	95	-1	171	908	496	-23
CIP 72	3.2	23.6	26.7	2.9	7.0	11.6	12.7	76	-70	164	1472	114	-48
CIP 71	6.1	19.3	18.5	5.7	12.5	6.5	12.4	73	-43	117	990	326	-6
Local Other	13.9		0.0		22.7	11.5	12.2						
Hohrae 2	8.5	16.0	4.3	10.8	20.5	6.4	12.0	67	-21	80	154	710	55
CIP 78	4.0	21.6	14.3	0.8	14.1	8.4	11.0	52	-63	142	739	-38	6
CIP 77	8.6	14.6	8.9	2.5	6.9	4.4	8.3	15	-20	64	425	84	-48
CIP 70	10.0	9.7	2.3	5.1	13.7	4.5	8.2	14	-7	9	36	283	3
CIP 83	7.5	10.7	8.1	5.0	8.1	2.0	7.9	10	-30	20	378	276	-39
Hohrae 1	11.5	6.8	3.1	2.1	15.3	5.6	7.8	8	8	-23	81	57	15
Local mutin		9.5		1.5	12.0	5.5	7.6						
CIP 73	7.3	8.4	6.6	5.2	5.7	1.3	6.6	-8	-32	-6	287	290	-57
Local Atabae	7.5	8.4	3.4	1.2	5.1	2.9	5.1						
CIP 76	4.5	7.0	3.5	3.6	3.2	1.5	4.3	-40	-58	-22	104	168	-76
CIP 81			3.9				3.9	-46	-100	-100	128	-100	-100
CIP 68	2.6	5.4		3.4		1.4	3.8	-47	-75	-40	-100	153	-100
CIP 65	6.6	1.5	0.1	1.6	4.9	2.7	2.9	-59	-38	-84	-92	21	-63
F Prob	0.030	< 0.001	< 0.001	0.005	< 0.001								
LSD (p≤0.001)	*6.1*	*1.0*	*6.5*	*2.3*	*5.0*								
*%CV / F Stat**	*48.7*	*42.3*	*48.1*	*3.7*	*26.3*								
Mean site	7.5	12.4	8.1	4.0	10.8	3.3	8.5						
Mean local	*10.7*	*8.9*	*1.7*	*1.3*	*13.3*	5.4	7.2						

*F statistic used in Baucau and Betano where REML analysis was used

Table 32. Sweet potato yields and yield components, replicated trials 2011/12

Trial	Variety	Yield (t/ha)	Plants /m² at harvest	Tubers /plant	Weight of 10 tubers (kg)	No. of marketable tubers /plot	Weight of marketable tubers /plot (kg)	No. of non marketable tubers /plot	Weight of non marketable tubers /plot (kg)
AILEU	Hohrae 3	10.7	1.9	2.0	0.27	65	25	30	2.0
	CIP 72	3.2	1.9	1.4	1.19	30	6	35	2.1
	CIP 71	6.1	1.8	2.3	0.16	52	13	49	2.7
	Loc. Other	13.9	2.0	8.8	0.79	131	21	307	13.6
	Hohrae 2	8.5	1.9	2.2	1.98	60	19	45	2.6
	CIP 78	4.0	1.9	2.1	1.08	22	6	71	4.0
	CIP 77	8.6	1.9	4.1	1.08	76	16	121	5.4
	CIP 70	10.0	2.0	2.9	1.74	69	21	75	3.7
	CIP 83	7.5	1.9	2.4	1.61	49	16	63	2.8
	Hohrae 1	11.5	2.0	2.0	2.89	65	27	31	1.7
	Loc. mutin								
	CIP 73	7.3	1.7	2.6	1.64	65	16	44	2.5
	Loc. Atabae	7.5	1.5	10.5	0.43	108	11	296	7.4
	CIP 76	4.5	1.7	1.9	1.21	49	10	39	1.7
	CIP 81								
	CIP 68	2.6	1.6	1.2	1.35	27	6	23	0.9
	CIP 65	6.6	2.0	2.1	1.60	44	14	59	3.0
	MEAN	7.5	1.8	3.2	1.3	61	15	86	3.7
	F Prob	0.030	0.002	< 0.001	< 0.001	< 0.001	*0.022*	< 0.001	< 0.001
	l.s.d. (p≤0.05)	*6*	*0*	*3*	*1*	*41*	*13*	*101*	*4*
	% CV	*49*	*8*	*57*	*27*	*40*	*50*	*70*	*60*
BETANO	Hohrae 3	24.2	1.4	7.9	2.1	127	40	118	18.0
	CIP 72	23.6	1.2	23.2	1.0	*386*	*43*	214	17.6
	CIP 71	19.3	1.5	8.3	2.1	*151*	*44*	99	5.3
	Hohrae 2	16.0	1.8	2.9	3.2	117	39	37	3.9
	CIP 78	21.6	1.0	10.9	1.9	224	50	66	5.0
	CIP 77	14.6	0.7	9.9	2.5	70	34	36	2.8
	CIP 70	9.7	1.0	19.2	0.5	*188*	*17*	262	5.9
	CIP 83	10.7	0.9	6.5	1.6	115	22	60	3.9
	Hohrae 1	6.8	1.2	0.6	4.3	36	16	5	0.2
	Loc. mutin	9.5	1.3	8.2	1.0	147	22	123	4.1
	CIP 73	8.4	1.6	4.9	1.2	153	18	71	2.2
	Loc. Atabae	8.4	0.9	18.9	0.6	252	19	208	6.1
	CIP 76	7.0	0.7	8.2	1.5	28	14	59	1.4
	CIP 68	5.4	0.5	8.9	1.2	*58*	*10*	35	1.4
	CIP 65	1.5	1.3	1.1	0.7	0	*0*	0	0.0
	MEAN	12.4	1.1	9.3	1.7	136.8	25.8	92.7	5.2
	F Prob	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	*n.s.*
	l.s.d. (p≤0.05)	*1.0*	*0.2*	*2.4*	*0.2*	*14*	*2.1*	*20*	*2.6*
	F Statistic	*42.3*	*6.9*	*9.1*	*12*	*13*	*10*	*9*	*2*

Trial	Variety	Yield (t/ha)	Plants /m² at harvest	Tubers /plant	Weight of 10 tubers (kg)	No. of marketable tubers /plot	Weight of marketable tubers /plot (kg)	No. of non marketable tubers /plot	Weight of non marketable tubers /plot (kg)
LOES	Hohrae 3	17.1	41	2.9	3.7		29		14
	CIP 72	26.7	39	17.2	1.0		24		43
	CIP 71	18.5	39	3.6	3.4		31		17
	Loc. Other	0.0	0	0.0	0.0		0		0
	Hohrae 2	4.3	44	0.9	3.0		8		3
	CIP 78	14.3	40	1.9	5.2		24		8
	CIP 77	8.9	22	2.0	6.4		18		4
	CIP 70	2.3	45	1.3	1.0		4		2
	CIP 83	8.1	33	2.0	2.8		13		8
	Hohrae 1	3.1	39	0.8	2.6		7		1
	Loc. mutin								
	CIP 73	6.6	34	2.4	2.5		12		5
	Loc. Atabae	3.4	29	3.2	0.8		3		6
	CIP 76	3.5	37	2.3	1.0		5		4
	CIP 81	3.9	31	0.8	4.2		8		2
	CIP 68								
	CIP 65	0.1	40	0.1	1.2		0		0
	MEAN	8.1	34	3	3		12		8
	F Prob	< 0.001	< 0.001	< 0.001	< 0.001		< 0.001		< 0.001
	l.s.d. (p≤0.05)	*6*	13	*4*	*3*		*11*		*9*
	% CV	*48*	23	*80*	*60*		*53*		*71*
BAUCAU	Hohrae 3	8.0	1.3	2.2	2.4	83		20	
	CIP 72	2.9	*0.7*	*1.7*	0.7	*41*		36	
	CIP 71	5.7	*0.9*	*2.1*	1.2	*62*		45	
	Hohrae 2	10.8	1.6	3.2	1.8	100		54	
	CIP 78	0.8	1.4	0.4	0.4	6		17	
	CIP 77	2.5	*1.3*	*1.3*	1.4	*27*		30	
	CIP 70	5.1	*1.6*	*2.4*	1.0	*55*		67	
	CIP 83	5.0	1.2	1.3	1.8	40		18	
	Hohrae 1	2.1	1.5	0.4	2.3	12		6	
	Loc. mutin	1.5	1.4	1.1	0.6	43		12	
	CIP 73	5.2	*1.8*	*2.3*	1.2	*60*		55	
	Loc. Atabae	1.2	1.5	0.6	0.6	11		19	
	CIP 76	3.6	*1.6*	*1.9*	0.8	*37*		59	
	CIP 68	3.4	*1.5*	*2.8*	0.7	*77*		48	
	CIP 65	1.6	*1.5*	*0.5*	0.7	*13*		16	
	MEAN	4.0	1.4	1.6	1.2	44.4		33.5	
	F Prob	0.005	0.002	*0.009*	*0.013*	*0.014*		*0.014*	
	l.s.d. (p≤0.05)	*2.3*	0.4	*0.7*	*0.5*	*22*		*12*	
	F Statistic	*3.7*	5.2	*4*	*3.6*	*4.1*		*3.3*	

Trial	Variety	Yield (t/ha)	Plants /m² at harvest	Tubers /plant	Weight of 10 tubers (kg)	No. of marketable tubers /plant	Weight of marketable tubers /plant (kg)	No. of non marketable tubers /plant	Weight of marketable tubers /plant
MAUBISSE	Hohrae 3	10	1.1	8	1.0	20	6	65	2.6
	CIP 72	7	1.7	4	1.0	27	5	34	1.3
	CIP 71	13	1.3	4	2.2	27	9	24	1.6
	Loc. Other	23	2.0	22	0.6	91	14	301	7.3
	Hohrae 2	21	1.9	7	1.8	48	16	68	3.1
	CIP 78	14	1.7	6	1.3	29	10	65	2.9
	CIP 77	7	1.0	8	0.8	21	4	54	1.9
	CIP 70	14	1.7	6	1.3	40	11	54	1.6
	CIP 83	8	1.5	8	0.7	28	5	77	2.5
	Hohrae 1	15	1.7	9	1.1	50	11	80	3.3
	Loc. mutin	12	1.6	13	0.6	43	6	161	4.5
	CIP 73	6	1.6	5	0.7	15	3	57	2.0
	Loc. Atabae	5	1.4	4	0.8	19	3	34	1.0
	CIP 76	3	1.3	2	0.9	11	2	16	0.7
	CIP 65	5	1.7	3	1.0	16	3	28	1.3
	MEAN	10.8	1.6	7.2	1.0	32.3	7.2	74.6	2.5
	F Prob	< 0.001	0.015	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	l.s.d. (p≤0.05)	5.0	0.5	5.8	0.5	24	3.5	85	1.8
	% CV	26	18	48	26	44	29	68	42

Hohrae varieties produced the largest and second largest tubers at three sites again proving their ability to produce large marketable yields. CIP 71 produced the largest tubers in Maubisse. However CIP 71 or CIP 72 did not feature in the top three for tuber size in any of the remaining sites indicating this may not be a big determinant in these varieties overall yield. Marketable yield was nevertheless satisfactory for these varieties. No significant correlation was found between the yield and weight of ten tubers in any station. Baucau displayed the strongest R^2 for yield being dependent on the number of tubers per plant (Figure 14).

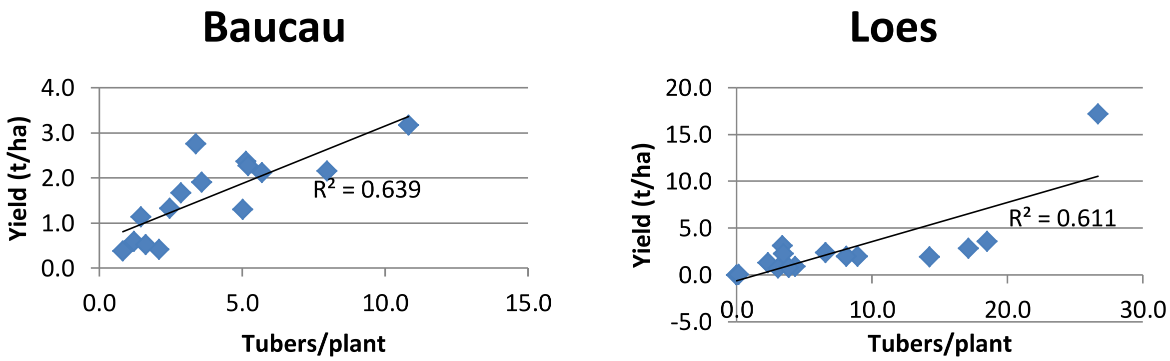


Figure 14. Correlations between yield and tubers per plant, sweet potato 2011-2012

Farmers' preferences

Table 33 presents the overall results for the four farmers' field days held in Betano, Baucau, Loes and Maubisse stations where a variety was tested. Effects of the variety, station, gender and an interaction between the latter two were identified when analysing participants overall preference (F Pr <0.001). There was also a strong variety x station (F. Pr 0.003) interaction but no interaction of variety and gender for overall preference. Variety, station (F Pr <0.001) and gender (F. Pr 0.013) also proved significant in relation to how farmers rated how sweet the sweet potatoes were. There were no interactions between variety and either station or gender in this case. Dry and crumbly textures tended to be preferred over soapy types.

Table 33. Farmers' preferences, sweet potato FFD results, 2-4 stations, 2012

Variety	*No. of tests (stations)*	*No. of respondents*	*"Wish to plant"(%)*	*"Sweet" (%)*	*"Dry/ Crumbly" (%)*	*"Soapy"* (%)*	*Average yield** (t/ha)*
L. Mutin	2	92	49	67	72	7	10.7
Hohrae 2	4	52	42	67	61	13	12.0
Hohrae 1	2	145	39	72	39	32	9.2
L. Atabae	2	68	37	60	59	17	5.9
CIP 83	3	107	34	52	37	49	8.0
CIP 71	4	145	34	61	62	21	12.4
Hohrae 3	4	145	30	65	42	43	14.0
CIP 72	3	106	27	56	27	59	19.1
CIP 70	2	77	23	68	41	39	9.4
CIP 73	4	145	19	48	27	55	6.6
CIP 78	3	106	19	43	24	59	16.7
CIP 77	2	68	16	33	37	56	11.8
l.s.d. (p<0.001)			*16*	*18*	*18*	*15*	
%CV			*138*	*81*	*106*	*106*	

*Participants opinion on how soapy varieties were was not assessed at Loes research station
**Average yield from locations where particular variety was taste tested

Reasonable positive correlations were found between participants overall preference and how sweet or dry/crumbly the variety was (Figure 15). Conversely the more soapy varieties tended to be negatively correlated with farmers' preferences. No correlation was found between yield and overall preference.

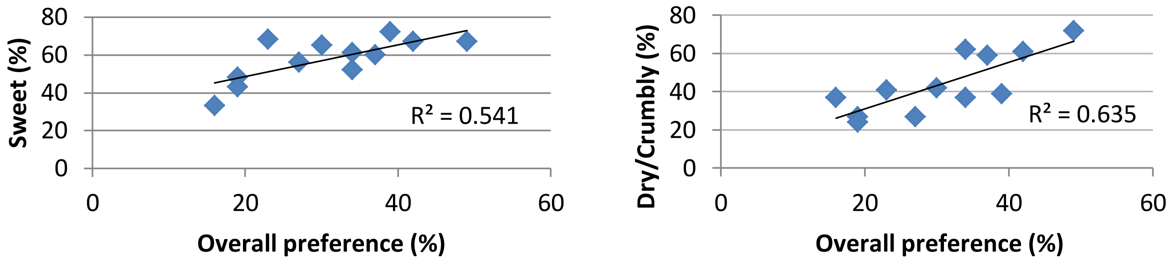


Figure 15. Correlations between farmers' preferences, sweet potato, 2012

Conclusions

Only one of the top four ranked varieties was rated at all field days. This goes a long way to explain a station interaction when all data was analysed together. The highest ranked variety proved to be Local Mutin. The released Hohrae varieties proved the next most popular. CIP 71 and CIP 72 provided reasonable acceptance on the taste tests conducted ranking in the middle order overall. Half the participants selected CIP 71 as their preferred variety in Maubisse and CIP 72 as their preferred variety in Loes. Both of these varieties ranked similar overall to Hohrae 3 which has a history of wide acceptance by farmers providing good promise for further investigation.

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

Materials and methods

Twent eight successful sweet potato variety trials were implemented by SoL over the period from 2005 to 2012 (7 years) at 7 different sites (Aileu, Betano, Baucau x 2, Maliana, Loes and Maubisse), testing the performances of 25 varieties (including 3 local varieties as controls). Some varieties were not included in all trials and some trials were not conducted at every site every year.

The dataset containing the majority of the varieties presented in Table 34, comprises 321 data points, i.e. variety per environment combinations. An environment (here synonymous of trial) is defined by the site, year and season (for instance Betano wet season 2009, Loes wet season 2010, etc). All data points are ANOVA or REML predicted means from 3 replicates, 2 in some cases.

Cross-site analyses were conducted using biplots (GenStat Edition 15) in order to evaluate the performances and consistency of the tested varieties across years and locations (genotype / environment). A limitation of the procedure is that only datasets with complete data points could be analysed. In addition, datasets resulting in higher percentages of variance explained by the biplot principal components analysis were preferred. Following those principles, two datasets were chosen. Set 1 maximises the number of environments and set 2 the number of genotypes.

Data set 1 investigated the performances of 9 varieties in 13 environments. This selection included 117 data points.

Data set 2, the selection which included the highest number of varieties, covers 12 of them in the nine 2011 and 2112 environments, corresponding to 108 data points.

Table 34. All sweet potato replicated variety trials, 2005-2012 (321 data points)

Yield (t/ha) /trial Variety	W06 AIL	W06 BAU	W06 MAL	W07 AIL	W07 BET	W07 MAL	W08 AIL	W08 BET	W08 BAU	W08 MAL	W09 AIL	W09 LOE	W09 MAL	W09 BET	W09 BAU
CIP 02	2.0	0.0	1.4	13.5	0.6	2.6	6.2	9.5							
CIP 03	2.7	2.2	2.8	14.2	0.3	0.8	9.7	2.6	3.5	9.9					
CIP 05	2.8			10.6	0.1	0.4	15.6	0.2		0.8					
CIP 15	10.2		1.7	18.5	0.6	2.3	28.5	11.0			2.7			10.3	3.1
CIP 04			2.0	34.9		0.3	28.4	11.4	6.9	10.4	10.2	30.0	4.4	18.1	9.7
CIP 08	23.5	2.2		16.7	0.0	1.3	26.0	17.0			10.5			11.6	3.6
CIP 17	11.1		0.1	42.4	0.7	0.3	17.9	0.5	2.9		11.1	9.7	1.6	4.4	3.9
Hohrae 3 (C	4.8	1.3	3.6	26.5	5.2	1.9	20.5	23.3	6.8	12.8	20.4	35.9	4.8	30.2	6.6
Hohrae 2 (C	24.1	4.8	5.6	23.9	1.7	2.7	23.7	8.1	5.7	9.8	18.7	24.3	5.6	15.6	4.8
Hohrae 1 (C	16.8	2.8	0.3	29.6	2.8	0.1	30.1	14.2	5.8	8.3	18.1	7.3	5.3	12.5	2.8
Loc. Mean		*0.7*		*9.8*			*16.1*	*1.7*				*3.5*	*0.6*	*5.2*	*0.5*
Loc. Mutin		*0.6*	*2.4*	*8.7*			*25.3*	*1.9*			*26.7*	*0.9*		*32.9*	*0.7*
Mean local	*10.9*	*0.7*	*2.4*	*9.3*	*1.3*	*1.3*	*20.7*	*1.8*	*5.3*	*8.7*	*26.7*	*2.2*	*0.6*	*19.0*	*0.6*
Mean site	10.9	1.8	2.2	20.8	1.3	1.3	20.7	8.5	5.3	8.7	14.8	15.9	3.7	15.6	4.0

Yield (t/ha) /trial Variety	W10 AIL	W10 BET	W10 LOE	W10 BAU	W11 AIL	W11 BET	W11 LOE	W11 BAU	W12 AIL	W12 BET	W12 LOE	W12 BAU	W12 MAU	No. Trials	St. dev.	Average yield (t/ha)	Yield adv. (%)
CIP 02														8	4.8	4.5	-32
CIP 03									*Total no. of data points: 321 (incl. 13% locals)*					10	4.7	4.9	-26
CIP 05														7	6.2	4.4	-34
CIP 15														10	8.9	8.9	34
CIP 04	12.7	2.8	1.4	2.5			7.1	1.9						18	10.5	10.8	64
CIP 08	5.8	3.6	7.3	6.8			6.7	2.6						16	7.9	9.1	37
CIP 17	11.4	1.1	10.5	2.9										17	10.4	7.8	18
Hohrae 3 (C	20.5	1.0	12.1	4.3	11.7	17.0	9.3	2.8	10.7	24.2	17.1	8.0	10.2	28	9.5	12.6	91
Hohrae 2 (C	11.4	1.1	7.6	6.3	14.3	12.1	2.9	3.9	8.5	16.0	4.3	10.8	20.5	28	7.5	10.7	61
Hohrae 1 (C	17.2	0.6	1.3	1.1	6.6	5.6	0.5	0.8	11.5	6.8	3.1	2.1	15.3	28	8.4	8.2	24
Loc. Mean	*28.2*	*2.1*	*2.4*	*0.4*										12	8.4	5.9	-10
Loc. Mutin	*10.4*	*2.9*	*0.1*	*0.1*		*11.8*				9.5		1.5	12.0	17	10.4	8.7	32
Loc. Ataba	*15.4*	*1.4*	*6.5*	*0.8*	*4.8*	*9.8*	*2.8*	*0.4*	7.5	8.4	3.4	1.2	5.1	13	4.3	5.2	-22
CIP 70	9.9	1.1	4.0	2.2	9.6	14.5	4.3	2.6	10.0	9.7	2.3	5.1	13.7	13	4.6	6.8	4
CIP 72	3.7	11.4	12.8	2.9	11.8	33.2	13.0	1.1	3.2	23.6	26.7	2.9	7.0	13	10.2	11.8	78
CIP 73	12.8	1.2	8.7	2.6	7.9	9.3	4.6	1.3	7.3	8.4	6.6	5.2	5.7	13	3.3	6.3	-5
CIP 76	4.5	1.3	7.2	1.5	5.6	6.9	2.1	0.6	4.5	7.0	3.5	3.6	3.2	13	2.2	4.0	-40
CIP 77					12.6	6.1	1.1	2.5	8.6	14.6	8.9	2.5	6.9	9	4.6	7.1	7
CIP 78					2.5	0.8	0.4	0.2	4.0	21.6	14.3	0.8	14.1	9	8.0	6.5	-1
CIP 83	16.9	2.6	10.6	4.4	16.0	16.2	1.6	2.7	7.5	10.7	8.1	5.0	8.1	13	5.3	8.5	28
CIP 64		0.6	2.5	0.8										3	1.1	1.3	-80
CIP 65					3.2	3.0			6.6	1.5	0.1	1.6	4.9	7	2.2	3.0	-55
CIP 66	4.9													1		4.9	-26
CIP 68					2.5	7.7			2.6	5.4		3.4		5	2.2	4.3	-35
CIP 71		1.7			8.6	32.8	14.7	2.3	6.1	19.3	18.5	5.7	12.5	10	9.6	12.2	85
Mean local	*18.0*	*2.1*	*3.0*	*0.4*	*4.8*	*10.8*	*2.8*	*0.4*	*7.5*	*8.9*	*3.4*	*1.3*	*8.5*		*7.7*	*6.6*	
Mean site	12.4	2.3	6.3	2.6	8.4	12.5	5.1	1.8	7.0	12.4	9.0	4.0	9.9	28	6.5	7.1	

Results

The average yield of the entire dataset (28 environments, 321 data points) was 7.1 t/ha (st.dev = 6.5). Yield averages from trial to trial varied from 1.3 t/ha to a maximum of 20.3 t/ha (wet seasons 2007 of Maliana and Aileu respectively), with the majority of sites performing within 2.5-12.5 t/ha. In a reversal of the first 5 years, the Aileu site always performed under 10 t/ha in 2011 and 2012, while conversely Betano produced over 12 t/ha in three out of the last four years.

The top 3 ranking varieties averaged over trials in all years was very similar to that obtained in 2012 with Hohrae 3 the highest yielding in both cases. CIP 71 was second highest yielding averaged over all trials with CIP 72 in third place – this is the reverse of the CIP 71 and CIP 72 rankings for 2012. All the Hohrae released varieties yielded above 8 t/ha.

The biplot from data set 1, which investigates the performances of 9 varieties in 13 environments (the last three years), is plotted in Figure 16 along with the ‘which wins where’ analysis. This analysis does not include CIP 71. The results, which represent 81% of the observed variation, clearly show that the Hohrae varieties did the best over multiple seasons in Aileu, Baucau and Maubisse (one season) while CIP 72 was best suited to the lowland north and south coast sites of Loes and Betano .

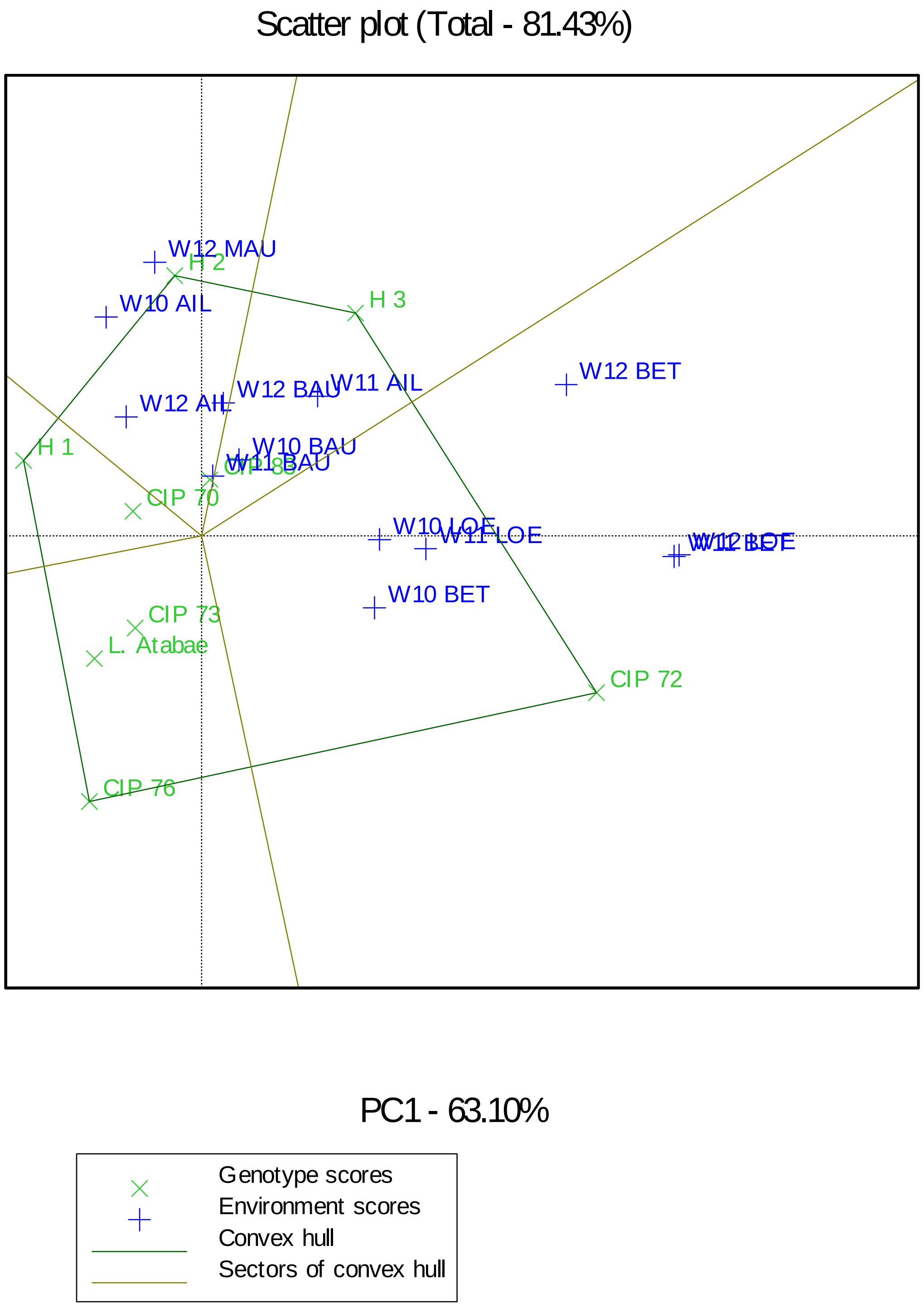


Figure 16. Biplot analysis (9 sweet potato varieties in 13 environments (set 1), 2010-2012

The biplot corresponding to data set 2, the selection which includes 12 varieties evaluated in all trials in 2011 and 2012, including CIP 71 is plotted in Figure 17. The analysis captured over 79% of the variability observed, a good percentage. It does not tell as straightforward a picture as Figure 16 however. CIP 72 is again best performer at the lowland sites and is on a par with CIP 71, particularly in 2011. However the highest yielding Hohrae 3 variety also performed best in these environments.

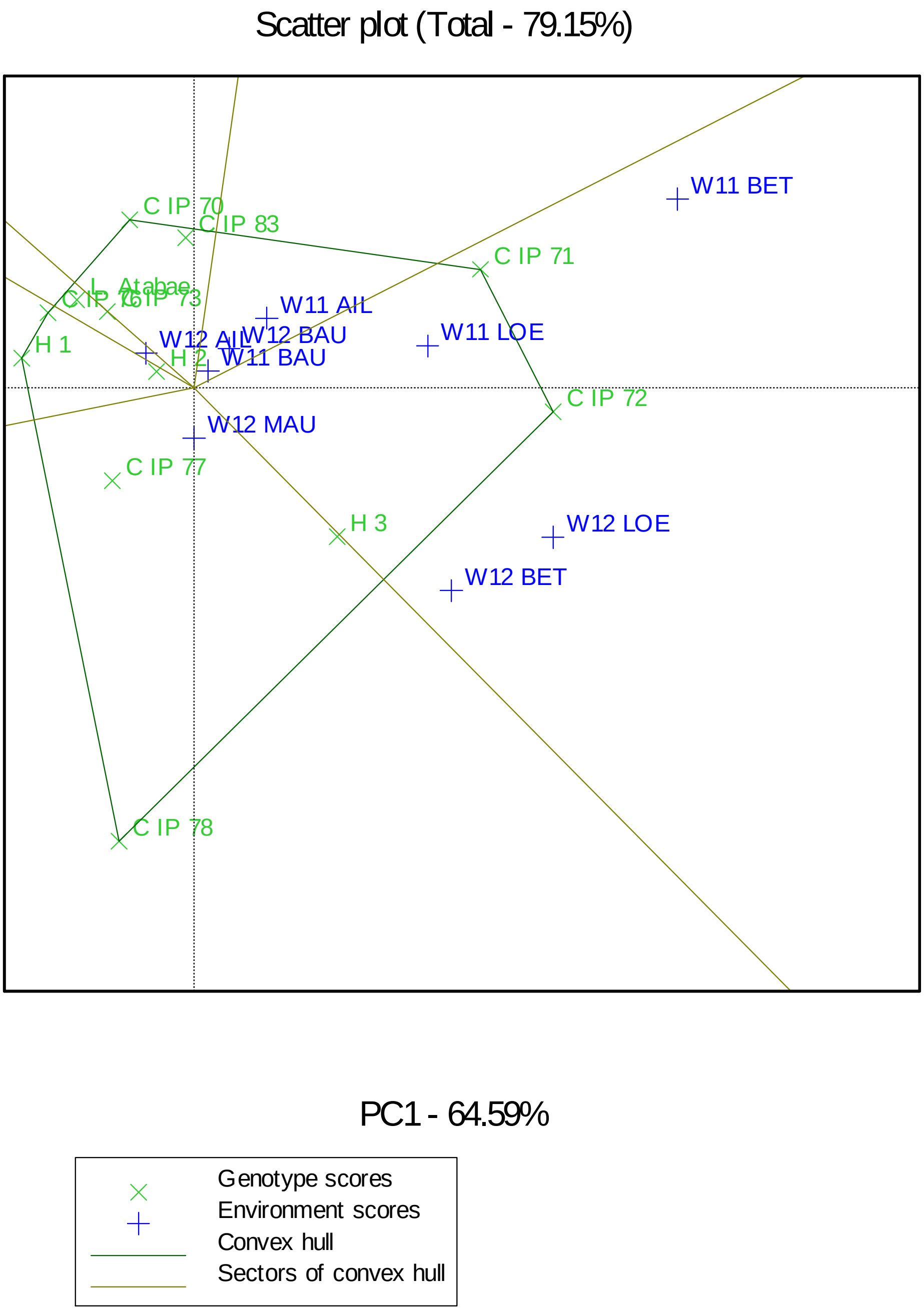


Figure 17. Biplot analysis of sweet potato variety by environment (set 2), 2011-2012

Conclusions

Over 7 years, SoL conducted 28 successful varietal sweet potato trials on 25 varieties, representing a total of 321 individual data points (variety per environment combinations). Results varied significantly both by genotype (varieties) and environment (locations, years, season).

A first phase of the clones evaluation led to the release of three varieties. Among them, Hohrae 3 confirms its position as the new standard. In the past few years CIP 71 and CIP 72 have proved likely to be of a similar standard to the released varieties. More attention is also now being devoted to the nutritional content in the form of vitamin of some of these test varieties (See Section 2.2.3).

The on-farm suitability and consistency of those potential candidates will continue to be investigated in the OFDT programme.

2.2.3 Sweet potato OFDTs 2011-2012

Three sweet potato varieties which showed promise in replicated trials on research stations during 2010-2011 were compared against a local and the high yielding released Hohrae 3 in on-farm unreplicated trials during 2011-2012. On-farm demonstration trials (OFDTs) were installed during the wet season at 111 sites across 12 Sub-Districts. The objective of the research was to determine which variety would meet the farmers' needs. The four test varieties were CIP 71, CIP 72 and CIP 83. These were compared with the released Hohrae 3 and a local variety commonly grown in the area. There was only sufficient material to plant CIP71 at a few sites and the results of this clone were not included in the analyses.

Materials and methods

The method in establishing OFDTs for sweet potato was almost same as the method applied during the previous year (SoL 2011). Sites established in the 7 Districts of Aileu, Ainaro, Bobonaro, Baucau, Manufahi, Liquica and Viqueque were representative of all Agro Ecological zone (AEZ) in Timor-Leste from sea level to approximately 1300 masl.

At harvest, the researcher and farmer harvested 5 pre-determined and marked sweet potato plants per plot. This method was developed in previous years when it was discovered that farmers were harvesting the largest roots as needed for the household. For each site, researchers collected the number of roots per plant, weight of sweet potatoes from 5 plants and farmers opinions about the taste and cooking attributes of each variety. Farmer field days were often held at the Sub District level to measure the latter.

Site characterization

A number of characteristics were recorded for each site including soil pH, colour, texture, latitude, longitude, and elevation. Soil texture was recorded based on a ribbon testing method, pH was measured with a mobile testing kit, and colour was classified according to a list of 7 pre-determined colours (See Section 2.1.3). A number of management factors were also recorded from each host farmer.

Analysis

Data entry and analysis was as done for other OFDT trials (See Section 2.1.3). Raw data was entered into an Excel spread sheet and then analyzed using Genstat Discovery 4. The results were analyzed by ANOVA (Unbalanced Model). In addition to the main analysis, analyses included variety and AEZ, soil pH, yield components, Sub-District and management practices.

Nutritional analysis

The nutritional assessment was conducted on samples of sweet potato in replicated trials growing at locations representative of the North coast - Loes Research Station, Liquica (08° 44' S, 125° 08' E;. 20 masl) - and of the South coast - Betano Research Station, Manufahi (09°16' S, 125° 68' E, 3 masl) - of clones Hohrae 1 (white coloured flesh) (Betano only), Hohrae 2 (light yellow flesh) and Hohrae 3 (light orange flesh) (Betano only), and two promising clones CIP 72 (light yellow flesh) and CIP 83 with light orange flesh from two replications in the 2010-11 season. Root samples were harvested, peeled and cut into approximately 200 g transverse sections which were hand-carried in paper bags to the quarantine analysis laboratory of the ChemCentre, Perth WA, Australia under a quarantine permit. Samples were then γ-irradiated prior to analysis. Macro and micro-elements (B, Ca, Cu, Fe, K, Mg, Mn, Mo, Na, P, S, Zn) were determined after nitric/perchloric acid digestion by inductively coupled plasma atomic emission spectroscopy (ICP-AES). The analysis of sugars by Method 32.2.07 and Method 44.4.13 (AOAC, 1999) and carotenoids (including β-carotene) (Denery, 2004) were by high-performance liquid chromatography. Dietary fibre was analysed by enzymatic gravimetry using AOAC method 985.29 (AOAC, 2005) and total starch by enzymatic digestion (AOAC, 1995). Crude protein (N x6.25) was calculated from N by combustion (Laboratory Equipment Corporation – LECO, St Joseph, MI, USA).

Results

One hundred and eleven trials were established on farmers fields but only forty one of these were harvested in such a manner to collect meaningful results. These results are presented below.

Trial Losses

As mentioned above, it is very difficult to determine the yield of root crops including sweet potato and cassava from trials conducted on farmer's fields in Timor-Leste. Farmers normally harvest root crops piece by piece instead of at one time. This makes it more likely that they will harvest some of the plots early. In this set of OFDTs, of the 111 trials established, yields were only recorded at 41 locations. Trial losses were mainly from farmers harvesting early but there was also animal predation especially by cows, buffalos as well as wild and domestic pigs.

Testing environments

Sweet potato OFDTs were conducted on a wide range of soil textures, pH, slope and elevation. Elevation of OFDT sites ranged from almost sea level to over 1,300 masl (Table 35). Trials were not installed in the 300-500 m range nor between 800 and 900 masl.

Table 35. Distribution of sweet potato OFDT sites by elevation, 2011-2012.

Elevation (masl)	*Locations 2011-2012 (%)*
0-100	25
100-200	12
200-300	5
300-400	
400-500	
500-600	8
600-700	2
700-800	10
800-900	
900-1000	15
1000-1100	8
1100-1200	10
1200-1300	2
>1300	2

Soil pH, elevation and texture

The average soil pH across the OFDT sites was 6.7, ranging from 5 to 8. By Sub-District, soil pHs ranged from 5.5 in Liquidoe to 7.5 in Laulara. As well as having the lowest pH for all included Sub-Districts, Liquidoe also had OFDT's at the highest elevation. Generally, in the past there was good interaction between Sub-District and soil pH and positive correlation between soil pH and elevation. It was observed that as the elevation increased, the soils become more acid.

Table 36. Soil pH and elevation, sweet potato OFDTs by Sub-District, 2011-2012.

Sub_District	*Soil pH*	*Elevation (masl)*
Aileu Villa	5.0	1119
Alas	6.8	47
Balibo	6.7	213
Baucau Villa	7.2	545
Laulara	7.5	1314
Lequidoe	5.5	1235
Maliana	6.8	198
Maubara	6.5	120
Ossu	7.4	1011
Remexio	7.3	1045
Vemasse	6.0	738
Viqueque Villa	7.3	16
Mean	*6.7*	
LSD (p<0.05)	*0.5*	*65.4*
F prob.	*<.001*	*<.001*

Variety

CIP 71 was cultivated in the Sub Districts of Maubara and Viqueque. In these two Districts, CIP 71 had very large tubers but there was insufficient material to plant over a larger area. For this reason, this variety was not included in statistical analyses. CIP 83 and Hohrae 3 also had large tubers (roots), and yielded double that of local varieties (Table 37).

Table 37. Yield components for OFDT sweet potato varieties, 2011-2012.

Variety	*Yield (t/ha)*	*Tubers per plant*	*Weight per tuber (g)*	*Yield advantage*
CIP 72	7.4	1.4	96.3	61%
CIP 83	10.9	2.7	167.2	137%
Hohrae 3	10.6	2.8	188	130%
Local	4.6	1.9	94.1	
LSD (p<0.05)	*5.2*	*0.64*	*89.7*	
F prob.	0.019	*<0.001*	*0.023*	

Districts

Trials with the highest yields were in the Sub-Districts of Manufahi, Viqueque and Bobonaro District (Alas, Balibo and Viqueque Villa, see Table 38). There was a significant interaction between Sub-District and variety, meaning that varieties grew better in some Sub Districts than other but not all varieties were adapted in all sub-districts.

Table 38. Sweet potato OFDT root yield (t/ha) by Sub-District 2011-2012.

Sub-District	CIP72	CIP83	Hohrae 3	Local
Aileu Villa	*	0.5	6.4	0.2
Alas	24.2	13.9	12.4	6.2
Balibo	17.4	18.4	8.5	7.8
Baucau Villa	1.9	2.5	5.5	1.4
Laulara	2.7	3.2	5.6	2.0
Lequidoe	2.4	2.1	4.0	1.9
Maliana	*	10.8	16.8	6.6
Maubara	*	3.9	17.7	4.3
Ossu	9.7	3.3	7.4	2.9
Remexio	2.7	3.1	2.9	1.3
Vemasse	2.1	3.0	9.1	5.8
Viqueque Villa	*	38.7	19.2	6.5
F Prob.	*0.014*			
LSD	*5.8*			

Interaction Variety x Sub-District: F prob <0.001

Agro ecological zones (AEZ) and yield

Yield results for each variety in each AEZ are shown in Table 39. Yield for all varieties were greatest in southern coast. There was an interaction between AEZ and variety, suggesting that it may be possible to recommend varieties for each AEZ.

Table 39. Sweet potato OFDT mean yield by AEZ, 2011-2012.

AEZ	*CIP72*	*CIP83*	*Hohrae 3*	*Local*	*Mean yield*
1 Northern coast (0-100m)	*	3.9	17.7	4.3	6.8
2 Northern slopes (100-500m)	*	11.2	16.3	6.3	11.3
3 Northern uplands (>500m)	8.1	5.7	8.2	4.1	6.4
4 Southern uplands (>500m)	2.6	2.5	4.1	1.3	2.7
5 Southern slopes 100-500m)	*	*	*	*	*
6 Southern coast (<100m)	6.1	32.5	17.5	6.4	15.8
F Prob. <.001					
LSD 7.6					
*Interaction Variety*AEZ: F prob <0.001*					

Agronomic factors affecting yield

The influence of a wide range of characters was tested for affecting the yield of sweet potato in a complete data set. A large number of characters were found to influence root yield. These include variety, Sub-District, AEZ, soil colour, elevation, mixed planting or monoculture. It was not significant in soil pH, soil texture, slope, and planting method.

Table 40. Significance of management factors affecting sweet potato yield.

Factor	*Significance P<0.05*			
	2011/12	*2010/11*	*2009/10*	*2008/2009*
Variety	✓	✓	✓	✓
Sub-District	✓	✓	✓	✓
AEZ	✓	✓	✓	✓
Soil pH	ns	✓	✓	✓
Soil colour	✓	ns	✓	ns
Elevation	✓	✓	ns	ns
Soil texture	ns	✓	✓	✓
Slope of land	ns	✓	✓	✓
Plant in lines or not	ns	✓	ns	ns
Mixed planting or monoculture	✓	ns	ns	ns
Weeding before planting	-	ns	-	-
Cuttings planted per hole (1 or 2)	-	✓	-	-

Soil pH

Although the interaction was not significant (as in 2011), sweet potato yields tended to be higher when grown on soils with pH near neutral (Table 41). Soil pH had much larger effect on sweet potato yields of crops planted in soils with soil pH below 6.

Table 41. OFDT yield by soil pH for all sweet potato varieties, 2011-2012.

Soil pH	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
Mean yield (t/ha)	5.3	2.3	5.6	4.6	12.7	8.9	9.1	6.2
LSD (p<0.05)	ns							

Soil colour

Sweet potato yields were affected by soil colour, with white and red soils having lower yields than light brown and black soils (Table 42). Although the analysis of variance showed a significant effect of soil colour on yield, the large LSD (5.9 t/ha) did not allow much discrimination between soil classifications.

Table 42. Impact of soil colour on sweet potato yield, 2011-2012.

Soil colour	*Yield (t/ha)*
Light brown	18.5
Dark brown	8.2
Red	5.5
Black	8.7
White	4.5
LSD (P<0.05)	*5.9*

Soil Texture

Sweet potato yield tended to be higher in sandy loam textured soils than the heavier clay textured soils (Table 43). In earlier trial years (2008-2011), heavier textured soils tended to produce higher yields.

Table 43. Impact of soil texture on sweet potato yield, 2011-2012

Soil texture	*Yield (t/ha)*
Clay loam	8.5
Fine clay	9.7
Heavy clay	6.9
Loam	7.6
Sandy loam	10.1
Silty loam	8.1
LSD (p< 0.05)	*ns*

Nutritional assessment

Nutritional analyses of Hohrae 1-3, CIP72 and CIP83 are summarized in Table 44. There were significant differences among the tested clones in the concentration of carotenoids, β-carotene, boron, copper, manganese, phosphorus, sodium and zinc. For carotenoids and β-carotene the range among clones was wide spanning from 'not detectable' to an average of 1209 µg β-carotene 100 g-1 edible portion with Hohrae 3. On the other hand, the differences among clones were non-significant for total sugars, starch, dietary fibre, protein, calcium, iron, magnesium, potassium, and sulphur.

These findings confirm others (Burri 2011) that the more orange the root flesh colour the higher the carotenoid content, as clones with flesh colours other than light orange, such as white and light yellow, had non-detectable levels of carotenoids. Burri's (2011) review showed that white fleshed sweet potatoes have non-significant levels of β-carotene. It is surmised that the local sweet potato which is white fleshed has non-detectable levels of β-carotene. In marked contrast, the light orange fleshed sweet potatoes CIP 83 and Hohrae 3 expressed β-carotene concentrations of 802 and 1209 µg 100 g-1, respectively. These results are in line with estimates from analyses of other light orange fleshed lines of 1180-2980 µg β-carotene 100 g-1 found by Teow et al. (2007) and from 111 to 2217 µg β-carotene 100 g-1 in Hagenimana et al. (1999). There is very wide range (1100-fold) in β-carotene concentration in sweet potato (Burri, 2011), Hohrae 3 can be classed as intermediate and clones are reported with 5-10 times more β-carotene (Burri 2011). We wish to evaluate such clones for adaptation to Timor-Leste.

Sweet potato stores well and maintains its β-carotene for at least 50 days; it is also retained during cooking (Burri, 2011) with the fraction retained after cooking and storage estimated at 90% (Burri, 2011). Bioaccessibility was also estimated as 25%. From this we can estimate the bioaccessible β-carotene in our light orange fleshed sweet potato clones as:

β-carotene content x fraction retained after cooking & storage x bioaccessible fraction

When β-carotene content of Hohrae 3 = 1209 µg 100 g-1; fraction retained after cooking and storage = 0.90; bioaccessible fraction = 0.25; then the concentration of bioaccessible β-carotene was 272 µg 100 g-1 (2.72 µg g-1).

Burri (2011) estimated the amounts (g d-1 and cups d-1) of orange-fleshed sweet potato varieties with different concentrations of β-carotene needed to meet the recommended dietary intake of Vitamin A (600 µg retinol equivalent (RE) d-1) of an individual with marginal Vitamin A deficiency. On this basis the grams per day of Hohrae 3 needed to meet the requirement for 1 person with marginal Vitamin A deficiency is calculated as: 600 µg RE d-1/ 2.72 µg bioaccessible β-carotene g-1 sweet potato = 221 g d-1. With one cup of sweet potato estimated to weigh 255 g (USDA, 2010), 221 g of Hohrae 3 sweet potato d-1 – just under 1 cup - will meet the requirement of an individual with Vitamin A deficiency. Putting this in the national production context, on the basis of a population of 1.1 million and a sweet potato production of 22.9 kg cap-1 yr-1, the average daily intake of sweet potato in Timor-Leste is 62.7 g cap-1 d-1. Clearly the new sweet potato clones with light orange flesh such as Hohrae 3 have the potential to make a major contribution to the Vitamin A needs in Timor-Leste.

Hohrae 3 has the useful combination of a dramatically improved yield with β-carotene rich root tubers so its adoption should be simpler than in other orange fleshed sweet potato interventions, which had lower yield advantages compared to local. A study in Mozambique demonstrated the high potential public health importance of an integrated agriculture-nutrition intervention with orange fleshed sweet potato to increase Vitamin A intake (Low et al., 2007). This was done by simultaneously increasing farmers' access to orange fleshed sweet potato vines, increasing nutrition knowledge and creating demand for orange fleshed sweet potato, and ensuring sustainability through market development. To this end a wide variety of activities may be needed in Timor-Leste such as community and national radio spots, presence at local markets, and integrated farmer and nutrition extension.

Table 44. Estimated amount in 100 g (edible portion) of raw sweet potato storage root:

Trait and unit	Overall mean	Significance of effect of			Hohrae 1	Hohrae 2	Hohrae 3	CIP72	CIP83	$LSD_{P=0.05}$
		Genotype	Location	G x L						
Sugars (g)	4.73	ns*	ns	ns						
Starch (g)	15.8	ns	ns	ns						
Dietary fibre (g)	2.70	ns	ns	ns						
Protein (g)	0.929	ns	0.004	ns						
Carotenoids (µg)	501.4	<0.001	ns	ns	nd**	nd	1358	nd	1122	217
β-carotene (µg)	408.8	<0.001	ns	0.02	nd	nd	1209	nd	802	173
Boron (mg)	1.23	0.03	ns	0.002	1.33	1.49	1.51	1.10	1.11	0.20
Calcium (mg)	25.0	ns	ns	ns						
Copper (mg)	1.37	0.03	0.008	ns	1.32	1.64	0.89	0.96	1.34	0.36
Iron (mg)	4.49	ns	ns	ns						
Magnesium (mg)	18.0	ns	<0.001	0.04						
Manganese (mg)	2.71	0.05	ns	ns	1.83	4.32	3.05	2.56	2.73	1.48
Phosphorus (mg)	54.0	0.007	0.001	ns	55	55	40	35	50	15
Potassium (mg)	45.0	ns	ns	ns						
Sodium (mg)	33	0.01	<0.001	0.01	15	10	10	7.5	7.5	3.4
Sulphur (mg)	20	ns	0.03	ns						
Zinc (mg)	2.80	0.004	0.001	ns	2.83	3.65	2.06	1.94	1.94	0.75

* ns = Not significantly different at P=0.05. Overall mean, significance of the effects of genotype, locations and their interaction, and genotype means at Betano with $LSD_{P=0.05}$ where significant at P=0.05.

Farmer's preference for sweet potato clones

A total of 198 farmers participated in field day taste tests during the 2011-2012 growing season, 40% of whom were female. The released Hohrae 3 variety was by far the preferred variety at all the field days (Table 45), even more so than their own local variety. CIP 83 scored poorly in almost all categories of agronomy and eating preferences.

Table 45. Farmer responses (%) to sweet potato varieties 2011-2012.

Characteristic	*Hohrae 3*	*CIP83*	*CIP72*	*Local*
Grows well	95	0	8	52
Big yield	93	8	8	9
Short season	92	8	8	5
Resists rot in ground	72	8	8	33
Tastes good	80	0	8	54
Good colour	90	0	8	24
Diversifies diet	95	0	8	37
Sells for a good price	96	8	8	13
Produces medial tubers	96	8	8	21
Big tubers	97	0	8	6
Will plant again	76	3	6	0

Conclusions

The released variety Hohrae 3 continued to produce consistently and had the best yields at all altitudes. CIP 71 and CIP 83 showed some potential, but further research will be required to evaluate them fully. They will be included in OFDT research in 2013. Among potential clones, only light orange fleshed clones, such as CIP 83 and Hohrae 3, expressed β-carotene concentrations with 802 and 1209 μg 100 g^{-1}, respectively. Clones with lighter flesh coloured roots had non-detectable levels of carotenoids. With an improved production potential combined with substantial β-carotene, the clone Hohrae 3 has the potential to contribute to both calorie and Vitamin A deficits in Timor-Leste.

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

Replicated trials for both 2010 and 2011 are included here as the 2012 trials were harvested too late for inclusion in this report. Trials were conducted at four sites in 2010 including Betano, Fatumaka, Loes, and Aileu. The 2011 trials were planted in the same locations, except for the Fatumaka trials which were relocated to the new Darasula research station nearby in Baucau District. The trials included the same set of clones as in previous years, allowing for a multiyear analysis.

Materials and methods

Each trial utilized randomized complete block design with three replicates, except the Aileu trial which had 2 replicates. The trials were planted in December/January of their respective years and harvested 10 to 12 months later.

Table 46. Cassava planting and harvest details, 2009-2010.

Location	*Number of entries*	*Planting date*	*Harvest date*	*Mean yield (t/ha)*
Fatumaka	18	18/12/2009	29/9/2010	5.5
Loes	18	08/01/2010	16/11/2010	56.0
Betano	18	04/01/2010	~Dec 2010	25.6

Table 47. Cassava planting and harvest details, 2010-2011.

Location	*Number of entries*	*Planting date*	*Harvest date*	*Mean yield (t/ha)*
Darasula	15	18/01/2011	29/11/2011	7.4
Loes	15	Dec 2010	Nov 2011	25.3
Betano	15	17/12/2010	01/12/2011	26.8
Aileu	15	06/12/2010	04/10/2011	15.5

Twelve to fifteen of the most promising clones were selected from the original germplasm import of 25 varieties. As in previous years, three of the best performing local varieties (*Mantega, Merah, and Etu Hare*) were included at all locations.

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 was 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.

Analysis

Data collected from the trials was entered into an Excel spread sheet and then analysed with GenStat Discovery Edition 4 and GenStat 15 via one way ANOVA in randomized blocks. For the multiyear analysis, a REML Linear Mixed Model in GenStat 15 was used. A principal component analysis (PCA) was used to describe the variation of variety yields across locations and years. PCA is one way to summarise variation in a large matrix of data (ie. variety by experiment) into a smaller number of components. When the data is 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

In the Fatumaka 2010 trials, a significant difference in both yield and starch content was observed with *Ai-Luka* 2 performing best of all varieties. Yields in the Baucau trials tend to be very low, with improved varieties showing a smaller yield advantage than at other sites.

Table 48. Cassava variety evaluation trial results, Fatumaka (Baucau) 2010.

Variety name	*Root yield (t/ha)*	*Starch content (%)*	*Yield advantage over average local (%)*
Ai-Luka 2	7.60	25.8	16
Ai-Luka 4	5.97	26.4	-9
Ca 013	5.78	22.5	-12
Local *Mantega*	4.06	25.0	
Local Merah	9.94	25.5	
Ca 018	4.73	30.5	-28
Ca 025	5.06	23.5	-23
Ca 042	6.80	25.3	4
Local Etuhare	5.70	29.4	
Ca 101	3.80	24.8	-42
Ca 102	5.56	27.1	-15
Ca 103	*	*	
Ca 104	2.42	24.5	-63
Ca 105	5.03	29.0	-23
Ca 106	4.98	25.4	-24
Ca 107	5.84	28.7	-11
Ca 108	4.70	26.2	-28
Ca 109	6.33	23.8	-4
f prob	0.377	0.03	
LSD	ns	4.29	
% CV	48.5	9.55	

In the Loes 2010 trials, a significant difference in both yield and starch content was observed. Yields were among the highest ever observed with an overall average yield of 56.03 t/ha and all improved varieties with the exception of Ca 025 produced a large yield advantage over the locals.

Table 49. Cassava variety evaluation trial results, Loes 2010.

Variety name	*Root yield (t/ha)*	*Starch content (%)*	*Yield advantage over average local (%)*
Ai-Luka 2	58.00	24.13	46
Ai-Luka 4	47.73	24.23	21
Ca 013	69.60	20.07	76
Local *Mantega*	53.73	23.43	
Local Merah	34.13	17.43	
Ca 025	20.40	22.17	-48
Ca 036	77.33	24.00	95
Ca 042	52.00	23.60	31
Local Etuhare	30.93	23.97	
Ca 101	62.67	23.97	58
Ca 102	66.13	23.60	67
Ca 103	85.33	19.43	115
Ca 104	46.40	24.67	17
Ca 105	73.47	30.13	86
Ca 106	46.53	28.27	18
Ca 107	58.00	26.07	46
Ca 108	71.33	29.50	80
Ca 109	54.80	26.93	38
f prob	0.001	<.001	
LSD	26.54	3.39	
% CV	28.5	8.4	

In the Betano 2010 trials, a significant difference was observed in both root yield and starch content. All improved varieties produced a wide margin of yield advantage over the locals.

Table 50. Cassava variety evaluation trial results, Betano 2010.

Variety name	*Root yield (t/ha)*	*Starch content (%)*	*Yield advantage over average local (%)*
Ai-Luka 2	32.47	21.87	108
Ai-Luka 4	22.80	22.20	46
Ca 101	22.19	20.93	42
Ca 102	25.03	18.70	61
Ca 103	27.09	15.10	74
Ca 104	28.07	26.43	80
Ca 105	26.87	24.57	72
Ca 106	37.33	25.63	140
Ca 107	33.87	28.13	117
Ca 108	19.51	24.47	25
Ca 109	32.47	26.40	108
Ca 013	15.87	16.60	2
Local *Mantega*	10.69	25.60	
Local *Merah*	7.13	26.97	
Ca 025	26.00	19.50	67
Ca036	34.33	23.60	120
Ca 042	30.80	23.83	98
Local *Etuhare*	28.93	20.70	
f prob	0.002	0.001	
LSD	13.33	3.38	
% CV	31.3	8.90	

In the Aileu 2010-2011 trials a significant difference was found for both root yield and starch content. Yield advantages were highest for *Ai-Luka* 2 with *Ai-Luka* 4 also performing well.

Table 51. Cassava variety evaluation trial results, Aileu, 2010-2011.

Variety	*Root yield (t/ha)*	*Starch content (%)*	*Yield advantage over average local (%)*
Ai-Luka 2	23.33	11.80	55
Ai-Luka 4	17.87	8.92	18
Ca007	7.07	5.36	-53
Ca013	16.80	7.38	11
Local *Mantega*	12.40	8.98	
Ca036	21.47	10.23	42
Ca042	15.73	8.26	4
Ca101	9.20	8.72	-39
Ca102	8.60	9.28	-43
Ca106	13.07	9.44	-13
Ca107	22.93	11.01	52
Ca108	12.00	9.63	-20
Ca109	18.53	11.50	23
Local1	13.07	8.39	
Local2	19.80	9.45	
f prob	0.001	<.001	
LSD	7.83	2.00	
% CV	30.36%	13%	

In the Loes 2010-2011 trials, a significant difference was found for both root yield and starch content. Only the two released varieties and Ca 013 outperformed the local. Flooding of the trial during the rainy season may have caused the unexpectedly poor performance of the other released varieties.

Table 52. Cassava variety evaluation trial results, Loes 2010-2011.

Variety name	*Root yield (t/ha)*	*Starch content (%)*	*Yield advantage over average local (%)*
Ai-Luka 2	41.60	26.10	37
Ai-Luka 4	37.73	24.80	25
Ca 013	37.20	19.53	23
Local Mantega	*34.13*	*29.33*	
Local Merah	30.13	10.23	
Ca 036	29.47	25.10	-3
Ca 042	26.93	26.33	-11
Local Etuhare	26.53	22.37	
Ca 101	23.87	20.53	-21
Ca 102	22.13	28.50	-27
Ca 103	20.13	26.50	-33
Ca 106	18.53	24.93	-39
Ca 107	17.33	27.60	-43
Ca 108	15.73	30.07	-48
Ca 109	8.930	28.07	-70
f prob	0.003	<.001	
LSD	14.6	2.994	
% CV	33.5	7.3	

In the Betano 2010-2011 trials, a significant difference was observed for both root yield and starch content. *Ai-Luka* 2 performed the best, with a 60% yield advantage over local varieties. HCN content was also measured for this trial, with the results presented in Table 53.

Table 53. Cassava variety evaluation trial results, Betano 2010-2011.

Variety name	*Root yield (t/ha)*	*Starch content (%)*	*HCN content (%)*	*Yield advantage over average local (%)*
Ai-Luka 2	39.47	27.13	51.67	60
Ai-Luka 4	24.73	28.53	51.67	1
Ca 007	29.89	19.20	125.00	22
Ca 013	24.40	27.77	91.67	-1
Local *Mantega*	29.19	32.57	35.00	
Local Merah	21.23	29.23	88.33	
Ca 036	28.97	28.07	125.00	18
Ca 042	29.47	29.20	100.00	20
Local Etuhare	23.40	23.63	40.00	
Ca 101	27.13	28.30	150.00	10
Ca 102	22.36	27.80	88.33	-9
Ca 106	19.73	22.17	100.00	-20
Ca 107	26.83	31.17	125.00	9
Ca 108	27.67	28.53	75.00	12
Ca 109	28.27	30.57	100.00	15
f prob	0.026	<.001		
LSD	8.917	4.752		
% CV	19.9	10.3		

In the Darasula 2011 trials, no significant difference was found for root yield, but a significant difference for starch content was observed. Local varieties performed well at this site, though a yield advantage was observed among some introduced varieties.

Table 54. Cassava variety evaluation trial results, Darasula (Baucau) 2011.

Variety name	*Root yield (t/ha)*	*Starch content (%)*	*Yield advantage over average local (%)*
Ai-Luka 2	7.33	20.4	0
Ai-Luka 4	7.73	21.1	5
Ca 013	9.33	15.3	27
Local *Mantega*	6.53	21.4	
Ca 036	7.07	21.6	-4
Ca 042	9.60	21.6	31
Local Etuhare	4.79	20.7	
Ca 101	5.13	19.8	-30
Ca 102	9.20	21.1	26
Ca 103	2.00	11.1	-73
Ca 106	7.73	22.4	5
Ca 107	11.20	22.8	53
Ca 108	0.73	0.0	-90
Ca 109	7.47	23.1	2
Local *Mantega*	10.67	21.2	
f prob	ns	<.001	
LSD	6.089	4.936	
% CV	51.4	15.6	

Starch production

There was considerable variation for starch production between varieties when tested at the 4 locations over 2 years.

Table 55. Cassava multisite starch yield advantages (%) 2010-2011.

Variety	*Aileu 2011*	*Darasula 2010*	*Betano 2010*	*Betano 2011*	*Darasula 2011*	*Loes 2011*	*Loes 2011*	*Mean*
Ca105		-16	86			156		75
Ai-Luka2	102	12	100	51	6	62	71	58
Ca036	61		128	15	8	115	17	57
Ca107	85	-4	168	18	81	75	-25	57
Ca109	57	-14	141	22	22	71	-60	34
Ca042	-5	-1	107	22	47	42	12	32
Ca104		-66	109			32		25
Ai-Luka4	17	-10	43	0	16	34	48	21
Ca106	-9	-27	170	-38	23	52	-27	20
Local *Mantega*	-18	-42	-23	34	30	46	58	12
Ca102	-41	-14	32	-12	38	80	-1	12
Ca108	-15	-29	34	11	-100	143	-25	3
Ca013	-9	-25	-26	-4	1	61	15	2
Ca103			15		-84	92	-16	2
Ca101	-41	-46	31	8	-28	74	-23	-4
Local *Etuhare*	-19	-4	69	-22	-30	-14	-6	-4
Local *Merah*	38	46	-46	-12		-31	-51	-10
Ca025		-32	43			-48		-12
Ca007	-72			-19				-46

Yield advantage

Ai-Luka 2 was a consistent high yielding variety across all tests sites over the 2 years. It produced an average tuber yield of 48% above the 3 local checks.

Table 56. Cassava multisite yield advantages (%) 2010-2011.

Variety	*Aileu 2010*	*Fatumaka 2010*	*Betano 2010*	*Betano 2011*	*Darasula 2011*	*Loes 2010*	*Loes 2011*	*Mean*
Ai-Luka2	55	16	108	60	0	46	37	46
Ca036	42		120	18	-4	95	-3	45
Ca105		-23	72			86		45
Ca107	52	-11	117	9	53	46	-43	32
Ca042	4	4	98	20	31	31	-11	25
Ca103			74		-73	115	-33	21
Ca013	11	-12	2	-1	27	76	23	18
Ca109	23	-4	108	15	2	38	-70	16
Ai-Luka4	18	-9	46	1	5	21	25	15
Ca104		-63	80			17		11
Ca106	-13	-24	140	-20	5	18	-39	10
Ca102	-43	-15	61	-9	26	67	-27	9
Local *Mantega*	-18	-38	-31	19	-11	36	13	-4
Local *Merah*	31	51	-54	-14		-14	0	0
Local *Etuhare*	-13	-13	86	-5	-35	-22	-12	-2
Ca025		-23	67			-48		-1
Ca101	-39	-42	42	10	-30	58	-21	-3
Ca108	-20	-28	25	12	-90	80	-48	-10
Ca007	-53			21				-16

Figure 18 is a Biplot analysis of tuber yield of the tested varieties across the 8 test locations. The biplot shows the position of each variety in relation to the 8 test locations. The two components of the biplot (PC1 and PC2) account for 80.1% of the total variation in the original data set. Four of the test locations are near the center of graph. Only the two Loes experiments (Lo11 and Lo10) and Betano 2010 are quite some distance from the center. Loes 2011 is positioned above and to the left of the center, and Betano 2010 is positioned below and to the right of center. This suggests that rank order of varieties in Loes 2011 is quite different to that of Betano 2010. In addition the test site Loes 2010 sits well to the right of the center, suggesting that there is no correlation between varieties yields in Loes across the 2 years (ie. 2010 and 2011), and no correlation between Loes 2010 and Betano 2012. Flooding of the Loes 2011 trial may account for this effect.

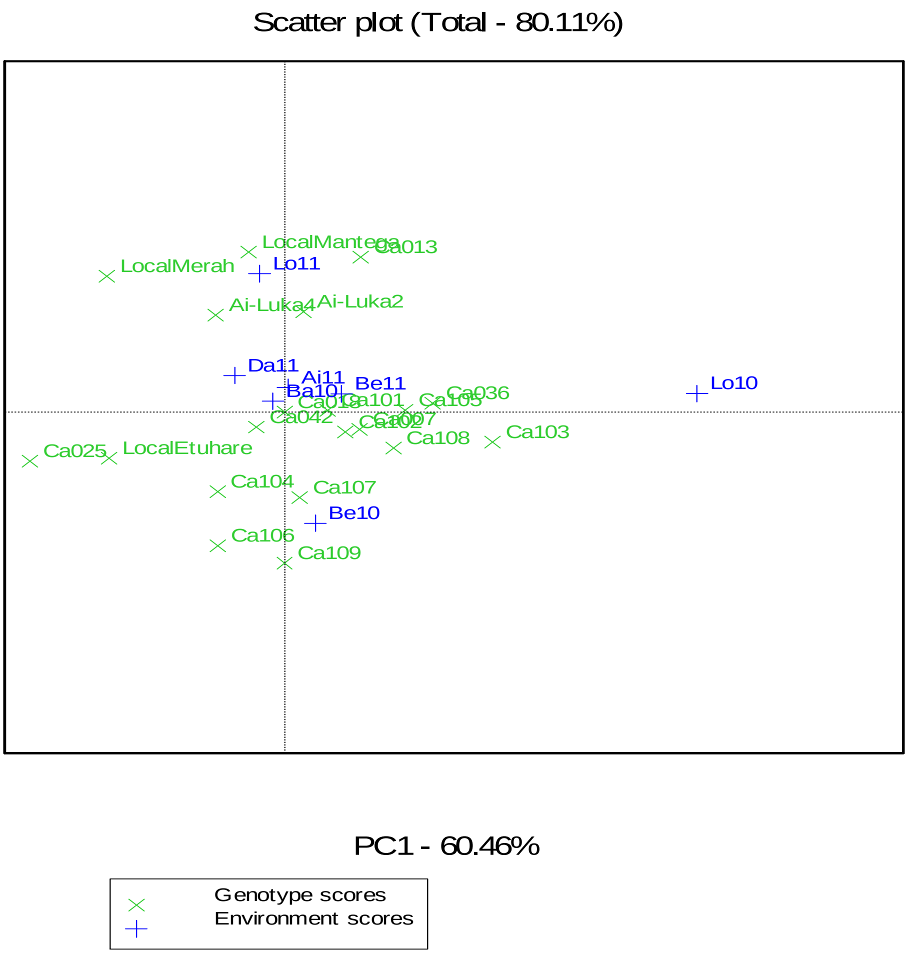


Figure 18. Biplot of multiyear cassava data 2008-2011.

2.3.2 Cassava performance across sites and years

A multiyear analysis was performed on all trials at the five sites for the years 2008 – 2011. The results of this analysis are presented in Table 57. Of the introduced varieties, only Ca 014 and Ca 025 failed to produce a yield advantage over local cassava. The released varieties Ai-Luka 2 and Ai-Luka 4 produced the highest average yields of all the tested varieties with yield advantages of 51% and 47% respectively. These varieties have been tested in 30 replicated trials since 2001, and have consistently maintained a high yield advantage over local varieties. The overall average yield for cassava for all sites and years was 21.44 t/ha. When analysed across all years, a significant difference in yield was observed for both variety and location. Among the test sites, Baucau proved to be the lowest producing and Loes the highest.

During the 2008 – 2011 testing period, the local variety *Mantega* has performed better than in previous testing years with a yield advantage of 36% over the other two local varieties. This is worth notice as it is a very popular variety among Timorese farmers who value its yellow colour and good taste.

Table 57. Multi-year cassava replicated trial yields by variety and location, 2008-2011.

Variety	*Average yield by location 2008-2011 (t/ha)*					*Variety average yield, all locations (t/ha)*	*Yield advantage over average local (%)*
	Aileu	Baucau	Betano	Loes	Maliana		
Ca 013	16.61	7.12	29.38	55.60	13.96	24.5	41
Ca 014	15.26	3.38	15.15	10.29	11.34	11.0	-36
Ai-Luka 2	24.94	8.08	30.99	53.98	12.96	26.1	51
Local *Mantega*	12.12	7.58	26.67	45.20	13.54	21.0	36*
Local *Merah*	11.68	7.10	17.59	34.18	6.21	15.3	-
Ca 025	14.98	9.02	26.35	22.62	4.68	15.5	-10
Ai-Luka 4	19.04	8.35	38.90	53.23	8.05	25.5	47
Ca 036	25.07	5.30	29.76	52.60	11.33	24.8	43
Ca 040	14.74	5.33	11.39	46.81	16.25	18.9	9
Ca 042	24.39	6.99	30.98	47.42	10.28	24.0	38
Local *Etuhare*	11.34	5.31	19.21	35.55	6.90	15.7	-
Ca 101	13.77	4.23	31.27	41.59	10.23	20.2	17
Ca 102	10.69	7.30	31.50	40.34	10.73	20.1	16
Ca 103	18.78	4.65	22.52	45.00	6.85	19.6	13
Ca 104	9.30	3.69	34.20	42.03	15.57	20.9	21
Ca 105	15.66	6.86	25.07	54.58	17.87	24.0	38
Ca 106	11.75	5.24	32.92	32.51	11.66	18.8	9
Ca 107	21.30	9.00	35.30	38.57	18.57	24.5	42
Ca 108	15.24	5.71	26.80	44.63	16.60	21.8	26
Ca 109	16.20	7.69	34.18	34.13	19.11	22.3	28
Location average	16.14	6.40	27.51	41.54	12.13	*Overall average production (t/ha)* 21.44	
f prob (Variety) <0.001						*f prob (Location)* 0.008	

* This figure represents the yield advantage over the average yield of other local varieties.

Starch content was also analysed across years with the results presented in Table 58. A significant difference was found for variety and the variety*location interaction, but not for location alone. The released varieties were on par with local varieties for starch content.

Table 58. Multiyear cassava replicated trial starch content by variety, 2008-2011.

Variety	*Variety average starch content, all locations (%)*	*Average starch production (t/ha)*	*Starch content advantage over average local (%)*
Ca 013	21.0	5.5	-13
Ca 014	21.2	3.1	-12
Ai-Luka 2	25.4	6.8	6
Local *Mantega*	26.0	5.3	13*
Local *Merah*	21.1	3.4	
Ca 025	22.1	4.3	-8
Ai-Luka 4	23.9	6.6	0
Ca 036	24.7	6.8	3
Ca 040	23.1	4.5	-4
Ca 042	24.1	6.1	0
Local *Etuhare*	24.9	3.6	
Ca 101	23.8	5.2	-1
Ca 102	25.9	5.6	8
Ca 103	21.6	4.9	-10
Ca 104	27.8	6.6	16
Ca 105	29.92	7.6	24
Ca 106	26.5	5.2	10
Ca 107	27.2	7.1	13
Ca 108	27.0	6.3	12
Ca 109	28.3	6.3	18
chi prob Variety	<0.001		
chi prob Location	0.516		
chi prob Variety x Location	<0.001		

* This figure represents the starch content advantage over the average of other local varieties.

Conclusions

The good performance of *Ai-luka2* and *Ai-luka 4* during the 2010-2011 testing years provide continued support for their choice as released varieties. These varieties have consistently maintained a high yield advantage since 2001 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.

The multiyear yield and starch analyses found Ca 014 and Ca 025 as having both a lower yield and lower starch content than local varieties. Their low performance indicates that they can be excluded from future trials.

The possibility of releasing Ca 109 as an industrial crop was raised during year. This variety yields well and has good starch content. 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 Ca 109 widely to farmers in a project which buys back planting material and dried chips for commercial starch production. The possibility of an industrial crop being released by MAF is set to be discussed by the variety release committee in 2013. Bitter cassava is grown in many areas by Timorese farmers, but whether it is suitable for MAF release is yet to be decided.

2.3.3 Cassava OFDTs 2011-2012

Cassava OFDTs were established in four Sub-Districts of Timor-Leste during the wet season of 2011-2012. The trial objective was to determine whether the elite cassava varieties identified in the research stations also performed well in farmer's fields. These trials followed OFDTs established in 2007-2008 which tested Ca 15 and Ca 26. These two varieties were released in 2009 as Ai-luka 2 & Ai-luka 4. Root crops, particularly cassava, are notoriously difficult to test on-farm in Timor-Leste as predation by animals and premature harvest by farmers often cause trial failures. Cassava is treated as reserve or backup food in Timor-Leste, and the usual practice is to harvest tubers from the plants as needed throughout the year.

Materials and methods

Cassava OFDTs were established in Maliana, Balibo, Liquiça Villa and Viqueque in 2011-2012. Five plants in each test plot were marked and it was agreed that the farmers would harvest these plants together with the researcher. While this system proved to be more effective than trying to harvest the entire plot together, trial failure for the 2011-2012 season was still over 50%. Eleven sites produced yield data. While these results do not constitute enough data for a thorough analysis, the results are presented here as an indication of how the varieties performed.

The trials were conducted on farmers' fields with no changes to their normal practices. District based researchers located farmers who were interested in hosting trials. At each site, the researcher laid out test plots of 5m x 5m and planted 25 cassava cuttings with 1m x 1m spacing. The host farmers provided the local variety for comparison. This resulted in a different 'Local' at each site but gives an accurate indication of what farmers in Timor-Leste typically plant.

In each plot, five plants were marked by the researcher and it was agreed that they would be harvested together with the farmer on a single day. This helps to mitigate trial failure due to random harvesting by farmers. From the five plants harvested, an estimation of total yield was made.

Results

The low numbers of harvested trials were not sufficient for a complete analysis and no significant difference was determined for yield, number of tubers, or tuber weight. As shown in Table 59, Ai-luka 4 produced the highest yield followed by Ai-luka 2 and the local. The results are presented graphically in Figure 19 and Figure 20 demonstrating Ai-luka 2 and Ai-luka 4 produced higher yields than local varieties at the majority of sites as represented by the points above the 1:1 line.

Table 59. Yield components for cassava OFDTs 2011-2012

Variety	*Yield(t/ha)*	*Yield(t/ha) (2010-2011)*	*Tubers per plant*	*Weight per tuber(g)*
Ailuka 4	6.7	12.2	1.4	485.1
Ailuka 2	6.4	5.8	1.5	454.7
Local	4.5	5.0	1.3	364.5
LSD ($p<0.05$)	ns	5.1	ns	ns

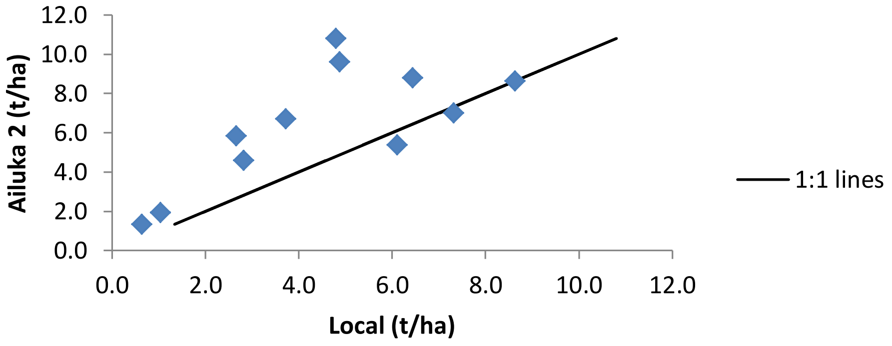


Figure 19. Yield of Ai-luka 2 versus local population 2011-2012

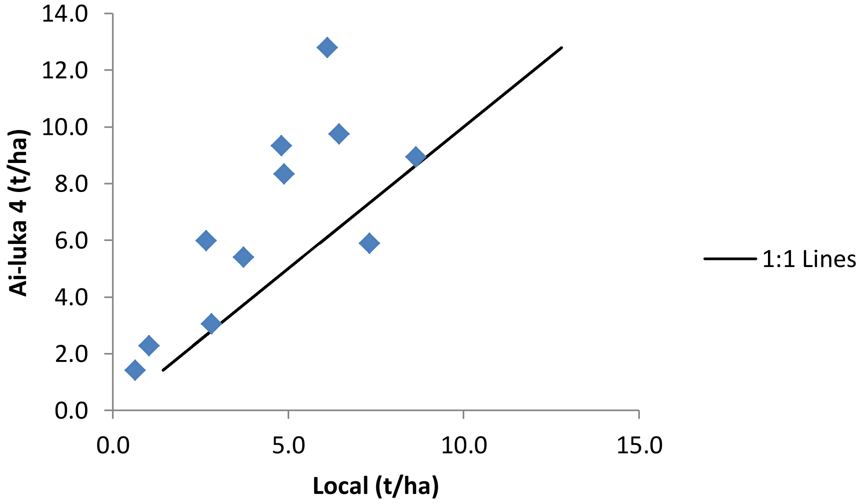


Figure 20. Yield of Ailuka4 versus local population 2011-2012

Conclusion

While conducting cassava OFDTs presents a number of difficulties, they provide valuable insight into cassava cultivation in Timor-Leste. Cassava remains an important contributor to the food security of Timorese farmers as it can be stored in the ground and harvested when needed. The results of 2011-2012 OFDTs shows the 2 released varieties provide high yields compared with the locals. In the future, research may be able to include new varieties in the OFDTs as Ai-luka 2 and 4 have proved to be high yielding and popular with farmers.

2.4 Rice

2.4.1 Irrigated aromatic rice observational trials, 2012

Replicated rice trials were planted in 2012 with a selection of 16 varieties from an original group of 33 imported from the IRRI International Finegrain Aromatic Rice Observational Nursery (IRFAON) in 2010. The selected varieties had performed well in observational trials in 2011 and were assessed in replicated trials in Maliana and Baucau. A selection of local and previously imported high-yielding varieties were also included as controls in the trials, as outlined in Table 60.

Table 60. Irrigated rice varieties by code and origin, 2012.

Code	Code origin	Variety Name
M24	IRRI	IR 77542-551-1-1-1-1-2
M26	IRRI	IR77734-93-2-3-2
Matatag 2	*Control*	*Matatag 2*
M37d	Pakistan	Basmate 310
Nakroma	*Control*	*Nakroma*
M34	IRRI	IR 81352-65-2-1-2
PSBRC 82	*Control*	*PSBRC82*
M19	IRRI	IR76993-49-1-1
M40	IRRI	IR 72
M20	IRRI	IR77512-128-2-1-2
M42	IRRI	PsbRR 18
M29	IRRI	IR 78554-145-1-3-2
M31	IRRI	IR 79478-67-3-3-2
PSBRC 80	*Control*	*PSBRC80*
M32	IRRI	IR 81166-39-1-2-3
M10	India	RR180-1
M17	Philippines	PR26645-B-7
M01	Vietnam	MB9855
M12	Africa rice	WAB450-11-1-1-P1-HB
Local President	*Control*	*President*
M13	Myanmar	YN2610-2-2-2-1-2-1
Local *Baucau*	IR 5	TL Baucau /Triloca
Local *Atabae*	Dinas	TL Atabae
Local *Maliana*	Local	TL Maliana
Local *Aileu*	IR 8	TL Aileu

Methodology

Each trial consisted of three complete randomized replicates with 2m by 3m plots. Seed was soaked in water for three days and dried in the sun for one day before planting into nurseries. Twenty day old seedlings were then transplanted into the plots with spacing of 15 cm between plants and 20 cm between rows. Border rows which were not included in the harvest data were planted around the perimeter of the trial. No fertilizer was applied, and the trials were harvested approximately 100 days later.

Data was collected in the field and then entered into Excel spread sheets and analysed in Genstat Discovery Edition 4 and Genstat 15. One way ANOVA in randomized blocks was used for the analysis.

Table 61. Planting and harvest details of rice varietal trials, 2012.

Location	*No. of entries*	*No. of replicates*	*Planting date*	*Harvest date*	*Days to maturity*	*Mean yield (t/ha)*
Baucau	25	3	29/02/2012	11/06/2012	103	0.9
Maliana	20	3	16/02/2012	22/05/2012	96	4.6
Aileu	25	3	23/02/12	13/6/12	111	3.4

* Total rainfall from planting to harvest date

Results

Maliana

In the Maliana trials, the average yield was 4.6 t/ha with a local variety from Aileu showing the highest production (Table 62). Of the test varieties, M 40 performed the best with a 16.7 % yield advantage over the average local production. Significant differences for yield and all yield components except the number of tillers per plant were observed among the varieties. Seed was not available for some varieties selected from the previous year's observational trials and were not planted in this experiment.

Table 62. Irrigated rice results, Maliana 2012.

Variety	*Yield (t/ha)*	*Weight of 100 seeds (g)*	*Plant height at harvest (cm)*	*Average tillers/plant*	*Yield advantage over locals (%)*
Local *Aileu*	5.4	2.6	72.9	17.7	18.3
M40	5.4	2.6	77.4	15.8	16.7
Local President	5.1	2.6	82.2	18.2	10.6
M34	5.1	2.4	77.6	17.8	10.1
PSBRC 80	5.0	2.4	79.3	17.4	9.3
M13	5.0	2.5	62.7	15.6	9.2
M42	5.0	2.4	59.7	21.5	8.6
Matatag 2	5.0	2.4	73.2	18.4	8.6
Nakroma	5.0	2.5	71.9	15.1	8.2
PSBRC 82	4.9	2.5	71.9	14.8	6.4
M26	4.8	2.4	64.3	16.4	3.9
M 31	4.8	2.5	73.6	15.5	3.6
M 19	4.7	2.4	75.5	14.7	2.5
M 10	4.6	2.5	66.6	14.2	-0.8
M 32	4.3	2.4	72.5	17.1	-5.9
Local *Maliana*	4.1	2.4	62.7	16.6	-9.9
M20	4.1	2.5	70.8	16.0	-9.9
Local *Atabae*	3.6	2.2	58.8	16.4	-22.2
M 37	2.9	2.2	100.3	14.3	-37.1
M29	2.7	2.4	80.7	16.7	-41.4
F prob	0.001	<0.001	<0.001	0.074	
LSD	1.14	0.14	7.71	ns	
CV%	14.47	3.29	6.24	13.73	

The average yield for the Baucau 2012 Irrigated rice trials was quite low at 0.86 t/ha, but there was a significant for difference for yield and all yield components except the number of stems with panicles. This was likely caused by a water shortage that resulted in insufficient water during flowering. As in the Maliana trials, M 40 performed well, though in this trial M 17 was the best performer with a yield advantage of 109% over the local average. The results of the trials are presented in Table 63.

Table 63. Irrigated rice results, Baucau 2012.

Variety	*Yield (t/ha)*	*Stems with panicles (%)*	*Panicle length (cm)*	*No seeds/ panicle*	*Weight of 100 seeds (g)*	*Plant height at harvest (cm)*	*Yield advantage over locals (%)*
M17	1.4	13.3	22.3	106.3	2.6	61.4	109.4
M40	1.4	15.0	19.4	111.6	2.6	46.2	103.6
M13	1.3	13.0	20.0	96.3	2.5	51.1	85.5
M31	1.2	16.3	20.0	83.0	2.6	62.7	73.2
PSBRC 80	1.1	13.7	20.7	92.9	2.7	51.7	60.7
M01	1.1	12.3	22.9	113.1	2.5	60.7	58.4
M20	1.0	15.3	18.7	91.0	2.6	52.0	51.0
Local *Atabae*	1.0	13.3	20.8	86.0	2.3	52.8	48.4
PSBRC 82	1.0	11.0	19.2	85.0	2.6	52.2	48.4
M 24	1.0	13.3	17.1	89.7	2.6	55.3	47.5
M19	1.0	14.0	19.4	91.2	2.6	54.1	45.2
M29	1.0	14.0	20.7	99.3	2.6	59.7	43.5
Nakroma	0.9	14.0	21.3	95.9	2.8	51.7	38.5
M 26	0.9	14.3	20.4	110.6	2.5	60.8	35.2
Local President	0.9	14.3	22.9	120.0	2.6	71.7	33.6
Local *Baucau*	0.8	15.3	19.7	83.8	2.6	54.7	18.7
M32	0.8	14.3	20.0	105.0	2.6	60.2	18.7
M42	0.8	14.7	23.8	124.6	2.6	55.3	15.5
Matatag 2	0.7	13.3	20.2	105.2	2.5	48.6	7.2
M10	0.8	10.7	16.7	101.0	2.5	56.2	15.5
Local *Maliana*	0.6	13.0	18.0	83.4	2.5	54.7	-14.2
M37	0.5	16.0	19.4	105.3	1.9	42.6	-20.9
Local *Aileu*	0.3	13.7	17.8	86.0	2.6	61.2	-53.0
M34	0.1	12.3	20.7	91.6	2.6	46.1	-91.0
M12	0.0	10.3	20.7	111.7	2.3	61.8	-100.0
F prob	<001	0.47	<.001	<.001	<.001	<.001	
LSD (p<0.05)	0.44	4.27	1.13	11.60	0.25	8.98	
%CV	31.7	19.1	3.4	7.2	6.1	9.9	
Mean high yld. control	*0.91*	*14.50*	*20.22*	*98.14*	*2.59*	*57.78*	
Mean locals	*0.67*	*13.83*	*19.06*	*84.81*	*2.48*	*55.84*	

In the Aileu 2012 trials, two of the local checks performed well with M 34 being the best test variety. Only yield measurements were taken at this trial, but there was a significant difference among the varieties. The average yield for the trial was 3.4 t/ha, and the results are presented in Table 64.

Table 64. Irrigated rice results, Aileu 2012.

Variety	*Yield (t/ha)*	*Yield advantage over locals (%)*
Local *Aileu*	4.8	37.8
M34	4.7	34.0
Local *Baucau*	4.6	28.0
PSBRC 80	4.3	22.5
M31	3.9	10.5
M26	3.8	8.6
M40	3.8	7.6
M20	3.7	6.0
M13	3.7	4.5
PSBRC 82	3.5	0.3
M01	3.5	-0.6
Nakroma	3.5	-0.9
M19	3.4	-2.9
Matatag 2	3.3	-4.8
M32	3.2	-8.3
M42	3.2	-9.5
M17	3.1	-11.1
M29	3.1	-11.4
M37	3.0	-14.0
M24	2.9	-16.2
Local *Atabae*	2.4	-32.7
Local President	2.2	-35.9
Local *Maliana*	2.1	-39.4
M10	2.0	-41.6
F prob	< 0.001	
LSD	0.5	
CV%	8.5	

Conclusions

The results of the 2012 trials have indicated that some of the aromatic varieties tested show potential and should be further tested next year. Varieties M40, M31, and M13 were among the top varieties at all three locations. Rice that is *morin* or “smells nice” is often selected at farmer field days as something that farmers are interested in planting. If a high yielding variety from the IRFAON group can be identified, it would likely prove to be popular with Timorese farmers. Also of note is the local President which produces a reddish coloured grain. This is also a highly desirable quality, and if further testing proves an adequate yield for the variety it may also warrant being considered for release. Past year’s field day surveys have shown that if a variety has a desirable quality such as aroma or colour, a slightly lower yield does not reduce farmer’s desire to plant it again.

2.4.2 Upland rice observational trials, 2012

Upland rice (*Oryza sativa* L.) is grown by approximately 14% of Timorese farmers and is thought to have been planted on the island in pre-Portuguese times. It is most commonly grown in the Districts of Baucau, Viqueque, Oecusse, and Bobonaro, with lesser quantities being observed in most other Districts. In October 2010, Seeds of Life imported 100 varieties of upland rice from the International Upland Rice Observational Nursery (IURON) at IRRI. These varieties were selected for their adaptation to conditions similar to Timor, higher yield potential, and a shorter growing season than Timorese local varieties. For the 2012 trials, 60 of the best performing varieties from last year were selected for testing alongside three local checks from Baucau and Viqueque.

Materials and methods

The trial was planted at Darasula research station in Baucau District at an elevation of 683 meters above sea level. Seed was sourced from the 2011 observation trials and plot size was limited to $2m^2$ due to the small amount of seed available. The seed was primed by soaking for three days, and then dried in the sun for one day before planting. Plant spacing was 20cm x 20cm and 3 seeds were planted per hill. The trial was planted 22 November 2011 and harvested according to the maturity of each variety. A complete randomized block design was utilized, with three replicates. A total of 222 mm of rain fell on the trial from planting to harvest.

Analysis

Data was entered into an Excel spread sheet and analysed using GenStat 15. As there was no row or column effect on yield, the data was analysed by one way ANOVA in randomized blocks. In order to normalize the data, a square root transformation was used for the analysis. The original untransformed yield data is also included here. The results of the top 29 entries and those for the locals in the 2012 trial are outlined in Table 65.

Table 65. Yields and yield components of upland rice trials, Darasula, 2012.

Variety	*SQRT Yield*	*Yield (t/ha)*	*Plant height (cm)*	*100 seed weight (g)*	*Seeds / panicle*	*Density plants/m²*	*Seeds/plant*	*Disease score+*	*Days to harvest*
RO03	1.26	1.58	65.0	2.09	160	12.67	62	2	126
RO12	1.24	1.55	53.9	2.10	135	9.33	51	2	140
RO54	1.16	1.35	47.6	2.05	132	9.83	103	3	140
RO46	1.14	1.31	66.5	2.68	249	9.50	88	2	148
RO98	1.12	1.25	57.3	2.47	96	11.00	55	3	140
RO50	1.10	1.20	38.3	2.46	73	11.50	42	3	145
RO102	1.08	1.16	64.7	2.46	168	15.50	81	3	140
RO21	1.07	1.14	63.1	2.60	115	13.00	115	2	140
RO28	1.07	1.13	38.0	2.41	220	5.17	79	3	126
RO64	1.04	1.08	56.0	2.46	198	13.33	59	2	126
RO29	1.02	1.03	54.8	2.21	478	8.33	93	3	126
RO06	1.00	1.01	75.9	2.29	197	8.83	67	4	126
RO43	0.99	0.98	40.5	2.50	272	12.33	75	3	140
RO59	0.97	0.94	58.4	2.54	197	9.17	126	3	126
RO22	0.94	0.89	53.8	2.28	210	9.00	76	3	148
RO52	0.94	0.88	59.7	2.16	148	9.67	93	3	148
RO41	0.94	0.87	31.2	2.42	266	10.00	67	3	140
RO47	0.93	0.87	59.5	2.46	142	8.33	42	3	148
RO32	0.92	0.85	55.6	2.34	153	7.67	105	3	126
RO26	0.91	0.83	59.3	2.63	105	9.83	85	3	147
RO17	0.91	0.82	54.4	2.46	183	11.33	125	2	126
RO62	0.91	0.82	55.6	2.35	189	12.17	86	3	140
R030	0.89	0.79	49.6	2.38	189	9.33	91	3	126
RO36	0.86	0.74	56.8	2.17	480	8.33	103	3	126
RO72	0.86	0.73	6.3	0.11	203	9.31	88	3	162
RO48	0.82	0.67	74.1	2.59	140	8.50	83	2	140
RO02	0.81	0.66	75.4	2.31	179	11.33	48	3	126
RO10	0.80	0.65	52.5	2.29	90	6.67	84	3	140
RO99	0.80	0.64	52.2	2.70	216	13.50	240	2	126
RLB	0.75	0.57	46.9	2.38	109	9.33	94	4	162
RLMB	0.44	0.19	38.8	2.22	484	5.13	82	3	148
RLL	0.20	0.04	48.1	2.34	205	10.17	92	3	148
F prob	<.001		<.001	<.001	<.001	<.001	0.13	0.784	
LSD	0.51		0.74	0.15	52.91	5.09	ns	ns	
% CV	41.7		6.3	6.1	17.9	33.8	9.9	38.4	

+ Disease scores are on a 1 to 5 scale with a score of 1 for no incidence and 5 for heavy infestation..

Results and discussion

While all varieties were affected by brown spot to some extent, many of the top yielding ones showed a level of infestation similar to or lighter than the local checks. Despite some occurrence of brown spot, yields for most improved varieties were much higher than local checks.

Yield advantages were calculated using the predicted means from the ANOVA compared to the average yield of local varieties. The majority of the introduced varieties out yielded the local average, with the top three varieties yielding over five times that of the local average. Yield advantages for the 12 varieties yielding over 1 ton per hectare are presented in Table 66.

Table 66. Top yielding upland rice varieties, Darasula 2012.

Variety	*Yield (t/ha)*	*Yield advantage over average local yield (%)*
RO03	1.58	585
RO12	1.55	574
RO54	1.35	500
RO46	1.31	485
RO98	1.25	463
RO50	1.20	444
RO102	1.16	430
RO21	1.14	422
RO28	1.13	419
RO64	1.08	400
RO29	1.03	381
RO06	1.01	374

Conclusion

It is clear from the yield advantages of the improved varieties that there is great potential to improve the production of upland rice in Timor-Leste. Brown spot had the same or lower incidence among improved varieties as it did with local checks. Further testing at multiple sites should be conducted in the coming years to test the top yielding varieties in different upland rice growing areas of Timor.

2.4.3 Rice OFDTs 2011-2012

Rice On-Farm Demonstration Trials (OFDTs) were established in 5 districts and 8 sub-Districts of Timor-Leste in the 2011-12 wet season. The trial objective was to determine whether a promising new rice variety identified in replicated trials performed well on farmers' fields under farmers' agronomic conditions. The test line, Matatag 2 was compared with the released variety, Nakroma, and the farmers' local variety.

Materials and methods

Twenty nine OFDTs were sown in three of the six agro ecological zones (AEZs) in Timor-Leste. These included the Sub-Districts of Aileu, Balibo, Baucau, Liquica, Maliana, Vemasse, Venilale and Viqueque. The trials were monitored by eight researchers. Farmers received 5 kg bags of the released variety Nakroma and 300 g of Matatag. Farmers supplied their own seed to establish a plot of the local variety which was used as a check. Local checks included old Portuguese varieties (e.g. Nona Portu), Indonesian varieties (e.g. President, Membramo), and more recent releases from IRRI (e.g. IR64).

Seed was usually first planted in a nursery to grow healthy seedlings before they were transplanted to a paddy field. As in previous years, the actual area planted to each variety (plot size) varied according to each farmer's bunded paddy area. In most cases the test varieties and the local were grown side by side in one paddy. Where possible, a 5m x 5m area was used for each plot. However at some sites smaller sample sizes were taken. Much of the process establishing rice OFDTs was no different to that described in the maize chapter of this report.

Researchers visited the sites an average of 6 times between planting and harvest. At each visit they recorded different information about the OFDT. Data collection protocols monitored progress of the trial/demonstration. In-season measurements included plant condition, identification of pests and diseases, wilting and other plant symptoms.

After harvest, the wet threshed grain was weighed. A sample of grain was also weighed, then dried and weighed again. The ratio of dry grain to wet grain from this sample was used to convert the weight of the harvested plot into a dry weight equivalent. All of the weights quoted in the results and discussion section are for paddy rice (dry, threshed, un-milled weights).

Analyses

Data from the 29 harvested trials was first entered into a MS Excel spread sheet database before being transferred for further analysis in Genstat Discovery Edition 4. Rice yield data was analysed by ANOVA (Unbalanced Linear Model) with variety and AEZ as constant factors in the model once the other locational factors had been tested.

Analyses were conducted for those trials where yield data was recorded. This allowed test varieties to be compared to both released and local varieties in a much more balanced way.

The influence of a wide range of factors on rice yields was tested. In turn, each factor was added to the model, one at a time. If they were significant, the factor was kept in the model, and if they were non-significant the factor was discarded. Once a significant factor was identified, the interaction of that factor and variety was also tested for significance at the $P<0.05$ level.

Results

Rice OFDTs were conducted on a wide range of soil texture, pH, slope and elevation. Elevation of OFDT sites ranged from about sea level to almost 1,100 masl in Aileu Sub-District.

The average of soil pH across the OFDT test sites was 7.2, ranging from 6 to 8.5. A high proportion of sites was defined as neutral (pH 6-7)

Trial loses and seed restriction for planting

A total of 46 rice OFDTs were planted with 29 producing useable yield data.

Variety

The yield advantage of Matatag and Nakroma over the local was not significant overall despite the fact that the local appeared to yield lower (Table 67, Figure 21).

Table 67. Rice yields of OFDT Varieties 2011-2012

Variety	*Yield (t/ha)*
Local	2.10
Matatag 2	2.57
Nakroma	2.75
LSD=(P<0.05)	ns

Figure 21 demonstrates graphically the yield relationships between the local and two test varieties. The difference in scale of the axes in the graph with Nakroma and Matatag demonstrate a slight yield reduction in several sites, but some wide differences of yield above local at the same sites are also shown. This gives encouragement that a more comprehensive set of trials may show that Matatag will be competitive with the local variety.

A significant difference in rice yield between Sub-District was evident (F Pr. <.001). Most varieties yielded best in Venilale Sub-District and worst in Vemasse Sub-District (Table 68). In this table the yield figures come from greater number of trials that contained a test variety and therefore are a more reliable estimate of the Sub-District effect. There was no significant interaction between variety and Sub-District. The higher yield of the released variety is consistent across Sub-Districts except Vemasse. Matatag 2 produced good yield in Maliana Sub-District and worst in Vemasse Sub-District.

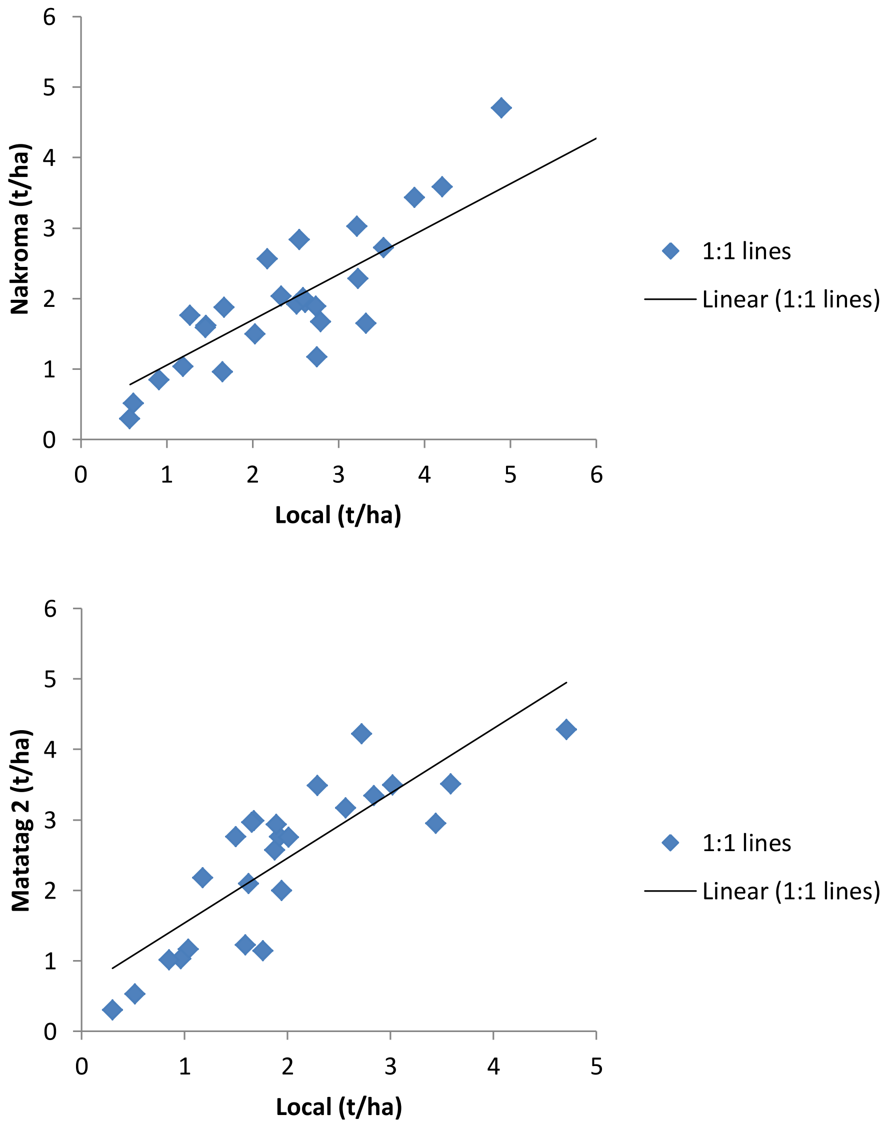


Figure 21. Comparison of 2 test rice varieties and local, 2011-2012

Table 68. Mean OFDT rice yields (t/ha), Sub-Districts, 2011-2012

District	*Sub-District*	*Sub-District mean yield(t/ha)*	*Yield of local(t/ha)*	*Yield of Matatag 2 (t/ha)*	*Yield of Nakroma(t/ha)*
Aileu	Aileu Villa	1.3	1.1	1.5	1.4
	Balibo	1.5	1.3	1.6	1.6
Bobonaro	Maliana	3.1	2.5	3.3	3.4
Liquisa	Liquica Villa	2.7	2.6	2.7	3.1
	Baucau Villa	2.4	1.9	2.8	2.5
	Vemasse	1.1	1.0	1.2	1.2
Baucau	Venilale	4.0	3.1	*	4.8
Viqueque	Viqueque Villa	2.7	2.0	3.1	2.9
	LSD=(P<0.05)	*1.340*			
	F.Pr	*0.002*			
	CV %	*54.17*			

Agro Ecological Zones (AEZ) and yield

Yield results for each variety in each AEZ where tested are presented in Table 69. There was a significant effect (F Pr. 0.025) of AEZ on rice yield at different locations. There was no interaction between variety and AEZ with either data set. Yields were found to be lower at higher elevation sites.

Table 69. Mean yields (t/ha) of rice OFDTs by AEZ, 2011-2012

AEZ	*AEZ mean yield (t/ha)*	*Yield of local (t/ha)*	*Yield of Matatag 2 (t/ha)*	*Yield of Nakroma (t/ha)*
3	2.5	2.2	2.6	2.8
4	0.9	0.8	0.6	1.5
5	2.7	2.1	3.1	2.9
LSD=(P<0.05)	1.88			
F.Pr	0.025			
CV (%)	53.5			

Agronomic factor affecting yield

The influence of a wide range of characters was tested for their effect on rice yield (Table 70). Half of the tested characters were found to have an influence on grain yield. These were Sub-District, AEZ, soil texture and elevation. No significant effect was measured for soil pH, soil colour, seedlings per hill of variety.

Table 70. Significance of Factors affecting rice yield, OFDTs 2011-2012

Factor	*Significance(p=0.05)*
Variety	x
AEZ	✓
Sub-District	✓
Elevation	✓
Seedlings per hill	x
pH	x
Soil texture	✓
Soil colour	x

Soil texture

Soil texture had a significant effect on rice yield across the test sites. Fine clay yielded the highest followed by sandy loam (Table 71). Those soils classified as clay loam and heavy clay was the lowest yielding. No interaction of soil texture and variety was evident.

Table 71. Effect of soil texture of rice yield 2011-2012

Soil Texture	*% of OFDTs harvested*	*Yield (t/ha)*
Clay loam	4	0.9
Fine clay	24	3.2
Heavy clay	4	0.6
Sandy loam	58	2.5
Silty loam	10	2.0
LSD=(P<0.05)	*1.4*	

Conclusion

The released variety Nakroma continued to perform well under all conditions as did the new test variety, Matatag 2. Further research across a larger number of sites is required to evaluate the performance of Matatag 2 further.

2.5 Peanuts

2.5.1 Replicated trials, 2011-2012

Peanut (*Arachis hypogaea* L.) lines tested by SoL were sourced from ICRISAT in India. These were selected by ICRISAT breeders for their adaptation to conditions similar to those found in Timor. Most of those included in the replicated trials were imported in late 2009. The first replicated trials on these varieties were conducted in 2010-2011. 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.

During the 2011-2012 cropping season, four peanut replicated trials were conducted at Aileu, Baucau, Betano, and Loes. Baucau and Aileu did not however produce a viable harvest. Characteristics of the varieties used in the trials are as presented in Table 72. Local checks were similar to the previous years' trials.

Table 72. Variety details, replicated peanut trials, 2011-2012

SoL Code	*Name*	*Botanical type*	*Seed skin colour*
Utamua (PT 05)	ICGV 88438	Spanish bunch	Brown
PT 21	*Local Mean*	*Timorese local*	*Red*
PT 22	*Local Boot*	*Timorese local*	*Brown*
PT 14 *	ICGV 96165	Virginia	Red
PT 20 **	ICGV 99017	Spanish bunch	Brown
PT 124*	ICGV 97120	Spanish bunch	Red
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

Methodology

Yields, yield advantages and yield components

Trials were successfully held in Betano and Loes during the wet season of 2011-2012. A total of 10 new varieties were tested in each trial together with the recommended Utamua variety (PT 05), PT 14, PT 20 and two local varieties which acted as checks.

All sites contained three replicates of 25 m^2. Complete randomized blocks were used. Planting hills (one seed per hill) were spaced at 40 cm x 20 cm corresponding to maximum plant densities of 11 - 12 plants/m². Neither fertilizer nor irrigation was applied. Trials were planted between October and December 2011 and harvested from March to May 2012 (Table 73).

Table 73. Planting and harvest details of peanut varietal trials, 2011-2012

Location	*Number of entries*	*Number of replicates*	*Planting date*	*Harvest date*	*Mean yield (t/ha)*
Manufahi (Betano)	15	3	15/12/2011	03/05/2012	0.77
Liquica (Loes)	15	3	11/10/2011	Mar/Apr 2012	1.82

A number of parameters were recorded during plant growth, starting with emergence rates. Flowering as well as the impact of diseases was monitored.

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. The yield components pod and seed dry weight, number of seeds per pod 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.

Data at each site were analysed separately using GenStat Edition 15 where analysis of variance or REML analysis was used in order to determine varietal effects. The analysis performed depended on the presence of row and/or column effects on yield (Table 74).

Table 74. Statistical tests used in the analysis of the 2011-2012 peanut varietal trials

Station	*Row/Col effects*	*Test*	*Type*
Betano	No	ANOVA	One-way in Randomized blocks
Loes	Column	REML	AR1 Random on Row

Yield advantages were calculated from the resulting predicted means over the average of the local varieties. The existence and degree of correlation between the predicted means of the yields and of the other parameters were then examined using a Simple Linear Regression. As yield ranges differed greatly from one trial to another, individual regressions were run (as opposed to running one regression over all data sets) in order to determine whether correlations were significant. The percentage of variability accounted for is equivalent to an adjusted R^2.

Results

Yields and yield advantages

Table 75 presents the dry pod yields at each site for all tested varieties, as well as the overall yield advantages over the local checks.

Variation among sites was very noticeable with Betano station yielding poorly. Utamua performed particularly poorly this year at Betano. This could have been influenced by reasonably good rainfall immediately before and after planting but having no rainfall in the second week after planting. Establishment rates were also much lower in Betano with the majority of plots having less than 2 plants/m².

The top yielding varieties were PT 137 and PT 131 with average yields of 1.75 and 1.66 t/ha, which corresponds to yield advantages of 90% and 80% respectively above locals. Ranking between the two sites was however very different with PT 137 being contained within the bottom half of variety yields in Betano.

Table 75. Peanut yields and yield advantages, 2011-2012

Variety	*Yields (t/ha)*		*Averages*			*Yield advantages (%) within site*	
	Betano	*Loes*	*St. dev.*	*Yield (t/ha)*	*Yield adv. (%)*	*Betano*	*Loes*
PT 137	0.88	2.6	0.87	1.75	90	143	78
PT 131	1.20	2.1	0.46	1.66	80	229	43
PT 136	0.98	2.3	0.65	1.63	77	168	54
PT 141	1.29	1.9	0.28	1.58	71	255	26
PT 138	0.91	2.2	0.64	1.56	69	151	49
PT 133	1.19	1.8	0.31	1.50	63	228	23
PT 142	0.39	2.5	1.06	1.44	57	6	69
PT 14	1.16	1.7	0.28	1.44	56	219	16
PT 21	0.32	2.1	0.90	1.22			
PT 20	1.10	1.3	0.10	1.20	30	201	-12
Utamua (PT 05)	0.33	2.0	0.83	1.17	27	-9	35
PT 132	0.61	1.6	0.52	1.12	22	67	11
PT 124	0.29	1.4	0.57	0.86	-6	-21	-3
PT 134	0.54	0.9	0.21	0.74	-19	47	-36
PT 22	0.41	0.8	0.21	0.62			
F Prob.	*<0.001*	*0.035*					
LSD	*0.14*	*0.99*					
%CV / F Stat	*10.6*	*2.35*					
Mean site	0.77	1.82	0.53	1.30			
Mean locals	*0.36*	*1.48*	0.56	0.92			

Yield components and other parameters

The predicted means for the yield components and other parameters associated with the yield are detailed in Table 76.

Most yield and yield components had significant varietal differences within station. Interestingly the significant differences were much stronger in Loes where the overall yield was only marginally significant. It is not surprising that Betano did not reach significance for a number of components given the low overall yield observed there. Vast differences can be observed between plant densities at the different sites. Utamua again was highlighted by its large pod and seed weights. Conversely its shelling percentage was among the lowest.

Little correlation was found between the yield components and overall yield at both research stations. It was only in relation to plant density when investigated using linear regressions that any kind of trend was recognized. Here the percentage of variability accounted for (adjusted R^2) was still a modest 36% for Betano and 19% for Loes (Figure 22).

Table 76. Peanut yields and yield components, replicated trials 2011/12

Variety	*Dry pod yield (t/ha)*	*Plants/m² at harvest*	*Weight of 100 pods (g)*	*Pods / plant*	*Seeds / pod*	*Weight of 100 seeds (g)*	*Shell (% dry weight)*
				Betano			
PT 137	0.9	1.6	153	20.3	1.88	106	69
PT 131	1.2	1.8	120	6.7	1.94	87	73
PT 136	1.0	1.2	145	22.9	1.80	102	70
PT 141	1.3	1.4	111	10.9	1.80	83	75
PT 138	0.9	1.9	133	10.7	1.78	94	71
PT 133	1.2	1.8	157	14.5	1.90	117	75
PT 142	0.4	1.0	131	10.8	1.83	90	69
PT 14	1.2	1.5	139	14.3	1.76	101	73
PT 21	0.3	1.1	137	12.3	1.91	94	68
PT 20	1.1	1.9	143	7.3	1.60	106	75
PT 05	0.3	1.1	164	8.3	1.70	119	74
PT 132	0.6	1.5	147	6.6	1.77	109	74
PT 124	0.3	0.7	130	15.8	1.88	94	73
PT 134	0.5	1.5	134	10.9	1.81	100	75
PT 22	0.4	1.8	127	8.3	1.71	92	72
Mean site	0.8	1.5	138	12.0	1.81	100	72
F Prob	*<0.001*	*0.027*	*0.046*	*<0.001*	*n.s.*	*0.012*	*n.s.*
LSD (p≤0.05)	*0.14*	*0.7*	*28*	*6*	*0.2*	*18*	*7*
%CV	*11*	*28*	*12*	*28*	*8*	*11*	*6*
				Loes			
PT 137	2.6	4.2	132		1.86	95	71
PT 131	2.1	5.4	111		1.86	82	74
PT 136	2.3	5.7	146		1.46	105	72
PT 141	1.9	6.2	131		1.97	99	76
PT 138	2.2	5.3	124		1.34	95	75
PT 133	1.8	4.6	150		1.82	119	79
PT 142	2.5	8.5	131		1.22	94	72
PT 14	1.7	5.5	137		1.73	99	72
PT 21	2.1	3.4	158		2.33	107	69
PT 20	1.3	4.3	128		1.37	90	70
PT 05	2.0	6.0	160		1.52	111	69
PT 132	1.6	6.7	138		1.11	107	76
PT 124	1.4	4.3	131		1.74	95	73
PT 134	0.9	5.0	154		1.89	114	75
PT 22	0.8	2.7	150		1.81	103	69
Mean site	1.82	5.19	139		1.67	101	73
F Prob	*0.035*	*0.002*	*<0.001*		*<0.001*	*<0.001*	*<0.001*
LSD (p≤0.05)	*1.0*	*0.9*	*4.3*		*0.1*	*3.0*	*1.2*
F Statistic	*2.4*	*4.5*	*7.1*		*4.6*	*5.2*	*8.8*

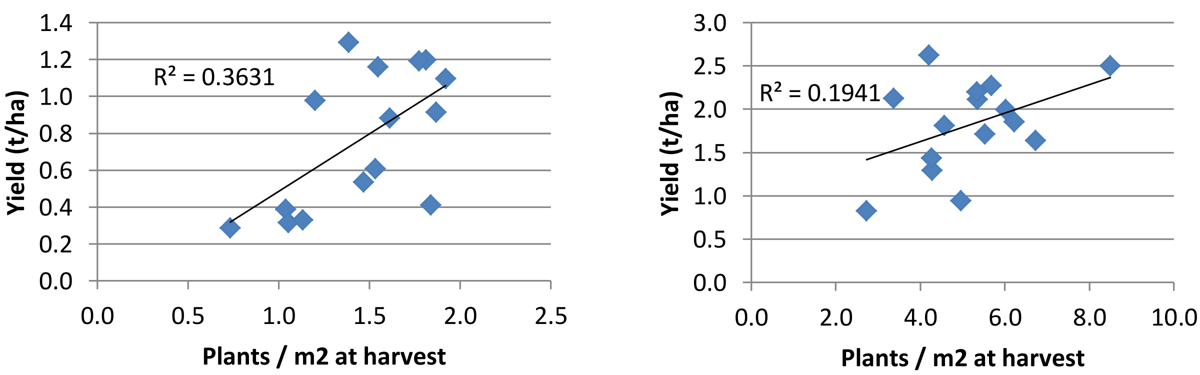


Figure 22. Yield and plant density correlation at Betano (left) and Loes (right)

Conclusions

With two of the four research stations not producing a viable harvest and a third producing a very low overall yield it was difficult to have a lot of confidence in the varietal differences observed. There was also an absence of strong correlations between yield and yield components.

The poor results for Utamua are disappointing and raise questions about its ability to thrive in low rainfall environments, particularly around planting. However it is now a widely accepted variety throughout the country with farmers expressing high approval and preference to use Utamua ahead of local varieties. It is important to keep reinforcing the importance of soaking the seed before planting to assist in achieving a good establishment.

Given the limited useability of the yield data recorded during this year further replicated trials will need to be conducted in the following years to try to conform the yield potential of the new varieties at various sites and agro ecological zones within Timor Leste.

2.5.2 Replicated trials, multi-year, multi-location analysis

Materials and methods

Six successful peanut trials were implemented over the period from 2010-2011 to 2011-2012 (2 years) at 4 different sites (Aileu, Baucau, Betano and Loes), testing the performances of 15 varieties.

Cross-site analyses were conducted using BiPlots (GenStat Edition 15) 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 1.81 t/ha (Baucau 2011 and Loes 2012 respectively) with only two sites yielding over 1 t/ha (Table 77).

This dataset included 88 data points (location and season × variety combinations). The same fifteen entries were used in each of the six trials. 79% of variability within this data was accounted for in the BiPlot. A BiPlot visualising how varieties performed by environment (year/season and location) is represented by (Figure 23). Data on this Biplot is partitioned by quadrant.

Utamua remains amongst the top yielding varieties when averaged over both years. It was however also amongst the most variable in this dataset. PT 131 and PT 142 yielded best over the six trials.

In terms of the BiPlot produced, this demonstrates graphically the big yields achievable in Loes compared with the other research stations. There was no variety that decisively outperformed the others at Loes in 2012 but PT 142 had a clear advantage in 2011 followed by Utamua. PT 137 performed best in Betano.

Conclusions

Some poor results in 2011 and the failure of half the trials in 2012 prevented the identification of a variety from the new set of entries to move forward to on farm testing. It is hoped that better growing conditions in the coming years may afford the opportunity to identify one or two high yielding varieties from this set that consistently outperform Utamua and provide an alternative to that variety as recommended for widespread dissemination to Timorese farmers.

Table 77. Variety yields across research stations in 2011 and 2012

	AIL 11	*BAU 11*	*BET 11*	*LOE 11*	*BET 12*	*LOE 12*	*Mean Yield (t/ha)*	*St. dev*	*Yield adv.*
Utamua	0.68	0.33	1.17	2.31	0.33	2	1.1	0.78	95
PT 14	0.38	0.23	1.23	0.95	1.16	1.7	0.9	0.50	62
PT 20	0.39	0.08	1.35	0.65	1.1	1.3	0.8	0.47	40
PT 21	0.17		0.45	0.72	0.32	2.1	0.8	0.70	
PT 22	0.01	0.09	0.69	0.48	0.41	0.8	0.4	0.29	
PT 124	0.45	0.13	0.72	1.45	0.29	1.4	0.7	0.52	27
PT 131	0.51	0.16	0.86	2.09	1.2	2.1	1.2	0.74	98
PT 132	0.76	0.10	0.72	1.30	0.61	1.6	0.8	0.48	46
PT 133	0.28	0.11	0.87	1.48	1.19	1.8	1.0	0.61	64
PT 134	0.39	0.07	0.78	1.30	0.54	0.9	0.7	0.39	14
PT 136	0.28		1.04	0.70	0.98	2.3	1.1	0.68	82
PT 137	0.79	0.11	1.04	0.77	0.88	2.6	1.0	0.76	78
PT 138	0.94	0.34	0.49	1.77	0.91	2.2	1.1	0.67	90
PT 141	0.44	0.07	0.56	1.78	1.29	1.9	1.0	0.69	73
PT 142	0.49	0.42	0.34	2.97	0.39	2.5	1.2	1.11	104
Local av.	0.09	0.09	0.57	0.60	0.37	1.45	0.58		
Average	0.46	0.17	0.82	1.38	0.77	1.81	0.92	0.63	

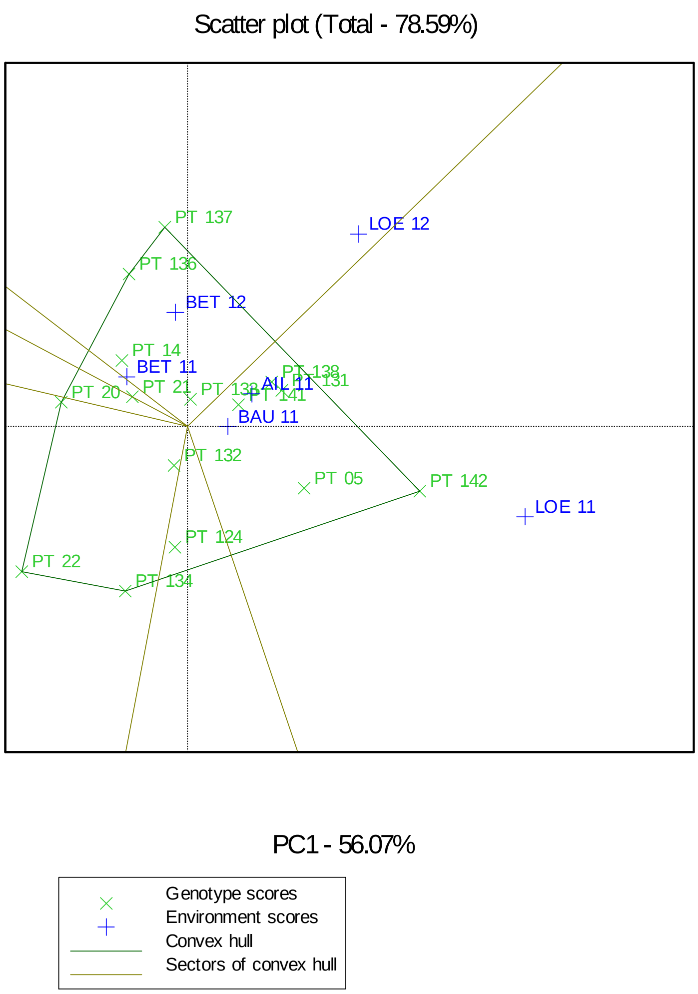


Figure 23. Biplot analysis (15 peanut varieties in 6 environments, 2011 & 2012)

2.6 Temperate cereals

2.6.1 Wheat and barley replicated trials, 2012

Both wheat (*Tritium aestivum* L.) and barley (*Hordeum vulgare* L.) are grown in the higher altitudes of Timor-Leste. One World Food Program report (2006) indicates that approximately 5% of total calorie intake in the country is derived from these crops. Although not a staple for a majority of farmers in Timor-Leste, it is a very important source of energy for rural inhabitants in steep high altitude areas where rice is not grown and maize yields are low. The grain of both crops can be stored for long periods and are easy to prepare for cooking. Grain is pounded to grits and boiled into a porridge to be eaten with vegetables and beans.

Replicated trials of both crops were installed at Fatulia in the Sub-District of Venelale in the District of Baucau and at Urulefa Research station, Maubisse. Unfortunately the trials at Urulefa become waterlogged after heavy rains and are not reported here.

The trial at Fatulia was installed at an altitude of 895 masl which is quite low compared to farmers' fields in Maubisse where wheat and barley are commonly grown. However fields of these cereals are found at similar altitudes in the vicinity of Venilale and nearby farmers considered this site to be suitable for the trial.

The soils were slightly alkaline at a pH of 8. Eight, one metre long rows were sown with two seeds per hill spaced at 10 cm between hills (1 m^2 per plot). Wheat was planted on 05 April 2012 and harvested between 05 July and 29 July 2012. The barley was sown on 06 April 2012 and harvested 16-29 July 2012. The trials consisted of 3 replicates in a randomized complete block design. The trials were neither fertilized nor irrigated as per the farmers' practices.

Results

Wheat

Grain yields averaged just under 0.7 t/ha across all plots (Table 78).

Table 78. Wheat yields and yield components, Fatululia, Venilale, 2012

Variety	*Yield (t/ha)*	*% germination at 2 weeks*	*Plant pop. (/plot)*	*Plant height (cm)*	*Head length (cm)*	*Grains/head*	*100 grain weight (g)*
Attila	0.34	66	52	59	9.7	52.3	4.1
Braham	0.39	92	52	65	8.8	43.2	4.0
Chara	0.69	93	64	61	7.1	32.8	4.0
Correl	0.74	73	61	54	7.3	47.2	4.2
Derrimut	0.40	80	59	57	6.4	43.5	4.2
Gladius	0.42	85	53	55	7.0	40.8	3.7
Kennedy	0.33	69	52	54	8.5	55.7	4.4
Local tiboa	*1.31*	*92*	*64*	*106*	*11.7*	*42.9*	*3.8*
PRL/2*Pastor	1.38	80	64	68	9.6	54.8	3.8
Rees	1.34	97	64	56	7.9	49.9	4.5
SB 196 W	0.59	69	57	66	11.0	60.3	4.0
SERI BABAX 020	1.35	88	63	67	9.4	57.5	3.8
SERI BABAX 025	0.43	96	53	54	16.0	47.8	3.7
Wee Bill 1	0.91	95	62	62	10.6	60.7	3.6
Yitpi	0.42	95	63	57	8.9	50.5	4.1
Young	0.72	76	62	55	6.9	39.3	4.2
Zebu	0.42	79	56	57	8.5	53	3.9
ZWC 04-37 IBWSN	0.29	82	56	62	8.2	51.8	4.6
Mean	*0.69*	*84*	*59*	*62*	*9.1*	*49.11*	*4.0*
Fprob	<.001	0.7	0.11	<.001	0.16	0.003	0.10
LSD	0.51	33.7	10.83	2.5	5.4	12.5	0.62
CV%	44.5	24.3	11.10	2.5	35.7	15.4	9.3

This yield is low compared with those from other wheat trial sites in earlier years (SoL, 2011). Plant heights were also greater. This would have been due to the different growing conditions at each site. Mean grain yields for 2009, 2010 and 2011 indicated that Yipti, Gladius, H46, Chara, Young, Correl and Braham were fairly consistent yielding varieties compared with the Local Tiboa. This was not the case in 2012 where the local yielded almost as much as PRL/2*Pastor and Rees. Yipti was late flowering and will not be included in future trials.

Barley

Germination in the barley trial was equal to that found in the wheat trial at the same location (Table 79). However, the plants were affected by drought and did not yield well. All entries outyielded the local which is different from past years (Sol, 2011). This trial will be repeated in 2013.

Table 79. Barley yields and yield components, Fatululia, Venilale, 2012

Variety	*Yield (t/ha)*	*% germination at 2 weeks*	*Hills/plot*	*Plant height (cm)*	*Head length (cm)*	*Grain/head*	*100 grain weight (g)*
2ND 25316	0.4	94	45	47	8.4	19.5	4.8
Fitzroy	0.4	94	54	45	7.4	18.7	4.2
Loc. Aisnata	*0.1*	*31*	*38*	*67*	*8.6*	*22.8*	*4.4*
Nakbatles	0.4	68	48	50	8.5	24.5	4.2
ND 23074	0.6	94	55	48	7.1	21.4	5.2
NRB 08304	0.5	94	62	47	8.2	24.1	5.0
NRB 08630	0.6	73	62	54	7.7	22.2	4.8
NRB 090033	0.4	97	61	48	6.8	17.2	4.6
NRB 090542	1.0	99	54	60	8.9	22.2	6.7
NRB 090861	0.5	98	55	51	8.2	24.9	4.7
Shepherd	0.6	97	55	46	7.1	19.1	5.2
Mean	*0.50*	*85.3*	*53.5*	*51.2*	*7.9*	*21.5*	*4.9*
Fprob	*0.07*	*0.05*	*0.133*	*<.001*	*0.10*	*0.009*	*<.001*
LSD	*0.45*	*40.6*	*16.48*	*2.341*	*1.47*	*4.073*	*0.7712*
CV%	*52.5*	*27.9*	*18.1*	*2.7*	*10.9*	*11.1*	*9.3*

2.7 Winged beans

2.7.1 Winged bean replicated trial, Loes 2011-2012

Winged beans (*Psophocarpus tetragonolobus* (L.) DC) are currently grown on a few farms in the Eastern Districts of Timor-Leste. However, they are extensively cultivated in other parts of Southeast Asia, the South Pacific and Africa as a source of nutritious food. This legume is known for its high protein content. All parts of the plant are edible including the young pods, leaves, young stems and tubers. In some countries, dry seeds are also pounded and eaten. There is considerable potential to improve food security in all parts of Timor-Leste if suitable high yielding varieties are made available to farmers. In the East of the country, winged beans are known as Duhaen, Wewe, Lari Lari or Duae.

Twelve improved winged bean varieties sourced from the Australian Tropical Crop and Forages Collection (ATCFC) were sown into observational plots in the Districts of Aileu, (sub-District of Aileu), Liquica (Loes research station), Maubisse (Maubisse Sub District) and Dili (Comoro) during the wet season of 2010-2011. The seed originating from Indonesia, Nigeria, Papua New Guinea, and Thailand were assigned names of D = Duhaen (Tetun for winged bean) and Indo for Indonesia, N = Nigeria, PNG (Papua New Guinea) and T (Thailand). These varieties were compared with two local varieties – one from Luro in Los Palos District and Laga in Baucau. Little seed was available for planting and no plants germinated in Betano, there was no seed set at 1650 masl in Maubisse and negligible seed was harvested from Dili. Only eight of the fourteen varieties evaluated at Loes in 2010-2011 yielding sufficient seed to be evaluated in replicated trials during 2011-2012. The results of this observational trial were reported in the SoL Annual Research Report for 2011.

Six improved varieties were compared with two local varieties (D Luro and D Venilale) at Loes Research Station during the wet season of 2011-2012. Of the six, one was from Indonesia (D Indo), one from Nigeria (D N 6), three from PNG (DPNG 10, 13, 31) and one from Thailand (D T 4) (Table 80). Unfortunately, the site suffered flooding during the wet season, resulting in poor plant populations and poor yields. However, it was possible to harvest sufficient pods to compare pod and seed size as presented in Table 80. Grain yield was closely related to the number of harvested pods per plot and plant populations.

Seed from this trial will be used for further evaluation during 2012-2013.

Table 80. Winged bean yield and yield components, Loes, 2011-2012

Variety	*Grain yield (t/ha)*	*Plant pop'n (/m^2)*	*Seeds / pod*	*Pod weight (g)*	*Seed weight (g)*
D Indo	0.68	0.7	13.3	5.4	0.25
D Luro	0.47	0.5	11.0	3.8	0.19
D N 6	1.09	1.1	12.3	7.1	0.29
D PNG 10	0.29	0.3	13.7	8.9	0.28
D PNG 13	0.80	0.8	14.7	7.9	0.31
D PNG 31	0.22	0.2	9.7	7.1	0.31
D T 4	1.09	1.1	11.7	5.2	0.35
D Venilale	0.05	0.1	10.0	3.9	0.32
Mean	0.58	0.6	12.0	6.2	0.29
F pr.	*0.05*	*0.05*	*0.10*	*0.04*	*0.06*
LSD (P<0.05).	*0.70*	*0.07*	*3.62*	*3.28*	*0.09*
CV %	*68.7*	*68.7*	*17.2*	*30.3*	*18.9*

2.8 Mungbean and black gram

Mung beans (*Vigna radiata*) (L.) Wilczek and Black gram (*Vigna mungo*) (L.) Hepper are a healthy addition to any diet. With a high concentration of protein (23%) and significant levels of other nutrients (particularly vitamins C, B1 and B2), mung beans can significantly improve the quality of the Timorese maize-rice based diet. Its abilities as a legume to fix atmospheric nitrogen are also valuable in a context where chemical fertilizers are not available to small-scale subsistence farmers.

Mung bean is thought to have originated in Mongolia where *Vigna radiata* subspecies *sublobata*) occurs wild. It 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). It is a highly prized short duration crop which, in the Indian sub-continent can be grown between rice and wheat crops or as a relay crop. The crop fits into post wet season harvest cropping systems in Timor-Leste or can be intercropped with maize. The plant prefers more fertile soils with near neutral pH and, in Timor-Leste is usually grown at altitudes of less than 700 metres above sea level (MAF, 2008). Mung beans can be boiled and eaten as a soup, ground and eaten as a paste, processed into noodles or even used as animal feed. In Timor-Leste the grain is most often boiled for consumption as a porridge or exported to Indonesia. There is a large unmet demand for mung bean in East Timor. Varieties with a dull seed coat are preferred.

Black gram originates from India where it is termed Urd. According to IFPRI (http://www.advanceagriculturalpractice.in/w/index.php/Blackgram), "the cultivation of this crop has been confined to Asian countries since the climatic conditions and the soil type of these countries suit the conditions required by this crop for survival. India is the leading producer of black gram or urd but other significant producers include Myanmar and Thailand. It is basically a warm weather crop and can be cultivated in areas receiving an annual rainfall of 600 to1000 mm. It can be cultivated from the sea level up to an altitude of 1800 masl. The optimum temperature requirement for the crop is 28-32°C. If the temperature is lower than 10°C germination does not occur. The black gram is a short-day plant and most of its cultivars flower in 12 to 13 hours of photo-period. Flowering gets delayed with an extended photo-period. As the altitude increases, flowering is delayed due to less ambient temperature".

Taxonomic classification of mung bean and black gram was often confused for many years because of their phenotypic similarity but they have been recognized as being different species since 1978. Because their physical characteristics and uses are similar, one local black gram was included in the trials described below and from henceforth the trials will be termed mung bean trials.

Materials and methods

Twelve mung bean varieties were evaluated from 2008 through to 2012. Three varieties were sourced from Indonesia (ILETRI), four were considered to be locals having been cultivated in Timor-Leste for a number of years (one was a black gram variety) and five were sourced from the Queensland Department of Primary Industries in Australia (Table 81). Data for the 2008 and 2009 testing have been reported previously (SoL, 2009).

Table 81. Mung bean population details, 2008-2012 in trials at Betano and Loes.

Population	*Origin*	*Seed size**	*Seed colour*	*Seed testa type*	*Other characteristics**
Celera	Australia	Small	Green	Bright	Good resistance to cracking and weather damage. Prone to lodging
Delta	Australia	Large	Green	Bright	Low resistance to powdery mildew. Prone to shattering
Diamond	Australia	Small	Green		Tolerant to tan spot. Tolerant to dry conditions
Metan	Timor-Leste		Black		
Satin	Australia		Green	Dull	
Sarity	Indonesia		Green		
Murai	Indonesia		Green		
Merpati	Indonesia		Green		
Besicama	Timor		Green		
Berken	Australia	Medium-large	Green	Bright	Prone to powdery mildew and tan spot
Balibo	Timor-Leste		Green		
Suai	Timor***		Green		

* Small: <4g/100 seeds; Medium:5g/100 seeds; Large:>6g/100 seeds

** Source: *Queensland Primary Industries and Fisheries - www.dpi.qld.gov.au*

**** Sourced from Vietnamese Jesuit priest in Suai. Probably an introduction from Vietnam.*

All trials were installed as a randomized complete block with plot sizes of 5.5m x 2.5m. with planting distance 25x15 cm. Mung beans usually take up to 40 days before flowering and another 30 days on average before producing seeds. However, the Australian varieties matured quicker. The trials were planted in May or June depending on availability of a planting rain. Each variety was hand harvested as the pods were dry, and often there were three times of harvest. Apart from yield, the yield components of plant density, pod length, seeds per pod, seed weight, pods per plant, maturation period and plant height were measured. There were 12 entries in each trial and the trial design was a randomized complete block design with three replicates. The planting and harvest dates of the trials installed at Betano and Loes between 2010 and 2012 are presented in Table 82.

Table 82. Planting and harvest details of mung bean varietal trials, 2010-2012

Location	*Number of entries*	*Number of replicates*	*Planting date*	*Harvest date*	*Mean yield (t/ha)*	*In-season rain (mm)*
Betano 2010	12	3	21/5/2010	31/7/2010	0.7	171
Betano 2011	12	3	15/6/2011	25/8/2011	1.4	126
Betano 2012	12	3	4/6/2012	20/8/2012	1.2	117
Loes 2010	12	3	19/5/2010	2/8/2010	1.1	0*

* Beans were planted after 47 mm of rainfall event, then no rainfall till harvest

A number of parameters were recorded during plant growth, starting with emergence and ended with harvest. The method of harvest allowed for the calculation of yield components. Grain yield was collected from the whole plot, and the number of plants in each plot at harvest were used to calculate plant density. Plant height was measured on 10 random plants, and the pods from these were used to measure pod length and seeds per pod.

After the harvest of the 2012 trial, a taste test was conducted with 38 local farmers (28 Male, 10 Female). Each of the 12 varieties were cooked and the farmers tasted the boiled product. Codes were given to the varieties so that the testers would not know the identity of the variety they were tasting. Farmers were shown the raw seed of each variety, the yield comparison and the cooked product, that they used for tasting. For each variety farmers were asked to describe the taste as sweet (yes/no), fragrant (yes/no), sticky (yes/no) and tasty (yes/no). At the end of the tasting they were asked to choose which variety they would like to plant. Each farmer was given the opportunity to choose two varieties.

Results

There were a range of yields between the sites, and significant variation was observed between varieties within each experiment.

Agronomic trials

Betano 2010

Mung bean yields in Betano 2010 were very low due to very low plant stand. The Indonesian variety Merpati was the highest yielding variety, and was higher than any of the three local check varieties (Table 83).

Table 83. Mung bean replicated trial, 2010, Betano.

Variety	*Yield*	*Plant density at harvest /m²*	*Pod length (cm)*	*Seeds per pod*	*Seed size (g/100)*	*Pods per plant*	*Plant height*	*Days to flower*
Local Balibo	*0.58*	*6.0*	*10.0*	*10.5*	*68.3*	*17.0*	*113*	*52*
Local Besicama	*0.48*	*2.0*	*11.0*	*10.3*	*65.3*	*38.7*	*105*	*52*
Diamond	0.83	5.0	8.6	9.9	45.0	40.3	48	29
Satin	0.68	8.2	9.7	8.4	61.0	18.9	74	52
Berken	0.55	7.2	9.5	9.9	62.3	12.2	67	35
Delta	0.81	5.5	9.0	10.0	66.3	33.6	74	36
Celera	0.53	4.2	8.8	10.9	33.3	33.6	53	36
Local black	0.70	7.3	10.0	9.9	52.3	20.4	132	52
Merpati	1.15	7.0	9.5	9.6	57.7	36.5	81	36
Murai	0.59	4.6	11.5	9.5	52.3	31.0	82	42
Sarity	0.64	7.2	10.7	9.0	52.0	29.7	85	36
Local Suai	0.55	6.1	9.9	11.5	69.3	13.0	144	52
F pr.	*0.005*	*0.52*	*0.07*	*0.721*	*<.001*	*0.271*	*0.52*	
LSD	*0.2819*	*ns*	*ns*	*ns*	*7.123*	*ns*	*ns*	
CV%	*24.7*	*52.4*	*10.7*	*17.1*	*7.4*		*52.4*	

Grain yield was not significantly correlated with any of the yield components, although grain tended to increase with increased plant numbers and more pods per plant.

Betano 2011

The 2011 trial in Betano had very low level of in-season rainfall, but was planted after receiving 55 mm of rainfall over a 2 day period. This residual soil moisture was significant enough for the test entries to yield as much as 2.2 t/ha (Table 84). Yields tended to be correlated with plant density which was very high compared with the 2010 trial. Pod length was also longer in 2011 compared with 2010.

Table 84. Mung bean replicated trial, 2011, Betano.

Variety	*Yield*	*Plant density (/m²)*	*Pod length (cm)*	*Seeds per pod*	*Seed size (g/100)*	*Pods per plant*	*Plant height (cm)*
Local Balibo	*0.7*	*18*	*10.4*	*10.9*	*72*	*4.8*	*76*
Local Besicama	*0.8*	*7*	*9.9*	*12.6*	*70*	*12.8*	*71*
Diamond	0.5	7	8.8	11.8	43	12.7	54
Satin	1.9	18	9.5	11.9	60	15.5	61
Berken	2.1	20	9.7	12.1	44	19.5	59
Delta	1.4	22	9.4	11.1	61	9.4	61
Celera	1.7	20	7.5	11.9	36	20.3	63
Local black	1.2	19	9.8	11.3	57	10.4	64
Merpati	2.2	22	8.8	12.1	57	14.9	62
Murai	1.7	24	9.2	11.5	62	10.5	73
Sarity	0.8	21	9.2	12.5	62	4.9	60
Local Suai	*1.8*	*8*	*7.2*	*11.1*	*36*	*59.6*	*55*
P value	<.001	<.001	0.006	0.766	<.001	10.32	0.21
LSD	0.47	3.9	1.44	ns	11.0	37.4	ns
%CV	19.8	13.4	9.4	10.2	11.9	4.8	15.4

Betano 2012

At Betano in 2012, all introduced lines were faster to flower and quicker to harvest than the local checks (Table 85). Grain yields were good for all varieties especially for the Indonesian released Merpati variety and the Australian entry, Delta. Plant density was much higher at Betano during 2012 compared with 2010 and 2011 and the pod length, seed size were similar.

Table 85. Mung bean replicated trial, 2012, Betano.

Variety	*Yield*	*Plant density at harvest /m²*	*Pod length (cm)*	*Seeds per pod*	*Seed size (g/100)*	*Pods per plant*	*Plant height (cm)*	*Days to flower*
Local Balibo	*1.2*	*26*	*9.0*	*10.6*	*66*	*7.7*	*76*	*59*
Local Besicama	*1.1*	*25*	*10.3*	*10.1*	*53*	*8.4*	*67*	*50*
Diamond	1.0	26	9.6	11.0	61	6.4	58	35
Satin	1.2	25	8.7	13	62	6.4	69	35
Berken	1.3	25	9.5	12.3	55	8.1	52	35
Delta	1.7	25	8.9	11.2	63	10.2	61	35
Celera	1.3	25	7.3	10.6	49	12.3	65	35
Local black	0.9	24	10.3	11.5	47	7.1	72	58
Merpati	1.3	25	9.7	10.6	66	8.2	63	35
Murai	1.1	26	9.6	11.3	56	7.4	67	35
Sarity	0.8	25	9.6	10.9	69	4.8	70	35
Local Suai	*1.1*	*25*	*6.6*	*10.6*	*54*	*8.5*	*67*	*35*
P value	0.002	0.952	<.001	0.006	0.579	0.009	0.074	
LSD	0.32	ns	0.98	1.25	ns	3.13	ns	
%CV	16.3	6.7	6.3	6.6	22	23.2	11.8	

Taste test

Thirty eight local farmers (10 females) who evaluated each of the test varieties at Betano during the dry season of 2012 were given the opportunity to appreciate the appearance, were advised of the yield during 2012 and were allowed to taste the cooked product. Based these evaluations (Table 86), preferences were made for some varieties over others. The Australian variety and the local black seeded (black gram) variety were the most preferred of the 12 tested varieties. Delta was chosen due to the sweeter taste being judged sweeter than the other varieties. The local black seeded variety was also highly preferred, but it is not clear the reason why. There were significant differences between varieties for sweetness and over all appeal, but not for tastiness, fragrance or hardness when cooked (Table 86).

Table 86. Farmer appreciation (%) of mung bean, Betano, dry season, 2012

Variety	*Hard when cooked*	*Tasty*	*Sweet*	*Fragrant*	*Like overall*	*Choose*
Delta	18	61	74	58	61	29
Local black	*29*	*55*	*42*	*47*	*47*	*26*
Celera	18	63	66	55	61	21
Local Suai	*11*	*66*	*63*	*66*	*66*	*21*
Local Besicama	*24*	*66*	*55*	*68*	*66*	*18*
Satin	18	68	71	76	68	18
Merpati	21	66	68	66	66	13
Sarity	26	50	37	61	42	13
Balibo	21	61	50	61	63	11
Berken	26	55	61	68	47	11
Murai	21	53	37	50	42	8
Diamond	29	39	47	50	34	5
LSD ($p<0.005$)	ns	ns	22	ns	22	

Combined analysis

The yield of each of the 12 varieties tested across 6 experiments are shown in Table 87. An Indonesian released variety Merpati produced the highest yield, followed by an Australian variety Delta (Table 87).

Table 87. Yield (t/ha) of 12 mung bean varieties grown in 6 experiments from 2008 to 2012.

Variety	*Betano 2012*	*Betano 2011*	*Betano 2010*	*Betano 2009*	*Betano 2008*	*Loes 2010*	*Mean*
Merpati	1.4	2.3	1.1	0.9	1.4	1.1	1.4
Delta	1.7	1.4	0.8	1.1		1.2	1.2
Satin	1.2	1.9	0.7	1.0		1.0	1.2
Berken	1.3	2.1	0.6	0.8		1.1	1.2
Murai	1.1	1.7	0.6	1.0	1.5	1.1	1.2
Celera	1.3	1.8	0.5	0.9		0.8	1.1
Local black	0.9	1.3	0.7	0.8	1.4	1.2	1.0
Sarity	0.8	0.8	0.6	1.0	1.7	0.9	1.0
Local Suai	*1.1*	*1.9*	*0.6*	*0.4*	*1.0*	*1.0*	*1.0*
Local Besikama	*1.1*	*0.8*	*0.5*	*0.5*	*1.0*	*1.5*	*0.9*
Local Balibo	*1.2*	*0.7*	*0.6*	*0.5*	*0.8*	*1.3*	*0.8*
Diamond	1.1	0.5	0.8	1.0	0.0	0.8	0.7
Mean Local	1.1	1.3	0.6	0.6	1.1	1.2	1.0
All Mean	1.2	1.4	0.7	0.8	1.1	1.1	1.1

The yield of each variety was compared with the mean of the local checks and Merpati and Delta were 38-45% superior in yield (Table 88)

Table 88. Mean mung bean yield increase above the local checks (%) 2008 to 2012.

Variety	*Betano*	*Betano*	*Betano*	*Betano*	*Betano*	*Loes*	*Mean*
Merpati	32	73	98	48	22	-7	45
Delta	64	4	40	86		-6	38
Satin	18	46	18	77		-16	29
Berken	23	61	-4	42		-8	23
Murai	6	30	2	64	37	-8	22
Celera	28	34	-8	54		-35	15
Local black	*-13*	*-4*	*21*	*34*	*23*	*-2*	*10*
Sarity	-19	-41	11	62	53	-27	6
Local Suai	*6*	*42*	*-4*	*-25*	*-12*	*-17*	*-2*
Local	7	-38	-17	-8	-11	19	-8
Balibo	13	-48	0	-16	-27	3	-13
Diamond	0	-63	44	69	-100	-33	-14
All Mean	14	8	17	40	-2	-12	12

Conclusions

Two varieties were chosen to be investigated in OFDTs during the 2012-2013 season. These were the varieties identified as being Merpati and Delta. Merpati possesses a shiny (glassy) seed testa while Delta is dull in character.

2.9 Climbing bean

2.9.1 Climbing bean replicated trials, 2010-2012

Red beans (*Phaseolus vulgaris* L.) are commonly grown in Timor and constitute a common part of the diet at higher altitudes. There are two forms of this species. The first is the bunch type, which are planted on the very first rain in maize fields, and are harvested before the maize flowers. The second type is a climbing bean, that is grown on bean poles, normally on the edge of the maize fields, or as a monoculture stand. In the second season (starting May/June) both bunch and climbing red beans are grown as a monocrop, as maize is generally not planted in the second season. Red beans contribute a significant proportion of protein in the diet of subsistence farmers. Red bean soup is a classic Timorese side dish. Surplus beans are also sold in local markets and can provide a valuable source of income.

The first observation trials were conducted in 2009 followed by replicated trials in 2010 (SoL, 2009, 2010). After the 2012 series of tests, the number of lines was reduced to 12 varieties, 10 introduced and 2 local varieties. This selection of 12 varieties was planted in replicated trials in Maubisse in 2011 and 2012.

Materials and methods

Prior to these trials, a set of 16 varieties originating from Rwanda and first tested in 2009 was trialled in 2010, along with local checks. From that series of experiments, 10 new lines were selected for on-going testing.

Two-meter wooden tripods were positioned over the hills to allow the plants to climb up. Two seeds were planted at the base of each leg of the tripod, giving 12 seeds planted per plot. Each plot was 1.60m by 0.8m, and was planted with a climbing trellis. The plants were not thinned after germination. In 2011 the trial was planted in February, and the 2012 was planted in November 2011. No fertilizer nor irrigation was used The pods were harvested up to three times to account for different maturation dates. Each time, the number and weight of fresh and dry pods and seeds were recorded. Trial details are presented in Table 89.

Table 89. Climbing bean trial details, wet season 2009-2010

Location	*Elev'n (masl)*	*No. entries*	*No. reps*	*Planting date*	*Days to maturity*	*Mean yield (t/ha)*
Maubisse 2010 Dry	1600	12	3	04/6/2012	144	0.55
Maubisse 2011 Wet	1600	12	3	15/2/2011	162	0.11
Urulefa 2012 wet	1350	12	6	Nov 2011		2.50

At harvest, the total number of plants pods and seeds were recorded in order to calculate the yield components of plant density at harvest, pods per plant and seeds per pod. The weight of 100 seeds was calculated from the whole plot production (after shelling and drying) and from the total number of seeds per plot.

The data of the replicated trial were analysed separately using One-way ANOVAs in Randomized blocks in GenStat Discovery 3 in order to determine varietal effects. No row or column effect were detected in the yields.

Yield advantages were calculated from the resulting predicted means over the average of the local varieties.

The existence and degree of correlation between yield and other yield compoennets 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

The yields and yield component data for the variety trials in 2010, 2011 and 2012 each site are presented the following tables.

2010 dry season

There was considerable variation in grain yield across the 12 varieties when planted in the dry season at Maubisse in 2010 (Table 90). The two local varieties were amongst the lower yielding and the top 2 varieties yielded more than double the best local checks. The varieties differed in seed weight, with the largest seeds weighing 60 g per 100 seeds, and the smallest seeds weighing just 21 g per 100 seeds. There was no significant differences between varieties for plant density, pods per plant or seeds per pod. The local varieties were some of the earliest to mature, with some of the introduced lines maturing 2-3 weeks later than the local varieties.

Table 90. Yield and yield components climbing bean varieties, Maubisse 2010 dry season.

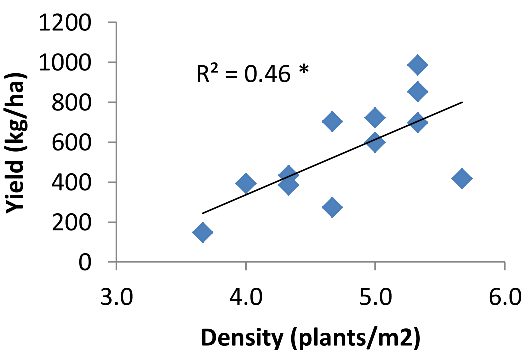
Variety	*Yield (kg/ha)*	*Plants / m^2*	*Pods/ plant*	*Seeds/ pod*	*Seed wt (g/100)*	*Days to mat.*	*Yield advantage (%)*
Gasilidia	987	5.3	10.5	3.5	51	149	265
Mwirasi	853	5.3	8.2	3.1	63	155	215
Cab 2	723	5.0	8.0	3.8	48	155	167
MAC 28	703	4.7	7.6	3.5	60	143	160
RWV 2409	697	5.3	7.8	3.0	58	155	158
Decelaya	600	5.0	7.9	3.1	46	137	122
RWV 1348	433	4.3	7.0	5.0	21	143	60
RWV 1002	417	5.7	6.0	4.1	29	149	54
Lokal Maubisse	*394*	*4.0*	*8.2*	*3.5*	*37*	*156*	*46*
Yol X Turiscai	387	4.3	6.3	3.3	48	155	43
Umubano	273	4.7	5.9	4.0	24	130	1
Lokal Turiscai Mutin	*147*	*3.7*	*5.3*	*2.9*	*27*	*137*	*-46*
MEAN	551	4.8	7.4	3.6	43	147	
P Value	*0.001*	*0.497*	*0.332*	*0.11*	*<.001*	*<.001*	
LSD	*340.2*	*ns*	*ns*	*ns*	*7.1*	*11.7*	
%CV	*36*	*22*	*30*	*21*	*10*	*5*	

Grain yield was positively correlated with high plant stand and number of pods per plant (Figure 24). Yield was not correlated with crop duration, but large seeded varieties, generally gave higher yields.

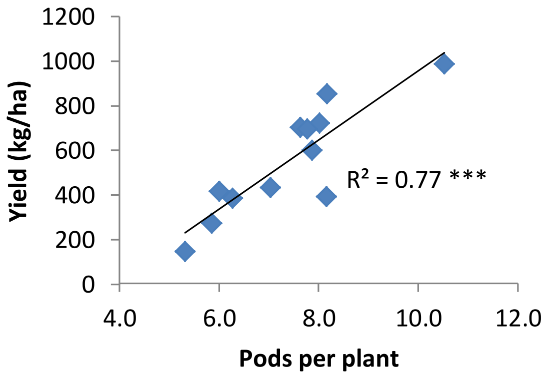
2011

Yields in the 2011 testing year were very low, with average yield across the varieties of 109 kg/ha, and a maximum of only 350 kg/ha (Table 91). Low grain yield was related to the poor plant stands of this trial caused by water logging at the site. Poor drainage at the site did not allow for optimum growth, and reduced not only plant establishment, but also further growth. As a result, future red bean research will be moved to a different site.

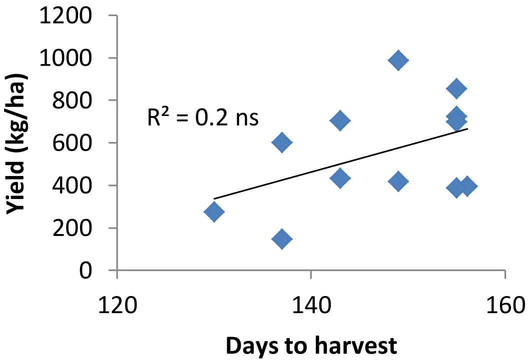
Even in these tough conditions, variety Mwirasi was the top yielding variety (Table 91), showing it has good tolerance of these conditions.



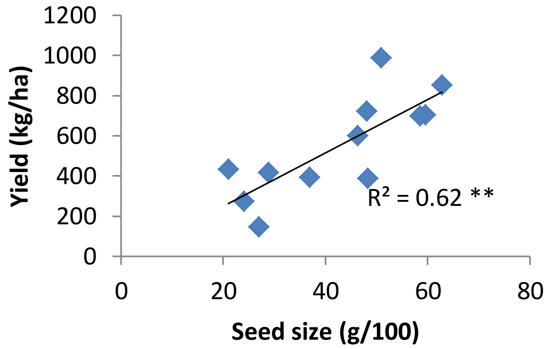
a) Yield versus plant density



b) Yield versus pods per plant



c) Yield versus days to harvest



d) Yield versus seed size (g/100)

Figure 24. Yield (kg/ha) and yield components climbing red bean, Maubisse 2010

Table 91. Yield and yield components, climbing bean varieties, Maubisse 2011.

Variety	*Yield (kg/ha)*	*Yield with covariate (t/ha)*	*Plant density (plants/m2)*	*Pods per plant*	*Seeds per pod*	*Seed Weight (g/100)*	*Days from planting to last harvest*	*Yield advantage above local (%)*
Mwirasi	350	290	3.5	5.3	4.0	60	162	204
Decelaya	132	36	4.3	2.7	3.5	42	162	15
RWV 1348	121	136	2.0	6.5	5.8	20	162	5
MAC 28	109	109	2.3	3.6	3.5	35	134	-5
Yol X Turiscai	103	142	1.5	5.7	3.9	40	159	-10
Umubano	100	133	1.6	5.3	4.2	31	146	-13
RWV 2409	74	52	2.7	2.3	3.8	42	129	-36
Gasilidia	55	51	2.3	2.0	3.0	49	162	-52
Local Maubisse	*39*	*35*	*2.3*	*2.0*	*3.5*	*29*	*122*	
Local Turiscai mutin	*7*	*108*	*0.1*	*	*	*	*	
MEAN	109	109	2	4	4	38.67	149	13
F Prov	0.047	0.101	*0.031*	*0.026*	*0.01*	*<.001*	*0.008*	
LSD	166.1	219.8	*1.866*	*3.161*	*1.75*	*0.1*	*60.44*	
%CV	62.2	57.6	*34*	*36*	*20*	*6*	*18*	

* No recorded data

2012

This site had the highest yields of any of the previous trials of red beans. Average yield of the trial was 2.3 t/ha, with the previous best average yield of about 1 t/ha in Maubisse 2010. The reasons for the high yield at this site are unclear. The site was located in the Urulefa research station, which is known to be very heterogeneous. As the site has been split into individual blocks, it seems the block used for red beans this year was more fertile/ or possessed more rhizobium than previous sites. From very soon after establishment, the crop was very green and vigorous, climbing to the top of the bean poles and covering the ground well before flowering.

There was significant yield variation between the varieties in the 2012 wet season. One of the introduced varieties (RWV1348) had the highest yield, and had a significantly higher yield than all other varieties (Table 92). RWV 1348 also had the distinction of producing pods for very long time. RWV 1348 first flowered a little later than all the other varieties (5 days later on average) but produced pods for an extra 40 days after the other varieties. The long period of pod setting resulted in a large number of pods produced and a greater yield. RWV 1348 is also distinctive in having more seeds per pod (8 compared to the average 5) and one of the smallest seed sizes (25 g/ 100 compared to an average of 41 g/100 seeds).

Table 92. Yield and yield components, climbing bean varieties, Urulefa 2012.

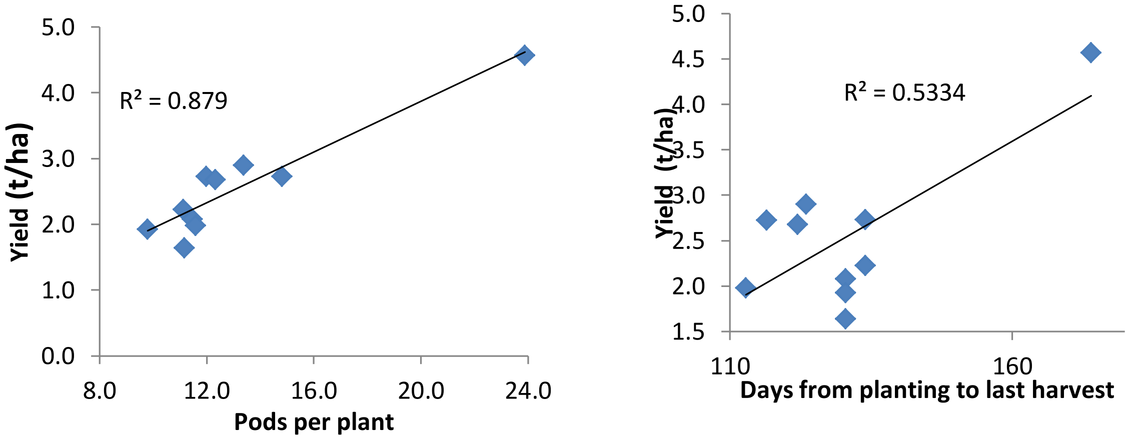
Varieties	*Yield (t/ha)*	*Density (plants/m2)*	*Pods/plant*	*Seeds/pod*	*Seed weight (g/100)*	*Days to last harvest*	*Days to first flower*	*Days to first harvest*	*Yield increase over local (%)*
RWV 1348	4.6	9.4	23.9	8.2	25	174	53	134	94
Mwirasi	2.9	9.4	13.4	4.5	50	124	46	104	23
MAC 28	2.7	9.4	12.0	4.4	55	134	50	113	16
Local Urulefa	*2.7*	*9.4*	*14.8*	*4.2*	*47*	*117*	*47*	*104*	
Gasilidia	2.7	9.4	12.3	5.2	45	122	45	104	14
Umubano	2.2	9.4	11.1	7.3	29	134	52	120	-5
Decelaya	2.1	9.2	11.5	4.6	43	131	46	104	-12
Local Maubisse	*2.0*	*9.4*	*11.6*	*5.1*	*36*	*113*	*48*	*105*	
RWV 2409	1.9	9.4	9.8	4.6	47	131	47	106	-18
Yol X Turiscai	1.6	9.4	11.2	4.7	33	131	49	106	-30
MEAN	2.5	9	13	5	41	131	48	110	10
F Prov	<.001	*0.49*	<.001	*<.001*	<.001	*<.001*	0.1	<.001	
LSD	0.86	*ns*	*3.9*	*0.7*	3	*10*	6	5	
%CV	28.05	*1*	*25*	*11*	7	*6*	11	4	

As in other years Mwirasi and MAC 28 produced consistent high yields, and these top varieties (including RWV1348) showed no disease symptoms. These two varieties showed a good high yield and were shorter in duration than the local varieties (Table 92). One of the local beans (Local Urulefa) also produced a high yield, just a little less than the top three.

Yield was correlated with the number of pods per plant and also with the plants maturation period (Figure 25).

Conclusions

As in previous years, many of the introduced red bean varieties produced more beans than the local varieties. However, one of the recent local tested (Local Urulefa) performed well in Urulefa in 2012, and this will need to be tested in other location to see if it has general adaptation.



a Yield vs pods per plant　　　　b Yield vs maturation period

Figure 25. Correlation of yield and a) pods per plant and b) maturation period, Urulefa 2012.

2.9.2 Climbing bean, multi-year and location analysis

Materials and methods

Twelve successful climbing bean variety trials (including 3 dry seasons) were implemented by SoL from 2009 to 2012 at 7 different sites, testing the performances of 10 climbing bean varieties (including 2 locals).

The entire dataset comprised 118 data points, i.e. variety per environment combinations. An environment (here synonymous of trial) is defined by the site, year and season (for instance Maubisse dry season 2009, Ossu wet season 2010, 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) and Urulefa (Ulu).

Cross-site analyses were conducted using biplots (GGE Plot procedure in Genstat 15) 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 (12 environments, 118 data points) was 0.7 t/ha against 1.0 t/ha for the local checks alone (8 environments, 17 data points, i.e. 11% of the entire dataset). Yield averages from trial to trial varied from a very low 30 kg/ha to a maximum of 2.5 t/ha (Lisalara 2010 and Maubisse 2010 respectively). About half the sites performed within 0.25-0.53 t/ha (Table 93).

Table 93. Climbing bean yields for 10 varieties from 12 trials

Variety	*Maub. 2009*	*Tur. 2009*	*Ven. 2009*	*Ail. 2010*	*Lis. 2010*	*Maub. 2010*	*Hol. 2010*	*Oss. 2010*	*Ven. 2010*	*Maub 2010D*	*Maub. 2011*	*Uru. 2012*
Mwirasi	0.34	0.24	0.51	0.33	0.01	3.63	0.32	0.13	0.44	0.85	0.29	2.90
RWV 1348	0.12	0.14	0.91	0.21		4.28	0.47	0.48	0.60	0.43	0.14	4.60
Decelaya	0.28	0.08	0.43	1.12	0.04	2.68	0.37	0.53	0.29	0.60	0.04	2.10
MAC 28	0.44	0.22	0.63	0.00	0.00	3.65	0.16	0.11	0.35	0.70	0.11	2.70
YOL X	0.14	0.18	1.07	0.23	0.03	2.96	0.10	0.29	0.59	0.39	0.14	1.60
Umubano	0.08	0.02	0.36	0.28	0.00	1.91	0.32	1.10	0.22	0.27	0.13	2.20
Gasilida	0.08	0.17	0.38	0.24	0.02	2.20	0.18	0.14	0.25	0.99	0.05	2.70
Local Turiscai	*	*	*0.58*	*0.36*	*0.01*	*0.68*	*0.27*	*0.54*	*0.35*	*0.15*	*0.11*	*2.70*
RWV 2409	0.36	0.20	0.41	0.18	0.11	2.00	0.15	0.05	0.29	0.70	0.05	1.90
Local Maubisse	*0.30*	*0.14*	*	*0.00*	*0.01*	*1.17*	*0.31*	*0.09*	*0.35*	*0.39*	*0.04*	*2.00*

Table 94. Mean yields and yield advantages, climbing bean, 12 experiments, 2009 to 2012

Variety	*Mean yield (t/ha)*	*Mean yield above locals (%)*
RWV 1348	1.13	138
Mwirasi	0.83	76
MAC 28	0.76	60
Decelaya	0.71	51
YOL X	0.64	36
Gasilida	0.62	30
Umubano	0.57	21
RWV 2409	0.53	13
Loc. Turiscai	*0.51*	*8*
Loc. Maubisse	*0.44*	*-8*

The imported varieties performed very differently with yield advantages ranging from more than double to a little over the average of the locals. RWV 1348 and Mwirasi and MAC28 performed the best overall.

Figure 26 presents the biplot resulting from the analysis of 10 varieties in all 12 environments. The two components combined explain 55% of the variation in the table of yield of 10 varieties across the 12 sites. In the biplots the locations are marked blue, and the varieties are marked in green. The graph is interpreted by comparing the position of the varieties relative to the trend line (blue line with the arrow). Varieties further to the right of the line perform better. Of the test locations, there does not appear to be any grouping of locations based on the same year or the same site. This suggests that each site/year is a unique combination of challenges. There seems no suggestion there should be different recommended varieties for different locations.

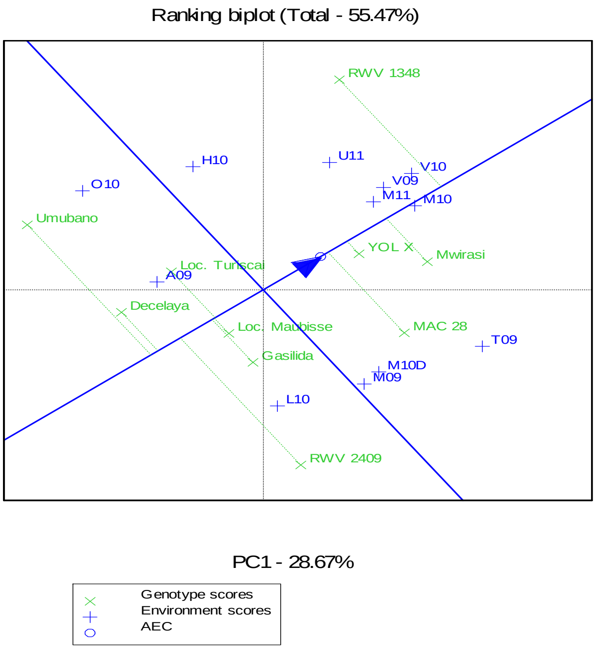


Figure 26. Ranking BiPlot of 8 climbing bean varieties in 12 environments, 2009-2012

Conclusions

After a series of 12 test locations with 10 varieties, a number of introduced varieties seem to be generally superior to the local checks. The varieties which performed the best presenting yield advantages of more than 50% over locals were RWV 1348, Mwirasi and Mac28. More seed of these three varieties need to be tested for suitability for cooking and eating, prior to consideration for release. The very high yield of RWV 1348, suggests that it can respond to good growing conditions. This could be explored more. If in fact this variety does respond to good growing conditions, it could be planted near a water source, such as bathroom drain, or kitchen over flow area, to produce beans over an extended period of time.

3. Formal seed production and distribution

Introduction

Maintaining access to a source of high quality seed is the key to a successful seed industry. MAF/SoL works towards producing a supply of quality seed for distribution to seed multipliers in Timor-Leste. This important link in the seed chain maintains the supply of breeder, foundation, registered and some “certified” seed for further multiplication directly by seed producers, Government and Non Governmental supported seed multiplication programs and the informal seed industry.

The program follows the Association of Official Seed Certification Agency (AOSCA) classification system where there are at least four seed classes: breeder seed, foundation seed, registered seed, and certified seed. The seed classes differ mostly in regard of their seed genetic purity.

The seed multiplication process commences with one or two hundred grams of Nucleus seed being produced by researchers. This is used to generate a small amount of genetically pure breeder seed. This activity is usually done at the research center under strict supervision of plant breeders. The rights and responsibilities for the production of breeder seed is that of the breeder who has released or has ownership of the variety. In many countries the rights to produce breeder seed belongs to Government research agencies and to private seed companies which may have developed that variety.

Under the single flow seed production system, breeder seed is the only seed source to produce foundation seed. Production of foundation seed is often done by Government research agencies usually by the seed production unit of Ministry of Agriculture crop divisions, or by eligible selected seed growers/private seed companies.

Breeder seed and foundation seed are the only source seed to produce stock seed. Agencies involved in stock seed production are usually the seed division unit of Ministry of Agriculture crop departments and qualified seed growers.

Stock seed is the main seed source to produce the last seed class to be planted by farmers for consumption or purposes other than for seed. The last seed class is usually named as certified seed if it is produced following a certification scheme or termed commercial seed or “truthful” seed if a certification scheme is not followed.

Component 2 of the MAF-SoL program is designed to produce good quality source seed for further seed multiplication steps. During its implementation, mainstream MAF capability for seed production and quality control is strengthened.

There are four main activities in the MAF/SoL seed production program. These are planning, growing of the seed crop, seed processing and seed storage. The crops themselves are grown by contract seed growers while seed processing and storage is at one of the six seed warehouse that have been established in six Districts. Seed quality control aspect relate to field-inspection and seed laboratory testing.

3.1 Seed production activities 2011-2012

Fifteen MAF staff members were involved in the source seed production program during 2011-2012. These were 2 pure seed officers, 11 District seed officers, 1 Seed analyst, and 1 national coordinator. During the year there was intensive mentoring and formal training to encourage an improved seeds system. Training courses included seed production training for

District officers and field inspection for seed certification (See Capacity Building in Section 9 of this report).

Contract seed growers multiplied seed in the Districts of Aileu, Baucau, Bobonaro, Manufahi, Liquica and Viqueque. About 70 ha of maize field, 27 ha of rice field and 16 ha of peanut field were registered and eligible for seed production in the rainy season of 2011-2012. During this period the amount of clean seed produced amounted to 22.9 tons of rice (Nakroma), 41.8 tons of maize (36.3 t Sele, 5.5 t Noi Mutin) and 4 t of Peanut (Utamua) (Table 95).

Table 95. Clean seed production of Nakroma, Sele and Utamua, 2011-2012

District	*Rice (Nakroma) (t)*	*Maize (Sele) (t)*	*Maize (Noi mutin) (t)*	*Peanut (Utamua) (t)*
Aileu	3.5	0.9	0	0
Baucau	17.4	3.0	0	1.3
Bobonaro	0	6.6	0	3.0
Liquica	0	6.0	0.5	0
Manufahi	0	19.8	5.0	0
Viqueque	3.0	0	0	0
Total	*22.9*	*36.3*	*5.5*	*4.3*

3.2 Seed distribution, rice, maize and peanut

Seed distribution, rice, maize and peanut

Seed harvested from 2010-2011 was distributed for 2011-2012 planting season to support the MAF/SoL research program (replicated trials and OFDTs), the MAF/SoL formal and informal seed production programs as well as MAF, and NGO seed production programs. About 40 t of Nakroma, 2.6 t of Utamua and 23.8 t of Sele seed were distributed within the period of Sept 2011 – August 2012 (Table 96).

Table 96. Rice, maize and peanut seed distribution (Sept 2010 to Aug 2011)

Commodity	*NGOs (t)*	*MAF District (t)*	*FAO (t)*	*MAF-SoL-FSP (t)*	*MAF-SoL-IFSP (t)*	*NGO-IFSP (t)*	*OFDT (t)*	*Total (t)*
Rice-Nakroma	0.37(1)*	37 (95)	0 (0)	0.4 (1)	0.5(1)	0.2 (0.4)	0.7 (1.8)	39 (100)
Peanut-Utamua	0 (0)	0.5 (0.5)	0 (0)	1.3 (50)	0.27(10)	1.0 (38)	0 (0)	2.6 (100)
Maize-Sele	3.9(17)	11 (48)	1.0 (4)	2.7 (11)	0.47(2)	1.7(7)	2.6(11)	24 (100)
Total	*4.3 (7)*	*48.5(74)*	*1.0 (1)*	*4.5(7)*	*1.2 (2)*	*2.9 (4)*	*3.3(5)*	*66 (100)*

* Figures in brackets are % of totals

In summary, most of the seed was distributed through MAF (73.8%), 6.6 % through NGOs, 1.5 % by FAO, 6.8 % through the MAF-Sol-FSP, 1.9% by MAF-SoL-IFSP, 4.3% NGO-IFSP, and 5.1% OFDTs.

Institutions that received SoL varieties for the 2011-2012 planting seasons were: the NGOs World Vision, Mercy Corp, CARE, HIVOS, Child Fund, Belun, CRS, IMM-Same, Uma Ita Nian Aileu, World Neighbors, International Organizations including GIZ, FAO, RDP3 and the national university (UNTL). The remaining seed was distributed to the MAF in the Districts of Aileu, Ainaro, Liquica, Baucau, Bobonaro, Ermera, Lautem, Manatuto, Manufahi, Suai, Viqueque and Oecussi.

3.3 Production and distribution of sweet potato and cassava stem cuttings.

Sweet potato cuttings of the three varieties released in 2006 (Hohrae 1, Hohrae2, and Hohrae 3) were multiplied in 6 Districts: Manufahi, Aileu, Viqueque, Liquica, Bobonaro and Baucau. Approximately 0.4 ha of sweet potato field was cultivated to produce stem cuttings for the 2011-2012 planting season (Table 97).

Sweet potato cuttings were planted at a distance of 50 cm x 25 cm (80,000 plants/ha). It was assumed that cutting multiplication rates of 2 month old plants gave an average of 4 stem cuttings/plant. Each square metre of field, therefore, could produce 32 stem cuttings. Based on that estimation, every two months about 320,000 cuttings can be harvested from the existing 1 ha sweet potato field plot. Two harvests can be made per season (640,000 cuttings) which is sufficient cuttings for 16 ha of sweet potato fields spaced at 50cm x 50cm (40,000 plants/ha) for consumption or commercial purpose.

During 2011-2012, approximately 150,000 sweet potato cuttings were distributed. The Districts they were distributed in are presented in Table 97. This was significantly more than in 2010-2011 (22,000 cuttings) and 2009-2010 (43,000 cuttings). Most of the cuttings (about 45%) were distributed to community seed production groups sponsored by SoL/MAF and NGOs. The remaining cuttings were distributed to OFDT (9%), FSP (10%), and directly to MAF sponsored farmers (22%).

Table 97. Production area and distributed cutting numbers by District, 2011-2012.

District	*Sweet potato*		*Cassava*	
	Area (m^2)	*Distributed stem cuttings*	*Area (ha)*	*Distributed stem cuttings*
Aileu	800	15,850	0	0
Baucau	7,150	69,093	0	0
Bobonaro	1,600	41,000	1	42,770
Liquica	200	500	1*	0
Manufahi	600	8,800	0.8	31,300
Viqueque	400	15,224	0	0
Total	*10,750*	*150,467*	*2.8*	*74,070*

Note: * The crop was destroyed through fire

Cassava stem multiplication fields were established at Loes-Liquica (1 ha), Corluli-Bobonaro (1 ha), and Betano-Manufahi (1 ha). Unfortunately the field at Loes was destroyed by fire. Planting dates for these cassava fields were August 09, December 09 and February 2011, respectively. The planting distance was 100 cm x 100 cm (10,000 plants/ha). To stimulate growing of lateral buds (to produce more branches or stem cuttings/plant) the plant was pruned at a height of about 40 cm. On average, each plant will possess three branches at harvest. One metre of cassava stem produces 4 cuttings. One hectare can therefore produce about 120,000 cassava planting cuttings. In 2011-2012, SoL distributed about 74,000 stem cuttings (Table 97). This number is about 4 times higher than distributed in 2010-2011 (20,000 cuttings). The increase is due to the opening of new cassava multiplication fields at Betano (Manufahi), Bobonaro, Liquica, Baucau, and Viqueque. Most of the distributed cuttings in 2011-2012 were allocated for MAF/SoL formal seed production (81 %) and the rest for the community seed production group program (18.7%) and OFDTs (0.3 %).

SoL formal seed production as percentage of national seed requirement, 2011-2012

The formal seed production component of SoL has more focus on producing source seed for further seed multiplication rather than for general farmer use. However, part of the seed produced by this component also goes directly to the MAF and to NGO for non-seed production purposes. Below is an estimation of the formal seed production component toward fulfilling the national seed need.

If seeding rates per ha of rice, maize, and peanut are 20 kg, 20 kg, and 150 kg respectively, the distributed seed for 2011-2012 would be enough to cover fields of approximately 1,571 ha of rice field, 1,190 ha of maize, and 17 ha of peanut. Given the total planted area of rice, maize, and peanut in Timor-Leste in 2010 were approximately 38,069 ha, 75,804 ha, 3,350 ha, respectively (MAF Crop division, 2009 and 2010), the component contributed more than 4 % of the national rice seed requirement for 2011-2012. Details are presented in Table 98.

Table 98. SoL formal seed production as a % of national formal seed need.

Crop/Variety	Est. Current planted area (ha)	Seed rates (kg/ha)	National seed requirement (t)	Distributed formal seed 2011/2012 (t)	Multiplier effect of seed growers	% formal seed contribution to national formal seed requirement (%)
Rice/Nakroma	38,069	20	952	39.3	50	205
Maize/Sele	75,804	20	1516	23.8	50	105
Peanut/Utamua	3,350	150	502	2.6	20	10
Sweetpotato/Hohrae 1, 2, 3	4,879	40,000*	195 mill	150,467*	20	1.6
Cassava/ Ailuka 2 and 4	6,936	10,000*	694 mill	74,070*	10	0.1

*= stem cutting (cutting)

Seed warehouse and national seed laboratory

Source seed is produced and distributed under the MAF/SoL brand and MAF/SoL takes full responsibility for its quality. It is still too risky to let inexperienced contracted seed growers to both grow and process source seed. Therefore, the main seed processing activity during 2011-2012 was done by MAF seed officers in seed warehouses. In the future it is envisaged that contracted seed growers may produce certified seed under their own brand. By then the seed producers would not only grow the seed but also process, store, bag, and distribute it.

For seed certification there are two types of assessment. The first assessment is done in the field during the growing periods and during seed processing. After passing field assessment the seed is tested in the seed laboratory. Field assessments are done by field seed inspectors and seed laboratory testing by a seed analyst (seed officer who has assigned as seed analyst).

The seed processing/warehouses established in the six Districts play an important role in the seed production process. Good seed processing can improve the percentage of pure live seed by properly removing the impurities, empty and cracked and diseased seed. To assist this process in 2011-2012, SoL/MAF supported the warehouses with 136 silos, 12 germinators plus seed cleaners, moisture meters, compressors, sealer and other equipment. A seed laboratory will be established at the MAF compound in Dili during 2013 to enhance quality control.

4. Community based seed production

Introduction:

Seed, fertilizer and irrigation are normally considered the three major inputs for boosting food production and productivity. Of these inputs, seed is the cheapest and has a high potential for increasing production and productivity of food crops in Timor-Leste. The current MAF/SoL released varieties consistently show significant yield advantages over traditionally grown local varieties in OFDTs. In 2010 the yield advantages were 47% more yield for Sele maize, 31% for Noi Mutin maize, 24% for Nakroma paddy, 47% for Utamua peanut, 66% for Hohrae 1, 80% for Hohrae 2, 159% for Hohrae 3 varieties of sweet potato and >50% for cassava (SoL 2010). However, the potential benefits of increasing production and productivity of food crops could not be reaped by the majority of farmers because of insufficient availability of quality improved seed and planting material.

The formal seed sector in Timor-Leste provides less than 10% of the seed requirement for major crops while 90% of the seeds are supplied through informal seed systems such as i) farm saved seed from the previous year's harvest, ii) farmer to farmer seed exchange, and iii) from local food-grain markets. For maize, which is grown by 88% of farming households in average of approximately 75,000 ha in normal years (NSD and UNFPA 2011, DNAH 2011)), the national seed requirement is approx. 750 tons if it is considered that 33% of the area is covered each year (Figure 27). The national supply of quality seed was less than 5% for the 2010-2011 wet season and less than 12% for the 2011-2012 growing season despite a 178% increase in production during the year. Much of this increase was through the SoL/MAF community-based seed production activities. The objective of this program through the National Directorate for Support to Agricultural Community Development is to increase the availability and accessibility of quality seeds of improved varieties among the poor farmers.

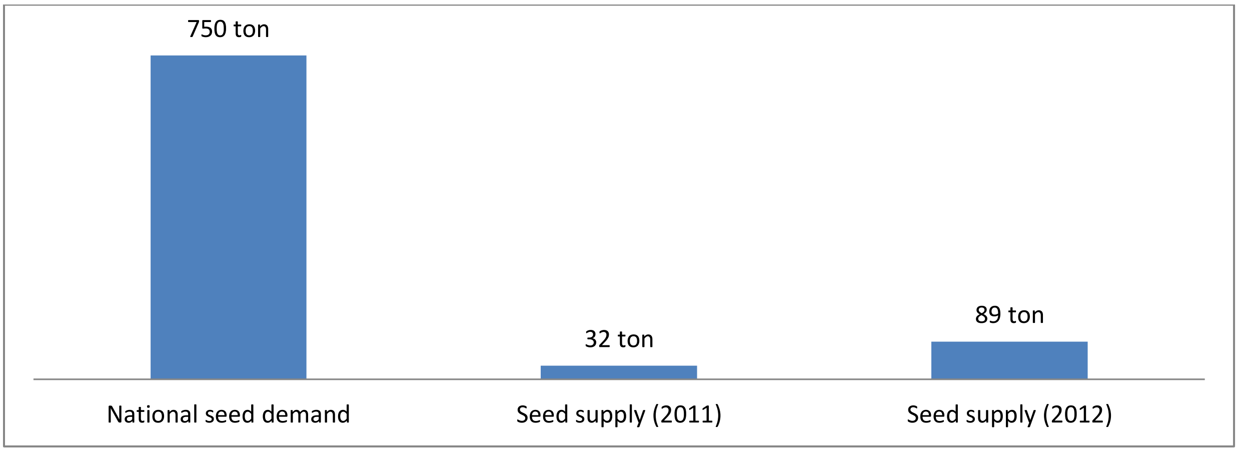


Figure 27. Maize: National Seed Demand and Seed Supply in Timor-Leste.

4.1 Community Seed Production Groups (CSPG) coverage in 2011-12 and 2012-13

In 2011-2012, MAF/SoL initiated the establishment of 40 Community Seed Production Groups (CSPGs) in each District totaling 280 CSPGs in 7 Districts, 30 Sub-Districts and 70 Sucos (Figure 28). After successful implementation of community seed production for one year, SoL organized review and planning workshops in each of the SoL program Districts with CSPGs, Suco Extension Officers SEOs) and local authorities and other seed actors. After receiving positive feedback from the workshops, MAF/SoL will expand the number of CSPGs from 280 to 680 in 2012-2013.

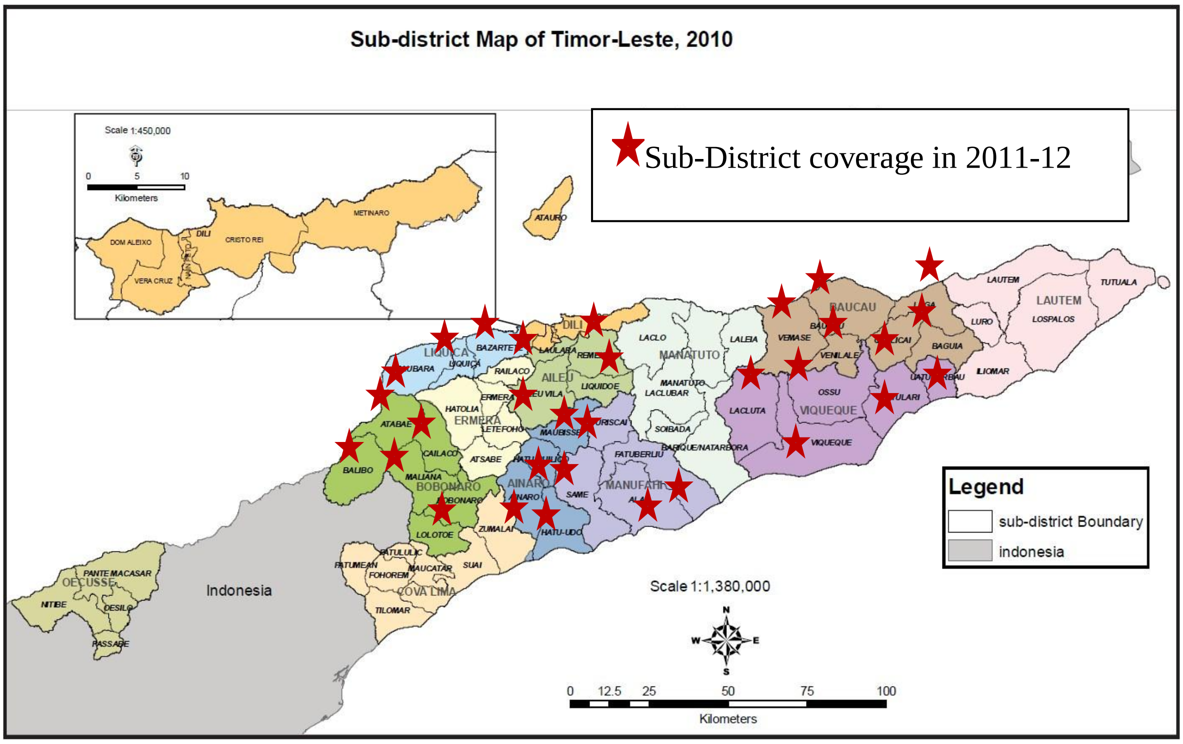


Figure 28. Sub-District Coverage by Community Seed Production in 2011 and 2012

In addition, NGOs including World Vision, CARE, Mercy Corps and Hivos established over 400 similar community seed production programs in 2011-2012.

It is planned for the 680 CSPGs to be established by MAF/SoL in 2012-2013 to expand into 11 Districts (85% District coverage), 45 Sub-Districts (and 135 Sucos on five major food crops: maize, paddy, peanuts, sweet potato and cassava in 2012. By this stage, in addition to the District coverage, 69% of all the Sub-Districts and 31% of all Sucos will possess groups.

4.2 Results in 2011-12 cropping season:

Eight varieties of the five major crops of Timor-Leste were introduced in the 2011-12 cropping season for community seed production. These included, 'Sele' variety of maize, 'Nakroma' for rice, 'Utamua' for peanut, 'Hohrae 1', 'Hohrae 2', 'Hohrae 3' for sweet potato and 'Ai-luka 2' and 'Ai-luka 4' for cassava. Summary results of these varieties for the year are as follows:

4.2.1 Maize seed production

A total of 320 community groups were involved in seed production of 'Sele' variety of maize. Of the total 90% were successful in harvesting maize while 10% suffered a crop failure largely due to free grazing animals and some from flash floods (Table 99).

Table 99. CSPG results for maize seed production, MAF & NGOs, 2011-12

Source	*Seed used/plot (kg)*	*Area of seed plot (m^2)*	*Total # of CSPGs*	*# CSPG with harvest*	*# CSPG with crop failure*
MAF	5	2,000	102	90	12
NGOs	5	2,000	228	199	29
Total			*330*	*289*	*41*

A total of 289 community seed groups were able to harvest the maize crops with an average yield of 159 kg per group (Table 100).

Table 100. Maize seed yield in MAF and collaborating NGOs' CSPGs, 2011-12

Source	*# CSPGs with harvest*	*Total seed produced (kg)*	*Average seed (kg) /group*
MAF	90	15,005	167
NGOs	199	30,835	155
Total/average	*289*	*45,840*	*159*

4.2.2 Maize seed marketing

Of the 297 successful groups, 34 groups had sold more than 6.5 t seed to NGOs and community members (Figure 29) with a total income of US$9544.00 by the end of 2012. All seeds were sold at $1.5/kg while 323 kg seed was sold at $0.50/kg just after the harvest.

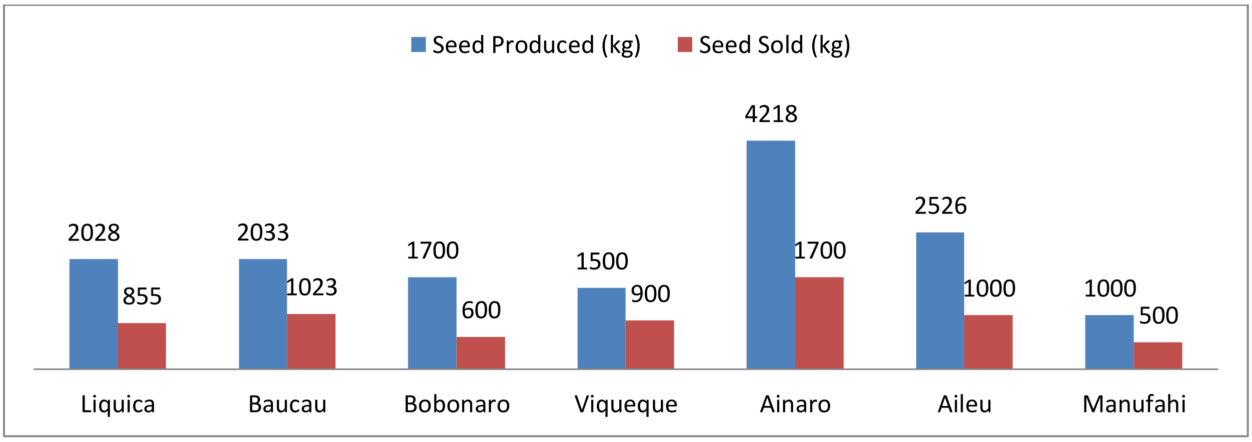


Figure 29. Maize seed production and sales by District CSPGs, 2011-2012.

4.2.3 Rice seed production

A total of 67 groups were identified for rice seed production in 2011-12. Of the total, 52 groups had a successful harvest and 15 groups (22%) suffered crop failures (Table 101). Nine groups in Manufahi District could not plant due to a breakage of the irrigation system; two groups in Viqueque could not plant (one group due to lack of water and other group due to lack of availabile tractor at planting time) and 4 groups in Bobonaro did not plant due to lack of water.

Table 101. Rice seed production by CSPGs, 2011-2012.

Source	*Seed used/plot (kg)*	*Plot area (m^2)*	*Total # of CSPGs*	*# CSPGs harvested*	*# CSPGs with crop failure*
MAF	5	2,500	61	46	15
NGOs	5	2,500	6	6	-
Total			*67*	*52*	*15*

Table 102 provides a summary of rice seed production by CSPGs in 2011-2012. The table shows that a group harvested an average of 522 kg of rice seed. Since NGOs focus mainly on upland areas, most of the NGOs did not plant paddy in the last season except for CARE with 6 groups in Atsabe, a Sub-District of Ermera.

Table 102. Rice seed yields in MAF and collaborating NGO groups in 2011-2012.

MAF and collaborating NGOs	# CSPGs with harvested seed	Total seed produced (kg)	Average seed (kg) /group
MAF	46	24,414	531

NGOs	6	2,750	458
Total/average	*52*	*27,164*	*522*

4.2.4 Rice seed marketing

Of the total 27 tons of rice seed produced by 52 community groups, only 2.3 tons of seed was sold @1.50/kg. The seed was purchased from community groups by NGOs. The remaining seed was reserved for further seed production, distribution among group members for food production, or to be sold/bartered to neighbours and NGOs.

4.2.5 Peanut seed production

Of the total 119 peanut seed production group in 2011-2012, 11 groups (9%) suffered a crop failure due to damage by animals (9 plots) and being destroyed by flashfloods (2 plots) (Table 103). However, 91% of the groups had successful harvest with average of 37 kg per seed plot. There is no significant difference in result between seed groups supported by MAF/SoL and NGOs (Table 104).

Table 103. Peanut seed production by CSPGs, 2011-2012.

Source	*Seed used/plot (kg)*	*Area of seed plot (m^2)*	*Total # of CSPGs*	*# CSPG with good harvest*	*# CSPG with crop failure*
MAF	10	650	49	47	2
NGOs	10	650	70	61	9
Total			*119*	*108*	*11*

Table 104. Peanut seed yield in MAF and collaborating NGO groups in 2011-2012.

Source	*Total # of CSPGs*	*# CSPG with good harvest*	*Total seed* produced (kg)*	*Average seed (kg) /Group*
MAF	49	47	1,675	36
NGOs	70	61	2,372	39
Total/average	*119*	*108*	*4,047*	*37*

Note: * refers to seed only and does not include other products such as small pods not used for seed.

4.2.6 Peanut seed marketing

Almost all community seed groups kept the seed for distribution to their members to expand peanut cultivation in their groups. Only one Farmers Association (Geriuai at Baucau) sold peanut seed of 30 kg @ $2.50/kg at the Trade Fair in Dili.

4.2.7 Cassava and sweet potato seed production

In the 2011-12 cropping season, 40 MAF/SoL groups established sweet potato production plots, and 25 groups cassava. NGOs had also commenced seed planting material production of these crops. Sweet potato and cassava groups had not harvested their cuttings prior to the publication of this report.

4.3 Policies for community seed production

The MAF coordinated the drafting of a national seed policy with the assistance of the international community, NGOs and farmers. The policy is expected to be finalized during 2013. MAF/SoL also developed a policy for supporting community seed production. The main points in this policy are:

- Work to be coordinated through the MAF and NGO extension services
- Support to be provided to existing MAF and NGO seed production groups
- Seed is to be sold not given free of charge to promote sustainable revolving systems
- Seed is given not for distribution only, but for sustainable multiplication
- Collected seeds will be redistributed to other new group in the same Suco
- Seed dependency to be reduced through increasing locally available seed
- Raise awareness of MAF released crop varieties in communities
- Disseminate seed through farmer to farmer exchange

- Develop farmers recognition of the importance of good seeds
- Create local markets for seeds

5. Farming systems research

5.1 Maize and velvet bean systems

Velvet bean (*Mucuna pruriens)* is a leguminous crop often intercropped with maize in order to improve soil fertility and reduce the weed burden. As a vigorous groundcover, it can be planted into 30-40 day old maize as an effective weed control method. Reports from Hataz in Bobonaro District and other areas suggest that it was intercropped with maize at least as long ago as the Portuguese era, but that seed has been unavailable since being lost when farmers fled the Indonesian occupation. It has also historically been grown as a food crop on the island, but the difficult process of preparation makes it a relatively minor food source. A wild variety known locally as *Karalele* (literally ‘itchy velvet bean’) grows in many areas of the island, but its skin irritating properties make it unsuitable for cultivation. SoL has tested velvet bean cropping systems on research stations and farmers’ fields since 2005, often in collaboration with partner organizations or local universities. Velvet bean has proven to be extremely popular with farmers, some of whom are still propagating and planting it several years after an initial small amount of seed was supplied for testing.

Velvet bean and cropping systems, 2008-2012

A long term rotation experiment continued at Betano research station during 2012. The aims of the research is to test the effect of velvet bean rotation on maize yields, and to test the common belief that using tractors to till the soil is the best way of preparing the land. The use of Round-Up (a selective herbicide) was also included in the trial as a method of weed control. Six planting/harvest cycles have now been completed over the course of the experiment with one season (dry season 2009) not being planted due to lack of rain.

At Loes, a similar trial was established to investigate the effect of the method of tillage, application of Round-up, and velvet bean rotation on maize yields. The dry biomass of weed and velvet bean was also recorded to assess the suppressive effect of velvet bean on the weed burden and the amount of velvet bean mulch produced.

A new velvet bean trial was also implemented this year. Due to a high number of requests from farmers in the area, a trial similar to the Loes experiment was planted in December 2012 in Viqueque near Viqueque Villa.

Methods

The design of the long term rotation experiment at Betano is as described in previous annual reports. Briefly, the trials were laid out in a randomized complete block design with 40 m x 20 m plots. Five treatments were applied in three replicates to compare mechanical ploughing as opposed to the farmers’ practice of no tillage, with or without Round-Up and velvet bean (Table 105). When velvet bean was included in a treatment, it was planted 30 days after the maize crop.

Table 105. Velvet bean/maize cropping systems trials, Betano 2011.

No.	*Treatment/Factor*				*Treatment*
	Tractor	*Round-Up*	*Hand prep.*	*Velvet bean*	
1.	X				Tillage (mechanical)
2.		X			Round-up
3.	X			X	Combination tillage/Velvet bean
4.		X		X	Combination round Up/ Velvet bean
5.			X	X	Combination hand preparation/ Velvet bean

In Loes, an extra treatment was added compared to the Betano experiment. The Loes experiment was designed as a factorial combination of three land preparation methods with and without velvet bean as a multicrop. The three methods of land preparation were, 1) mechanical tillage, 2) weeding by hand, and 3) application of roundup with no soil tillage (Table 106.). The inclusion of all combinations of all factors allows for the interaction effect to be measured for each of the treatment structures. Plots of 20m x 12m were laid out in randomized complete block design with four replicates. One of the replicates was affected by flooding, however, and only the remaining three were included in the analysis.

The Viqueque trial was conducted as a factorial combination with the same specifications as Loes except that plots were 149.5 m^2 in area. As it was conducted off-station, biomass of weeds and velvet bean was not measured. At the site of this experiment, farmers generally plant a crop of maize during the wet season, followed by a crop of either mung beans or dryland rice.

Table 106. Velvet bean/maize cropping systems trials, Loes 2011-2012.

No.	*Treatment/Factor*				*Treatment*
	Tractor	*Round-Up*	*Hand prep.*	*Velvet bean*	
1.	X				Tillage (mechanical)
2.		X			Round-up
3.			X		Hand preparation
4.	X			X	Combination tillage/ Velvet bean
5.		X		X	Combination Round up/ Velvet bean
6.			X	X	Combination hand preparation/ Velvet bean

Note: In all cases sowing was done by placing seeds in holes made with a planting stick (standard farmers' practice)

At planting time, weeds and if need be, residual velvet bean, were slashed manually (as a tractor would have crushed the velvet bean pods) when not sprayed with Round-Up. Prior to planting, the soil was tilled with a tractor or not, depending on the treatment. Maize was planted with two seeds per hill at a planting distance of 75×50 cm (i.e. 2.6 plants/m^2) in Betano and at 75 x 25 cm (i.e. 5.33 plants/$m^{2)}$ in Loes. Velvet bean was planted approximately a month later with a 1 plant/m^2 density (one seed per hill). The plots without velvet bean were weeded twice, as farmers commonly do. The weight of wet and dry weed or velvet bean biomass was measured through 5 samples (quadrats of 1m^2) prior to planting and prior to harvest. At harvest, the number of maize plants were counted as well as the number of cobs per plot. The production per plot was weighed, prior to and after drying, as well as the weight of 100 seeds.

Table 107. Planting and harvest details of velvet bean experiments, 2011-2012.

Location	*Season*	*Number of replicates*	*Planting date*	*Harvest date*	*Days to maturity*	*Rainfall (mm)**	*Mean yield (t/ha)*
Betano	Wet	3	15 Dec. 2011	2 April 2012	109	424	2.39
Betano	Dry	3	30 May 2012	4 Oct. 2012	127	156	1.23
Loes	Wet	4	12 Dec. 2011	28 March 2012	107	639	1.30
Loes	Dry	3	30 May 2012	16 Oct. 2012	139	65	2.00
Viqueque	Wet	3	17 Dec. 2011	24 March 2012	98	752	3.27

* Total rainfall from 1 week prior to planting to one week prior to harvest.

Results were analysed in GenStat Discovery 4 using ANOVA (Unbalanced ANOVA for the factors analysis and ANOVA One-Way in Complete Randomized Block for the overall cropping system treatment). For the Loes factorial combination trial, a Two-Way ANOVA was used to investigate the method of land preparation, planting of velvet bean, and the interaction of the two factors.

Results - Betano

In the 2011-2012 Betano wet season trials, plots planted with velvet bean produced double the yield of plots that were not intercropped. The three land preparation methods were significantly different from each other, with mechanical tillage producing the best yields followed by Round-Up and hand preparation. This is the same result as in the previous (2011) dry season, but further testing will need to be conducted before a recommendation on land preparation can be formulated. As with previous trials, larger cob size accounted for the increased yields in the plots planted with velvet bean. The results of the trial are presented in Table 108.

Weed biomass was higher in the velvet bean plots than in some previous trials, but the overall benefits of planting velvet bean were still clear.

Table 108. Maize-velvet bean replicated trial results, Betano wet season 2011-2012.

Treatment	*Dry biomass at harvest (t/ha)*		*Maize yield (t/ha)*	*Plant density at harvest (plant /m²)*	*No. cobs/ plant*	*Cob weight (g) (seeds only)*	*Seed weight (g/100)*
	Weeds	*V.bean*					
Tillage & velvet bean	0.34	1.32	3.37	5.46	1.02	51.6	30.0
Round-up & velvet bean	0.00	0.97	2.85	4.66	1.23	50.2	29.0
Hand weeding and velvet bean	0.13	0.70	2.79	5.39	1.19	46.1	29.3
Tillage (mechanical)	0.09	0.00	1.24	3.11	1.22	32.8	28.7
Round–up	0.22	0.00	1.71	4.60	1.29	29.7	29.0
F prob	*0.369*	*<0.001*	*<0.001*	*0.005*	*0.375*	*0.001*	*0.754*
LSD (P<0.05)	*ns*	*0.30*	*0.24*	*1.04*	*ns*	*9.09*	*ns*
%CV	*129.2*	*26.7*	*5.3*	*11.9*	*4.8*	*11.5*	*4.4*

In the 2012 dry season trials, maize yield was again significantly higher in plots planted with velvet bean with an average yield advantage of 169% over plots without velvet bean. While there was not a statistically significant difference between land preparation methods, maize yields continued to follow the trend from the previous wet season with tillage, Round-Up, and hand weeding producing the highest respective yields. Both cob size and seed size accounted for the increased yield in the plots planted with velvet bean. The results of the 2012 dry season trials are presented in Table 109.

The 2012 trials included the second dry season trials to be implemented in the long term experiment at Betano. In both instances, the yield advantage was much higher than in the previous wet season. The same effect can be observed at the Loes trials, and suggests that planting velvet bean may have some effect on drought tolerance.

Table 109. Maize-velvet bean replicated trial results, Betano dry season 2012.

Treatment	*Dry biomass at harvest (t/ha)*		*Maize yield (t/ha)*	*Plant density at harvest (plant /m²)*	*No cobs /plant*	*Seed weight/ cob (g)*	*Seed weight (g/100)*
	Weeds	*V.bean*					
Tillage & Velvet bean	0.00	1.00	1.72	3.24	1.08	48	31
Round-Up & Velvet bean	0.00	0.98	1.62	2.98	1.16	49	30
Hand weeding and velvet bean	0.00	1.13	1.60	2.46	1.11	59	30
Tillage (mechanical)	0.76	0.00	0.60	2.79	0.95	21	29
Round -Up	1.09	0.00	0.63	3.04	0.97	19	29
F prob	*0.005*	*0.002*	*<0.001*	*0.346*	*0.567*	*0.003*	*<0.001*
LSD (P<0.05)	*0.57*	*0.55*	*0.21*	*ns*	*ns*	*17.94*	*0.49*
%CV	*81.4*	*46.8*	*9.2*	*15.5*	*17.1*	*24.2*	*0.9*

Table 110 outlines the yields and yield advantages for the duration of the long term velvet bean experiment at Betano. The yield advantage for intercropped plots has ranged between 77% and 100% for wet season trials, and 169% to 233% for dry season trials. The velvet bean groundcover was particularly vigorous during this season, and resulted in a complete absence of weeds in plots where it was planted. The trials have shown a consistent advantage to planting velvet bean and are an excellent example of a local technology that deserves further research and promotion in Timor-Leste.

Table 110. Maize yield with and without velvet bean from long term rotation trial Betano.

Treatment	*Maize yield (t/ha)*				
	Wet season 2009-10	*Wet season 2010-11*	*Dry season 2011*	*Wet season 2011-12*	*Dry season 2012*
Velvet bean	0.5	2.3	3.5	3.0	1.64
No velvet bean	0.26	1.3	1.05	1.5	0.61
Yield advantage	*83%*	*77%*	*233%*	*100%*	*169%*
F prob.	*0.043*	*0.001*	*<0.001*	*<0.001*	*<0.001*
LSD (p<0.05)	*0.20*	*0.48*	*1.10*	*0.36*	*0.12*
%CV	*43*	*21.7*	*37*	*13*	*8.7*
V. bean dry weight at harvest (t/ha)	9.0	10.1	0.4	10.0	1.0
Rainfall from planting to harvest (mm)	400	500	301	424	156

Results - Loes

In the Loes 2011-2012 wet season trials, no significant difference was found between the treatments for maize yield or yield components. There was a significant reduction of the weed burden, however. The results of the trial are presented in Table 111.

Table 111. Maize-velvet bean replicated trial results, Loes wet season 2011-12.

Treatment	*Dry biomass at harvest (t/ha)*		*Maize yield (t/ha)*	*Plant density at harvest (plant /m^2)*	*No cobs/ plant*	*Seed weight/ cob (g)*	*Seed weight (g/100)*
	Weeds	*V.bean*					
Tillage & velvet bean	0.00	3.30	0.88	1.27	1.08	64	28
Hand weeding and velvet bean	0.06	4.10	1.39	1.25	1.21	88	29
Round-up and velvet bean	0.00	3.00	1.94	1.25	1.57	101	29
Tillage (mechanical)	2.10	0.00	1.19	1.43	1.23	69	29
Hand weeding	3.70	0.00	1.04	1.08	1.28	72	28
Round-up	2.90	0.00	1.25	1.44	0.99	78	29
F prob.	*<0.001*	*<0.001*	*0.139*	*0.896*	*0.103*	*0.076*	*0.701*
LSD (P<0.05)	*1.40*	*0.80*	*ns*	*ns*	*ns*	*ns*	*ns*
%CV	*60.1*	*31.2*	*40.6*	*36.5*	*21.7*	*21.7*	*3.4*

As in the previous years of the Loes velvet bean trials, no interaction between velvet bean and land preparation method was found.

Table 112. Land preparation method/velvet bean replicated trials Loes, 2011-2012.

Factor (number of modalities)	*F prob.*		
	Maize yield	*Dry biomass v.bean at harvest*	*Dry biomass weeds at harvest*
Factor 1: Land Preparation method (3)	0.122	0.148	0.086
Factor 2: Velvet bean (2)	0.270	<0.001	<0.001
Interaction (6)	0.186	0.148	0.533

In the 2012 dry season trials, velvet bean failed to produce a significant yield advantage. The weed burden was reduced in plots planted with velvet bean, but this did not have a significant effect on yields. The results of the 2012 trials are outlined in Table 113.

Table 113. Maize-velvet bean replicated trial results, Loes dry season 2012.

Treatment	*Dry biomass at harvest (t/ha)*		*Maize yield (t/ha)*	*Plant density at harvest (plant /m²)*	*No cobs/ plant*	*Seed weight/ cob(g)*	*Seed weight (g/100)*
	Weeds	*V.bean*					
Tillage & velvet bean	0.00	4.50	2.21	2.1	1.24	91	29
Hand weeding and velvet bean	0.00	3.30	2.10	1.2	1.94	111	29
Round-up and velvet bean	0.00	4.80	2.34	1.9	1.25	100	29
Tillage (mechanical)	3.23	0.00	2.11	2.1	1.09	98	29
Hand weeding	2.93	0.00	1.28	1.3	1.16	89	28
Round-up	4.67	0.00	1.96	1.6	1.42	88	27
F prob.	*<0.001*	*<0.001*	*0.295*	*0.429*	*0.662*	*0.821*	*0.334*
LSD (P<0.05)	*1.30*	*1.70*	*ns*	*ns*	*ns*	*ns*	*ns*
%CV	*40.5*	*43.5*	*27.1*	*36.1*	*48.5*	*23.7*	*4.9*

As in the previous planting, no interaction was found between land preparation method and velvet bean.

Table 114. Land preparation method/velvet bean replicated trials Loes dry season 2012.

Factor (number of modalities)	*F prob.*		
	Maize yield	*Dry biomass v..bean at harvest*	*Dry biomass weeds at harvest*
Factor 1: Land preparation method (3)	0.708	0.822	0.961
Factor 2: Velvet bean (2)	0.183	0.022	0.195
Interaction (6)	0.706	0.344	0.280

Table 115 outlines the mean yield for plots with and without velvet bean for the duration of the experiment at Loes. As with the Betano experiment, yield advantages tend to be higher in the dry season. The Loes experiment has shown a significant advantage to planting velvet bean only once (dry season 2011).

Table 115. Historical yield advantages from Loes replicated trials 2012-2012.

Treatment	*Maize yield (t/ha)*			
	Wet season 2010-11	*Dry season 2011*	*Wet season 2011-12*	*Dry season 2012*
Velvet bean	2.5	2.3	1.40	2.21
No velvet bean	1.9	1.5	1.16	1.80
Yield advantage	32%	53%	21%	23%

Results - Viqueque

Due to a high demand among farmers in the Viqueque area, a wet season velvet bean trial was implemented in 2011-12. This was the first velvet bean trial to be conducted off-station, and land was provided by a local farmer. There is a long history of velvet bean intercropping among Timorese farmers, with evidence that it was used in several parts of the country. Reports from farmers indicate that velvet bean was common in some areas approximately 40 to 50 years ago, but that seed stores were lost and no new sources could be identified for several decades. Seeds of Life has been the only known source of velvet bean seed in the country since independence and small amounts of seed have been recognized and readily accepted by farmers.

The Viqueque trials followed the same format as Loes, but biomass data were not collected due to the difficulty of doing this off-station. While no significant difference was found for velvet bean planted plots, this has also been the case for the first-year trials at Betano and Loes. This supports the theory that velvet bean produces a cumulative benefit that is more easily seen after a second year's planting. The results of the Viqueque trial are presented in Table 116.

Table 116. Maize-velvet bean replicated trial results, Viqueque, wet season 2011-12.

Treatment	*Maize yield (t/ha)*	*Plant density at harvest (plant /m²)*	*No cobs/ plant*	*Dry seed weight/ cob (g)*	*Seed weight (g/100)*
Tillage & velvet bean	3.8	6.2	0.7	85.0	28.0
Hand weeding and velvet bean	3.5	6.1	0.6	74.8	27.7
Round-up and velvet bean	2.9	6.	0.6	80.4	26.6
Tillage (mechanical)	3.0	4.5	0.7	58.5	24.3
Hand weeding	3.5	5.3	0.9	66.8	24.5
Round-up	3.0	5.6	0.7	67.2	26.6
F prob.	*0.876*	*0.049*	*0.683*	*0.141*	*0.072*
LSD (P<0.05)	*2.03*	*1.12*	*0.39*	*21.00*	*3.34*
%CV	*34.1*	*11.0*	*30.9*	*16.0*	*7.1*

No interaction effect was observed between land preparation method and use of velvet bean (Table 117).

Table 117. Velvet bean treatments, Viqueque wet season 2011-12.

Factor (number of modalities)	*F prob.* *Maize yield*
Factor 1: Land Preparation method (3	0.672
Factor 2: Velvet bean (2)	0.620
Interaction (6)	0.740

Conclusions

Velvet bean continues to be in high demand among Timorese farmers and results of the long term trials support the case that it is a beneficial local technology. Its effectiveness as a weed suppressant is supported by the multi-year trials and it has often proven to significantly improve maize yields. The trend of even higher yield advantages occurring in the dry season should be looked at further in the coming years, as this may be a useful drought or marginal area strategy if the effect can be proven.

5.2 Grain bins for maize storage

Background

Weevil *(Sitophilus zeamais)* damage is a major constraint to long term maize storage. Most Timorese farmers are only able to store maize for less than 12 months. This fits the annual cycle of cropping, but does not allow for keeping surplus food from one year to the other, Even within a year, weevils can often do considerable damage to stored maize. In maize that is threshed and stored in a ply sack, within 12 weeks, more than 50% of the maize has been eaten by weevils. Maize that is not threshed, and is stored in the sheath, as most Timorese farmers do, has a slower rate of weevil infestation, but weevil damage is still a significant issue.

The most common method of weevil free storage is the use of second hand fuel drums. Since Indonesian times, farmers have valued the second hand fuel drums for maize storage. The fuel drum is cleaned and dried before use. The drum has a small (65mm diameter) opening, making access difficult. The drum is often stored in the house and has been proven by many farmers for many years to stop weevil infestation.

The drum prevents weevil damage as it forms an airtight seal. As the maize seed is still alive, and any weevils in the maize are also using oxygen (O_2) the oxygen level in the drums drops. At the same time the level of Carbon dioxide ($C0_2$) increases. The impact of low O_2 levels and high $C0_2$ results in the death of any weevils in the maize. In this way, air tight storage is able to kill any weevils in the grain, and prevent any weevil damage to the grain.

More recently, there has been a move to find new ways of grain storage, that could be manufactured in Timor. In conjunction with Drums on Farm and East Timor Roofing, a new design of grain storage bin has been developed and is being sold to farmers in Timor-Leste. The bin is based on the design of a water storage tank, that East Timor Roofing have made for many years. The grain storage bins are made in Baucau, using imported flat galvanised iron. The advantage of the bins is that they are new, and have been purpose built for grain storage. The walls of the bin are corrugated, giving good strength to the drum. The flat tops and bottoms of the bin are also made of galvanised iron, with a plastic layer, to prevent moisture entering the grain bin. The bins are made the height of one sheet of galvanised iron (approx. 90cm after corrugation). The volume of the bin is adjusted by changing the diameter of the bin at manufacture. East Timor Roofing has been successfully making 200l and 400l grain bins for general use.

The challenge of the grain bin is to make the inlet and outlet airtight. To achieve this, the design has a 10 cm opening, with a screw cap lid. The outlet uses a poly pipe, with a screw top fitting with an o ring.

Testing the new grain bin with farmers

Various models of the new grain bin were tested with approximately 20 farmers at field days at Darasula seed shed. The options shown were 200l and 400l sizes, with both a single and dual inlet/outlet.

Overall, the farmers liked the very sturdy construction of the bins. The corrugated iron walls allows a great strength to the bins, that was not possible with flat iron sheets. Most farmers had some experience with silos (150-400 kg capacity) that had flat iron sheets.

The 100 mm outlets allowed easy access of grain into and out of the bin. Farmers were able to pass grain into and out of the bins, with very little difficulty. There was some difficulty closing the lower outlet, when there was grain still in the bin. As the screw cap was closed, grain coming down the outlet would block the thread, making it difficult to close the cap in an air tight manner. This was solved by using a plastic bag, or rag to act as a barrier, to stop the grain flowing. A better purpose built plug, the same size of the outlet could be built to block the grain, and allow the cap to be screwed.

The farmers liked the dual outlet system, but were concerned that the plastic fittings may not last as long as the tank. The extra long inlet at the top of the drum was seen as a weakness, and the farmers preferred a short outlet to reduce damage to the inlet.

Materials and methods

A replicated trial was established to determine the ability of the new design grain bin to kill weevils. Weevils were placed in the filled grain bin from 3 days to 4 weeks, and then observed, to see the effect of confinement in the bin on their activity.

Three grain bins were used in the experiment, each one was a replicate in the experiment. The bins were filled with clean maize that had no live weevils. In each bin, live weevils were placed in a netted enclosure, and placed in the bin. The bins were closed and opened at a prescribed time to see the condition of the weevils in the bin. At each observation, fresh live weevils were added to the bin, in the netted structure. The weevil enclosure was supplied with approximately 50 g of maize and 200 weevils. Weevils were sourced from a weevil farm, that consisted of same grain that was stored in a woven sack.

Results

There was no increase in weevil death rate death from 3 to7 days of storage. At more than 10 days of confinement weevil death increased from 33 % to 100% (Table 118).

Table 118. Weevil death rates when stored in a filled grain bin for 3 to 28 days.

Days	*Weevil deaths (%)*
3	10 a
5	5.4 a
7	4.2 a
10	33.3 b
21	92.5 c
28	100 c

This data are good evidence that the new design grain bins are able to disinfest weevils in stored maize. The tested drums are suitable for Timorese farmers. In addition, they have shown to have the storage qualities of the familiar second hand fuel drums. Grain bins can now be recommended for wide-spread use among Timorese farmers.

The level of infection tested in this experiment was very low, at about 1 weevil per litre of maize. It is expected that at infection rates greater than 1 weevil/ l the rate of weevil death would be greater, as the respiration of the extra weevils, would deplete the oxygen faster. This is a feature of air tight seed storage, the higher the level of infection, the faster the weevils are killed.

What is not known is the effect of the grain bin being only partly filled with grain. A partly filled grain would have less ability to kills weevils, as there is a larger volume of air, and consequently oxygen. Further research is required to investigate the impact of partly filled bins on rate of weevil death.

5.3 Sweet potato nutrient-addition pot trial

Background

Adoption of the recommended sweet potato varieties in Baucau has been quite high. Some farming families have been producing good yields and profited selling the large tubers. However, one of the early adopters (Sra Martina) experienced problems with her crops during 2010 and 2011. Her farm is located on the red soil of the Baucau plateau, inland from Triloka. The site had been cropped for many years, and continuously cropped with sweet potatoes for 4 years from 2006-2010. She reported that disease was affecting the plants, producing very poor growth and very low yield. The plants did not appear to express fungal rot or bacterial disease symptoms and soil nutritional problems were suspected. Based on soil tests of similar soils from nearby, the soil was suspected of having low levels of Fe, Zn and P. No fertilizer had been applied in earlier years and it was also considered that nitrogen would also be limiting foliage growth. Soil pH was 6.0 to 6.5.

In response to farmer's problems, a pot trial was established to determine the soil's most limiting nutrients.

Materials and methods

A pot trial using sweet potato as the test species was established to define if the problems observed by Sra Martina could be relieved by micronutrients, P or complete nutrient addition.

Complete nutrients were added in two ways, firstly as cow manure, and secondly as a commercially available complete nutrient mix. A second hypothesis was that micronutrients or Phosphorus could be the limiting factor in the soil, so there was a treatment with only added Phosphorus as triple super phosphate (TSP) and further treatment where only micronutrients were added.

The pot trial had 5 treatments. The treatments were a 1) Control, with nothing added to the soil, 2) added micronutrients, 3) added complete nutrient mix, 4) added TSP and 5) added cow manure. The application rates are described in Table 119.

The trial was established 6 April, and harvested in 3 August 2012. One research unit was a 30 cm diameter pot.

Table 119. Treatments in sweet potato nutrient pot trial

Treatment	*Rate*	*Analysis*
Control	0	
Micronutrients	15 g/pot	S 6%, Ca 10%, Mg 3.6%, Mn 2.9%, Cu 1.2%, Zn 1%, Bo 0.09% Mo 0.004%
TSP	15 g/pot	
Complete Nutrients	15 g/pot	N 13%, P 2%, K 6%,17.5%, S 17.5% Ca 4.9%
Cow manure	5kg/10kg soil	Unknown

Stem length was measured 6 weeks after planting, as was plant vigour, area of the youngest expanded leaf 10 weeks (13 June) after planting. At harvest, the tubers were removed, counted and weighed.

Results

There were large visual differences between treatments during the trial (Figure 30, Figure 31). The control (no additions) had very poor growth. The application of micro nutrients had no effect on plant growth, leaf size or final harvest. There was some visual response to added P, but there was no effect on yield at harvest. The application of complete nutrients and cow manure produced good healthy growth throughout the trial. These two treatments produced longer runners, and larger leaves, and looked significantly healthier than all other treatments at 6 and 10 weeks after planting. All other treatments were similar to the control. The complete nutrient treatment was healthier and had longer stems than the treatment with added manure (Table 120).

Table 120. Treatment responses in sweet potato pot trial at 6 and 10 weeks.

Treatment	*Stem length 6 weeks after planting (cm)*	*Health Index (1 to 5*)*	*Area youngest expanded leaf (cm2**)*	*Tubers per pot****	*Yield (g/pot)****
Control	9.3	1.7	31	6.7	220
Micronutrients	10.4	2.3	34	6.7	220
TSP	10.6	3.2	40	5.7	250
Complete nutrients	15.2	5.0	71	5.0	390
Cow manure	13.2	3.0	69	6.3	801
CV%	7	18.3	13	5.1	240
LSD	1.8	1.0	12	ns	9.2

** Measured 10 weeks after planting, Maximum score was 5 **also measured 10 weeks after planting. *** 17 weeks after planting*

At harvest at 17 weeks after planting, the complete nutrient and manure treatment produced greater tuber weight than all of the other treatments (Table 120). Although the complete nutrient treatment had a greater top growth than the manure treatment, the yield of the manure treatment was much higher. This may be case of over growth of the sweet potato in response to the complete nutrient solution, resulting in lower yield. It is possible that the well fertilised treatment could have produced a higher yield if grown for a longer time.

Summary

The sweet potato problem identified at Sra Martina's farm is most likely nutritional. The limiting factor is not likely to be P or micronutrients. It is most likely the limiting nutrient is nitrogen.

Figure 30. Visual differences of control and full nutrient added treatment.

Figure 31. Measuring soil pH in pot trial

5.4 Rice agronomy trials, 2012

During the 2012 rainy season, agronomy trials were planted at the Irrigated Rice Research Site (IRRS) near Maliana in Bobonaro District. The trials measured the effects of seedling age and number of seedlings per hill on yields of the MAF released variety *Nakroma*. The trial was implemented to test some of the recommendations of SRI (System of Rice Intensification), which are commonly advocated by MAF and other programs. The Timor-Leste SRI guidelines advocate transplanting of young seedlings and low plant densities of 1 seedling per hill. (Deichert, Barros, & Noltze, 2009) The 2012 rice agronomy trials assessed the effectiveness of these two recommendations.

Methodology

The effects of two treatments, seedling age and planting density, were evaluated. The trial was designed as a factorial combination with 14, 21, and 30 day old seedlings (T 1-3), and planting rates of 1, 2, and 3 seedlings per hill (Q 1-3). Treatments for the experiment are outlined in Table 121. Plots were planted with 25cm spacing between lines and 20cm spacing between hills.

Table 121. Treatments for agronomy trials, Maliana 2012.

Seedlings per hill	*Age of seedling (days old)*		
	14	20	30
1	T_1Q_1	T_2Q_1	T_3Q_1
2	T_1Q_2	T_2Q_2	T_3Q_2
3	T_1Q_3	T_2Q_3	T_3Q_3

The trials were weeded with a non-motorized mechanical weeder and by hand three times throughout the growing season. Other than the treatments being tested, only local agronomic practices were used and no fertilizer was applied to the trial. Planting dates were staggered due to the required differences in age of the seedlings, but all plots were trans-planted in February and harvested on 25 May.

Results were analysed in GenStat Discovery 4 using both one way and two way ANOVA. Complete treatments were analysed, as well as the effect of individual factors and their interaction.

Results

Results of the trial are presented in Table 122. No treatment had a significant effect on yield or final height, but a significant effect on seed weight was observed. With individual factors, however, the results were more conclusive. While planting density was not found to affect yield or yield components, a significant effect was found for seedling age across all measured parameters.

Table 122. Results of agronomy trial, Maliana 2012.

Treatment	*Yield (t/ha)*	*Weight of 100 seeds (g)*	*Plant height at harvest (cm)*
T_1Q_1	5.93	1.65	63.2
T_1Q_2	6.33	1.70	65.8
T_1Q_3	5.67	1.53	63.1
T_2Q_1	4.33	1.30	61.9
T_2Q_2	4.67	1.40	61.6
T_2Q_3	6.00	1.63	64.0
T_3Q_1	5.00	1.37	60.2
T_3Q_2	4.72	1.41	61.1
T_3Q_3	5.00	1.57	61.7
F prob	*0.106*	*0.043*	*0.138*
LSD ($p<0.05$)	*ns*	*0.26*	*ns*
%CV	*16.1*	*10.0*	*3.5*

Table 123 shows the effects of the two factors on yield, seed weight, and plant height at harvest. Planting density had no significant effect on any of the measured components, but there was a clear significant effect of seedling age on yield and all components. The recommendation of low planting densities by SRI would be beneficial as seed saving measures, but were not shown to have a significant effect on yield.

Table 123. Age of seedlings / planting density agronomy trials, Maliana 2012.

Factor (number of modalities)	*F prob.*		
	Yield	*Weight of 100 seeds*	*Plant height at harvest*
Factor 1: Age of seedlings (3)	0.030	0.029	0.027
Factor 2: Planting density (3)	0.508	0.182	0.491
Interaction (9)	0.235	0.112	0.402

Table 124 shows the clear trend of higher yields and yield components for a seedling age of 14 days compared to 21 or 30 day old seedlings. Planting younger seedlings was shown to have an advantage of approximately 1 t/ha over planting older seedlings.

Table 124. Effect of seedling age on rice yields, Maliana 2012.

Age of seedlings (days)	*Yield (t/ha)*	*Weight of 100 seeds (g)*	*Plant height at harvest (cm)*
14	5.98	1.63	64
21	5.00	1.44	62
30	4.91	1.45	61
LSD ($p<0.05$)	*0.85*	*0.15*	*2.16*

Conclusions

This trial is the first of its kind to be conducted by Seeds of Life, and further agronomic trials are planned for the coming years. Fourteen day-seedlings were shown to have significantly higher yields than seedlings left longer in the nursery. Planting density was shown not to have a significant effect, but this should be further tested in later trials. As SRI and other agronomic systems become more common among Timorese farmers, it becomes increasingly important that their recommendations be tested. A repeat of this trial was implemented in late 2012 and will be included in the 2013 Annual Research Report. This will allow for a multi-year analysis which produces more robust results to test the effectiveness of these SRI recommendations.

6. Social science research

6.1 Farmer baseline data survey (*Buka Data Los*)

During the 2011-2012 growing season, 219 farmers participated in 225 OFDTs in seven Districts (Ainaro, Aileu, Baucau, Bobonaro, Liquiça, Manufahi and Viqueque). This number is smaller than the number of OFDTs in 2010-2011 (277) and in 2009-2010 (480).

The OFDT farmers were surveyed and interviewed to obtain information on their livelihood status and current farming practices. This survey is termed *Buka Data Los* (BDL) which means 'looking for true or reliable data' in Tetun. The BDL survey provides information on the number of members in each household, whether the house was headed by a male or female, the type of crops grown, food security by household, reasons for crop failures or poor yields and a measurement of household wealth. For 2011-2012, BDL data was available for 219 farm households, but was not always complete for each of these households.

Farmer household and gender participation

Farming in Timor-Leste is very much a collective activity in which most household members participate. Young boys, for example, tend animals and older family members perform light duties such as milling grain. In 2011-2012 most farm households participating in OFDTs had between three and nine members to distribute the workload, with an average of 6.8 persons per household (Table 125). The larger households (greater than 10) were usually extended families living under the same roof (i.e. grandparents, parents and children).

Table 125. Number of members of OFDT households, by District

Members per household	*District*							*Total households*	
	Ainaro	*Aileu*	*Baucau*	*Bobonaro*	*Liquica*	*Manufahi*	*Viqueque*	*(Number)*	*(%)*
1				1				1	0.5
2	1		3	2	2		2	10	4.6
3	1	1	5	4	2	2	2	17	7.8
4	1	1	6	3	1	3	4	19	8.7
5	2	2	3	6	4		3	20	9.1
6	1	2	3	3	5	1	2	17	7.8
7	3	4	5	4		4	7	27	12.3
8	2	3	3	3	2	4	5	22	10.0
9	2	1	5	6			2	16	7.3
10		2	2		5		1	10	4.6
11	2		1	1	3			7	3.2
12	1	1	1		1			4	1.8
13			1					1	0.5
14	1							1	0.5
15(*)							1	1	0.5
63(*)							1	1	0.5
(blank)		14	5	1	4	1	20	45	20.5
Total	*17*	*31*	*43*	*34*	*29*	*15*	*50*	*219*	*100*

(*) These were actually farmer groups, not single households

Although farm households operate as production units, the head of household is considered to be the most senior person in house. Often this is a male but regularly females provide overall leadership in the house. During 2011-2012 24% of the surveyed OFDT households were reportedly headed by women and 76% by men (Table 126). This compares with 34% and 66% respectively in the 2010-2011 survey.

Table 126. Gender participation as heads of households, 2011-2012

District	*Sub-District*	*OFDT Farmers*			*Percentage*	
		Male	*Female*	*Total*	*Male*	*Female*
Ainaro	Maubisse	14	3	17	82	18
Aileu	Aileu Villa	10	11	21	48	52
	Laulara	2	2	4	50	50
	Remexio	2	1	3	67	33
	Liquidoe	2	1	3	67	33
Baucau	Vemase	14	7	21	67	33
	Venilale	8	2	10	80	20
	Baucau	10	2	12	83	17
Bobonaro	Balibo	13	1	14	93	7
	Maliana	12	8	20	60	40
Liquiça	Maubara	10	2	12	83	17
	Liquiça	10	7	17	59	41
Manufahi	Alas	13	2	15	87	13
Viqueque	Ossu	24	1	25	96	4
	Viqueque	22	3	25	88	12
Total		*166*	*53*	*219*	*76*	*24*

Cropping patterns

Farmers in Timor-Leste grow a wide range of food crops to spread the risk of failure in one or more commodities. A list of food crops cultivated by farmers conducting OFDTs in 2011-2012 is presented in Table 127. The risk of crop failure is also reduced though intercropping. The key food crops grown during the year were cassava, pumpkin, maize and sweet potato. Household consumption from harvest of these was supplemented with yard-long beans, taro, peanut and a wide range of other traditionally grown species. Irrigated rice was cultivated by 20% of the respondents, and upland rice by 3% of them.

Table 127. Food crops planted in house gardens or bush gardens

Crops planted English	*Tetun*	*Latin*	*Total*	*% of total respondents*
Cassava	Aifarina	*Manihot esculenta Cranz*	133	61%
Pumpkin	Lakeru	*Cucurbita spp*	124	57%
Long season maize	Batar Bot	*Zea mays* L.	119	54%
Sweet potato	Fehuk midar	*Ipomea batatas (L.)* Lamb	88	40%
Cowpea	Foretalin	*Vigna unguiculata subsp. Sesquipedalis (*Verdc*)*	74	34%
Taro	Talas	*Colocasia esculenta* L. Schott	60	27%
Short season maize	Batar Lais	*Zea mays* L.	54	25%
Cucumber	Pipinho	*Cucumis sativus*	51	23%
Arrowroot	Kontas	*Maranta arundinacea* L.	48	22%
Irrigated rice	Hare irigasaun	*Oryza sativa* L.	43	20%
Red bean	Koto mean	*Phaseolus vulgaris* L.	36	16%
Wild yam	Kumbili	*Dioscorea spp.*	34	16%
Peanut	Forerai	*Arachis hypogaea* L.	32	15%
Sorghum	Batar hun a'as	*Sorghum bicolor* L.	28	13%
Potato	Fehuk ropa	*Solanum tubersosum* L.	19	9%
Mung bean	Foremuunggu	*Vigna radiate (L)* Wilczek	17	8%
Elephant foot's yam	Maek	*Amorphophallus paeoniifolius (*Denst.*)*	15	7%
Yam bean	Singkumas	*Pachyrhyzus erosus* L.	14	6%
Bitter bean	Kotomoruk	*Phaseolus lunatus* L.	7	3%
Upland rice	Hare rai maran	*Oryza sativa* L.	6	3%
Improved maize	Sele, Noi Mutin	*Zea mays* L.	5	2%
Foxtail millet	Botok	*Setaria italic* L	2	1%
Pigeon pea	Tunis	*Cajanus cajan* L.	1	0.5%

N=219

Apart from the foodcrops, many farmers also have fruit trees, such as bananas and papaya, in gardens near their houses. Some respondents mentioned these as well, but that data has not been included in the list.

The distribution of the number of crops cultivated by the OFDT farmers (Figure 32) shows that, if possible, farmers prefer to cultivate several crops to reduce the risk of loss of food or income due to crop failure. Close to 70% of the farmers cultivate between 4-7 food-crops.

Table 127 also shows that tuber crops are prominent key staples for farmer households. Some of these (cassava and sweet potato for example) can be harvested over a period of time and provide valuable supplements to maize and/or rice and/or replace them during lean times. Tubers store well in the ground and are also harvested opportunistically as wild products from surrounding forests.

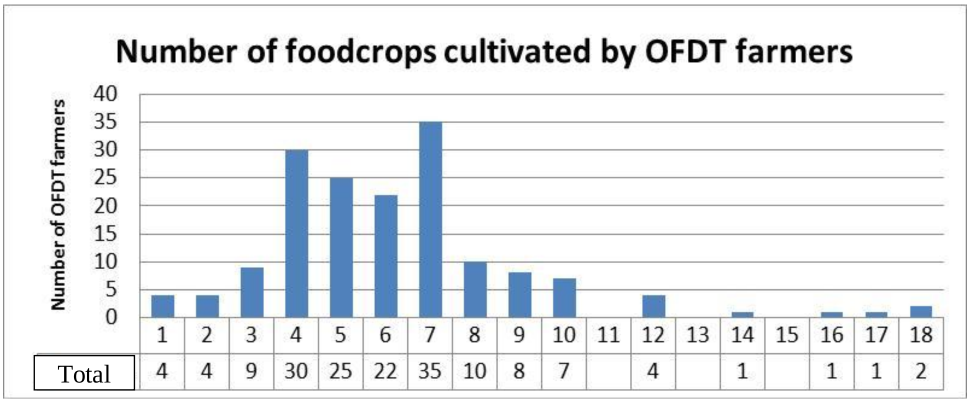


Figure 32. Number of crops cultivated by OFDT farmers (N= 163)

Food security

Data from the survey provide an indication of maize production adequacy for domestic consumption among the participant farmers (see Table 128). Respondents were asked whether they considered their last maize harvest was either insufficient to cover their annual needs, sufficient or they considered they had a surplus.

The percentage of farmers who considered that their maize harvests were particularly poor in 2010-2011 (to eat during the 2011-2012 growing season) was 47%. The percentage of male OFDT farmers who reported they did not have enough maize was lower than the percentage of female farmers. Comparing the reported maize insufficiency with the figures of previous years (Table 129) shows that the percentage in 2011-2012 for insufficiency was the highest in five years. Maize insufficiency was reportedly the highest in Baucau (73%), where it was only 13% in the previous year – the lowest of six Districts in that year. At the opposite end of the spectrum, the percentage of farmers who had a marketable surplus (8%) was almost the same level as the previous year.

Table 128. Respondent measures of food sufficiency (maize)

	Insufficient	*%*	*Sufficient*	*%*	*Surplus*	*%*	*Total*
Ainaro							
Aileu	8	42	10	53	1	5	19
Baucau	22	73	7	23	1	3	30
Bobonaro	13	46	14	50	1	4	28
Liquiça	11	65	3	18	3	18	17
Manufahi			9	90	1	10	10
Viqueque			8	80	2	20	10
Male	34	41	42	51	7	8	83
Female	20	65	9	29	2	6	31
Total	*54*	*47*	*51*	*45*	*9*	*8*	*114*

N=114

Table 129. Respondent food security over years (maize)

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

The BDL questionnaire also asks the farmers who reported they did not have sufficient maize reserves in which month they ran out of stock. Figure 33 shows the situation in 2011. Based on the responses from 23 OFDT farmers (of the 54 who reported not having sufficient maize), some 47% of them ran out of maize by May.

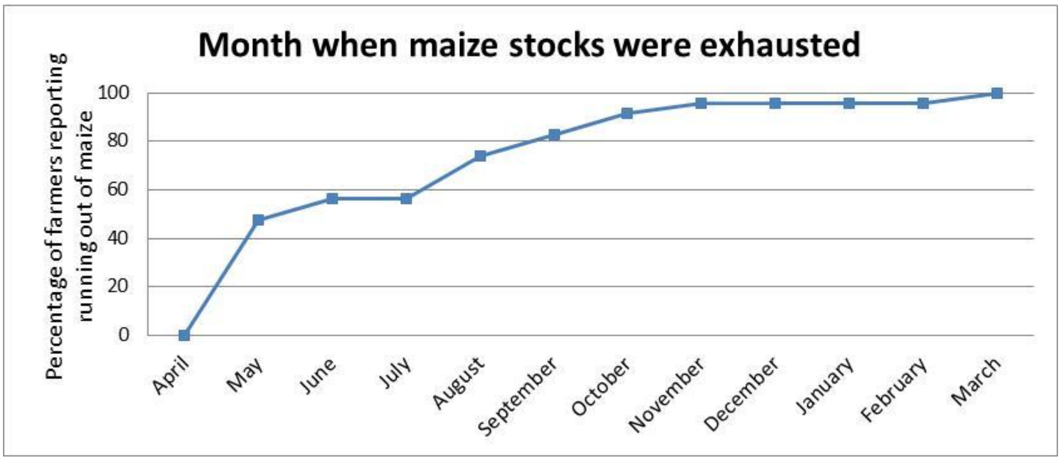


Figure 33. Maize sufficiency in farm households (2011)

The comparison of sufficiency in self-grown maize over the last five year, as shown in Table 129, and the information in Figure 33, indicates that the Timorese farmers had much less maize in 2011-2012 than in previous years. In 2010-2011, there were very heavy rains at the start of the growing season, and a longer than usual rainy season. MAF reported that, in that growing season, only about 20% of the normal maize harvest was harvested, which meant that the farmers ran out of maize more quickly in 2011-2012 than in previous years.

The BDL recorded data from 58 farmers on causes of crop damage in 2010-2011 (Table 130). Weather related factors were the most common. Too much rain was mentioned by 76% of the farmers who provided information on crop damage. There were also six farmers who reported crop damage because of lack of rain. In 2010-2011 attacks by rats were also a major cause of crop damage, reported by 41% of the farmers reporting crop damage. Damage by pests, which was only reported by two farmers in 2010-2011, this year caused damage for 14 farmers. Damage by strong winds, which particularly affects local taller varieties of maize, were more a cause of damage than in 2010-2011 (when it accounted for 4% of the damage, compared to 7% this year).

Table 130. Farmer's perceptions of factors reducing harvest yields by District

District	*Cause of crop damage*				
	Lack of rain	*Too much rain*	*Rats attack*	*Strong winds*	*Pests*
Ainaro		16			
Aileu		2	5	2	1
Baucau		14	13		5
Bobonaro	4	5			
Liquiça	2	7	6	5	8
Total	*6*	*44*	*24*	*7*	*14*
% of causes	*6*	*46*	*25*	*7*	*15*
% of farmers reporting damage	*10*	*76*	*41*	*12*	*24*

The most common practices of storage of maize seeds and seeds of other crops are presented in Table 131. By far the most common practice was storing the maize above the fireplace or somewhere else in the house (58% of respondents). It is believed that the smoke and dry atmosphere above the fireplace reduces weevil damage. Other storage techniques included storage in a tree (to reduce rat and other animal damage). The use of improved storage techniques such as air tight silos and jerry cans remained infrequent. These improved storage techniques are designed to reduce oxygen levels in the containers to a level in which weevils cannot survive (see 5.2).

Table 131. Storage methods for maize seed (and other crops)

Method	*Ainaro %*	*Aileu %*	*Baucau %*	*Bobonaro %*	*Liquiça %*	*Manufahi %*	*Viqueque %*	*Average %*
Above the fireplace	100	32	46	55	71	31	63	58
Drum			5		12	15		4
Hanging in tree		63	39	3		54		26
Inside the house		5					25	2
Jerry can				31	6			8
Other			5	3	6		13	4
Plastic bottle			2	7				2.2
Sack			2		6			1.5
Total # of respondents	*17*	*19*	*39*	*27*	*16*	*11*	*8*	*137*

N=145 storage methods mentioned by 137 respondents

Economic status

The socio-economic standing of the farmers participating in the OFDTs was assessed to evaluate the range and average level to determine whether SoL was directing its varietal evaluation program correctly. The program aims to direct its activities towards an appropriate range of farmer families. Two levels of general household wealth were measured. These were the house type and household ownership of purchased consumer goods.

The standard residential housing among farmers participating in OFDTs is presented in Table 132. House style and quality are a widely used proxy for relative economic standing and tend to correlate well with household financial capacity. Roof type is a common indicator of household wealth with farmers opting for a waterproof galvanized iron covering if they can afford it. A majority (62%) of participating farmers did have fully or partially galvanized iron roofs in 2011-2012. This is lower than in previous years (Table 134). In 2011-2012 around 74 % of the OFDT farmers lived in houses with non-brick walls, most of which were made of wood or sago palm (*bebak*). The percentage of OFDT farmers with full brick walls was just over half of what it was in the previous two years. In 2011-2012, 81% of the farmers had non-cement or non-tile floors, which was the lowest reported figure over a five year period.

Table 132. House types across the seven Districts

District	*Ainaro*	*Aileu*	*Baucau*	*Bobonaro*	*Liquiça*	*Manufahi*	*Viqueque*	*Average*
N=	*16*	*23*	*37*	*34*	*22*	*15*	*9*	
	%	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Corrugated iron roof	47	77	54	65	55		20	54
Corr. iron & other roof			19	6		29		8
Palm leaves & thatch	53	23	27	29	45	71	80	38
Full block wall	6	35	11	18	5		11	13
Concrete/brick		35	11	18	5			12
Rock	6						11	1.3
Half block wall	6	4	24	18	9			12
Brick & corr. iron	6		8	12	9			6
Brick & other		4	16	6				6
Non-brick walls	88	61	65	65	86	100	89	74
Palm trunk (bebak)	25	4	14	59	23	100	33	34
Bamboo	25	43	46		32		44	27
Earth		9	5		18			5
Corr. Iron & other	25				5		11	4
Corrugated iron		4			9			1.9
Wood				6				1.3
Grass	13							1.3
Cement & tiles floor	6	43	30	21				19
Cement	6	35	22	14				14
Tiles		9	8	7				5
Non-cement floor	94	57	70	79	100	100	100	81
Soil or clay	94	57	68	79	71	100	100	77
Wood			3		29			5

The housing conditions of the OFDT farmers and the ownership of consumer goods seem to indicate that the OFDT farmers in 2011-2012 were on average poorer than the OFDT farmers of 2009-2010 (Table 133 and Table 134).

Table 133. Wealth measures by key commodity ownership

District	*Ainaro*	*Aileu*	*Baucau*	*Bobonaro*	*Liquiça*	*Manufahi*	*Viqueque*	*Average*
N=	*17*	*31*	*43*	*34*	*29*	*15*	*50*	
	%	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Chairs (wood, plastic)	41	52	70	76	45	100	2	49
Radio	76	42	47	21	31	47		32
TV	6	39	33	18	7	7		16
Telephone / mobile	76	48	60	26	28	27	2	35
Refrigerator / freezer		10	5					2
Bicycle		13	7			33	2	6
Motorbike		26	14	12		20		10
Car / angguna		3	2					0.9
Rice husker								
Rice milling								
Boat								
Generator		6	2					1.4

Table 134. Wealth measures across years

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

Conclusion

The BDL survey presented above provides a measurement of the farmer households that participated in SoL OFDTs during 2010-2011. Most of the data indicate that OFDT farmers were subsistence farmers cultivating a wide range of crops to reduce the risk of food shortages. Close to 50% of the farmers did, however, start running out of stored maize early in the year. This loss of carbohydrate was most likely made up through the consumption of tubers, and in some cases, subsidized Government rice.

7. Climate and climate change on agriculture

Activities included in the climate change section of the Seeds of Life (SoL) program during the year included a) the development of District climate posters to promote an understanding of the effect of climate and climate change on agriculture at the District level. b) the development of ENSO (El Nino Southern Oscillation) index graphs to forewarn the oncoming annual climate variation. c) The development of soils maps to assist with resolving plant nutrition issues and d) a brief summary of a terracing study.

7.1 District climate posters

Posters were developed presenting a) a topographical map of the District possessing rainfall, maximum and minimum temperatures for Sub-Districts) b) a short description of ENSO and the ways that La Nina and El Nino affect rainfall in Timor-Leste, c) rainfall maps showing current and predicted rainfall for 2050, d) A description of the annual variability in climate that can be caused by ENSO and finally, a few suggestions on ways in which it may be possible to mitigate the effects of climate change on food production. A representative poster for Baucau District is presented in Figure 34.

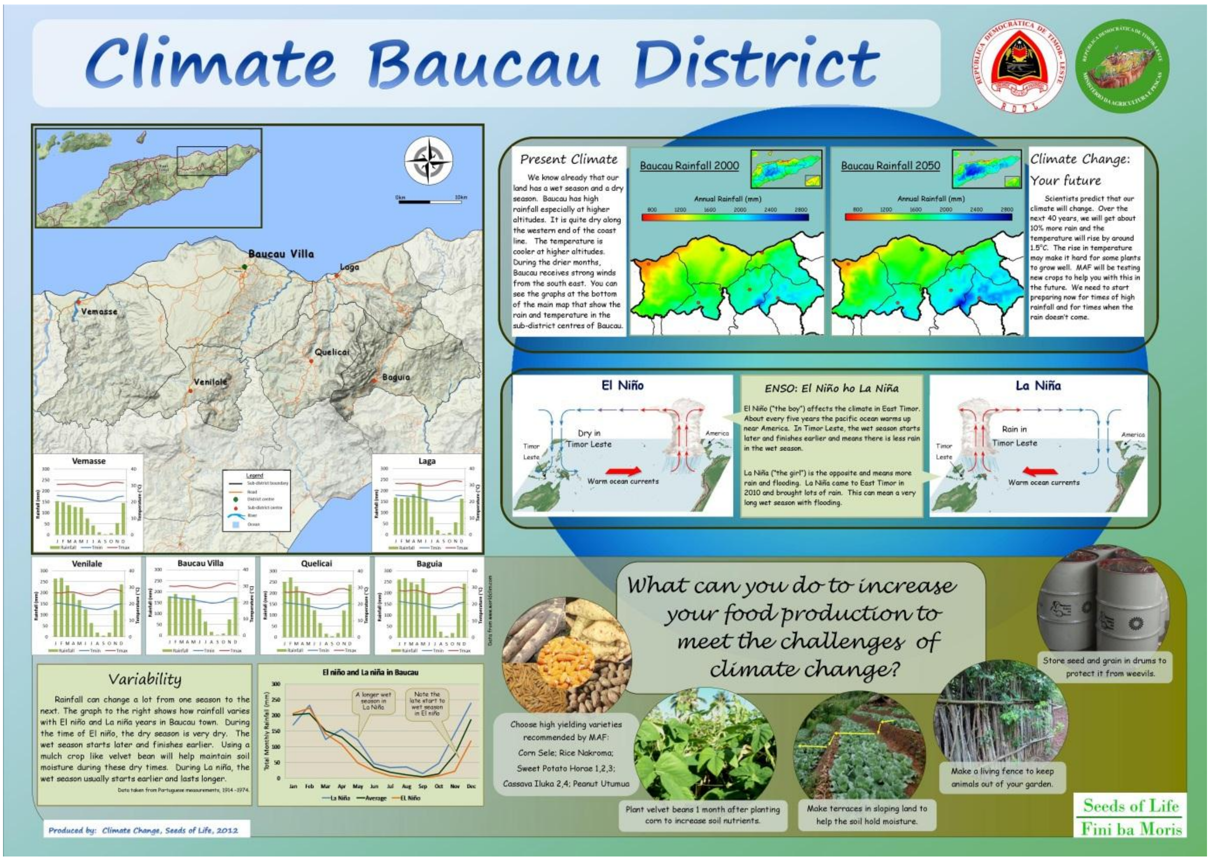


Figure 34.   Climate and climate change poster for Baucau District

7.2 Sub-District rainfall and temperature patterns

Rainfall and temperature graphs were included for each Sub District centre based on modelled data from Worldclim. Figure 35 below presents an example from the Baucau District climate poster.

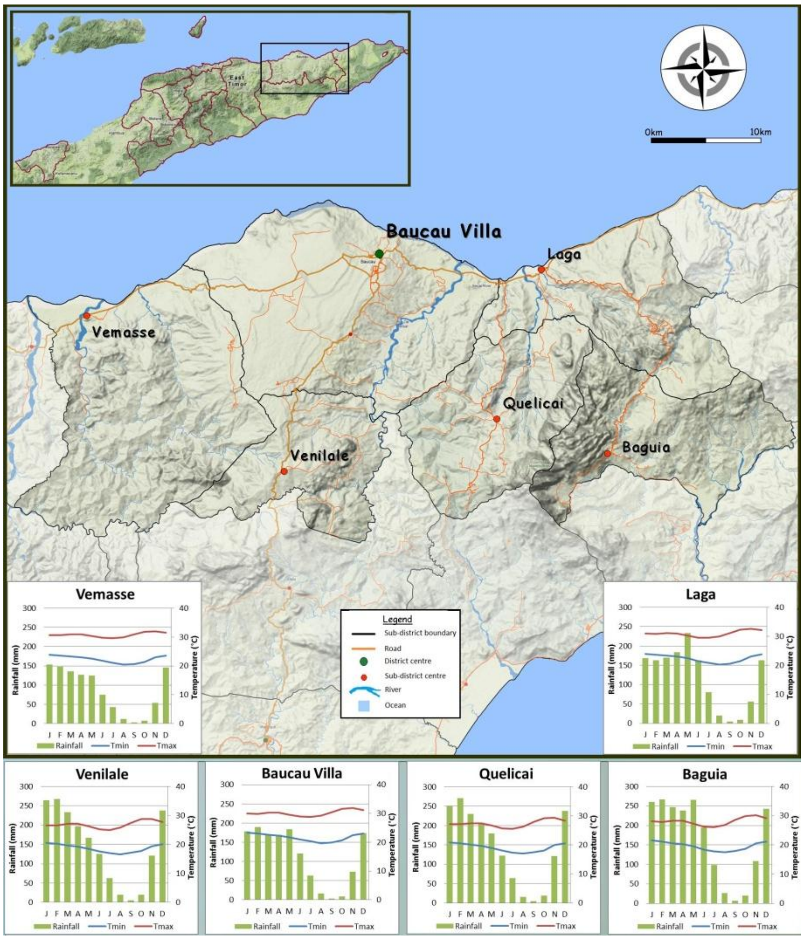


Figure 35. District rainfall and temperatures in Timor-Leste

7.3 ENSO in Timor-Leste

The El Nino Southern Oscillation (ENSO) has a significant impact on the climate of Timor-Leste. Through analysis of historical records it was found that Timor-Leste receives, on average, 19% less rain during an El nino event and 19% more rain during a La nina event. Historical records from Portuguese data (Santiga) were analysed for each of the thirteen District centres. Using historical Southern Oscillation Index figures (ref: Australian Bureau of Meteorology, http://reg.bom.gov.au/climate/current/soihtm1.shtml) and ENSO events identified over the past 100 years (ref: National Weather Service, NOAA, http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml; “Historical El Nino Events, https://sites.google.com/site/medievalwarmperiod/Home/historic-El-nino-events) Start and finish dates of each ENSO event were determined by consideration of the monthly SOI historical data. Using the historical Portuguese rainfall data, rainfall totals were calculated from those months which were considered to be El nino or La nina. Outliers for El nino were considered to be those months during an ENSO event where the SOI was negative and the rainfall was above average. These outliers were not included in calculating the total. The same method was applied to data during La nina events where the SOI was positive and the rainfall was below average. Figure 36 below shows the impact of ENSO on the rainfall of Timor-Leste:

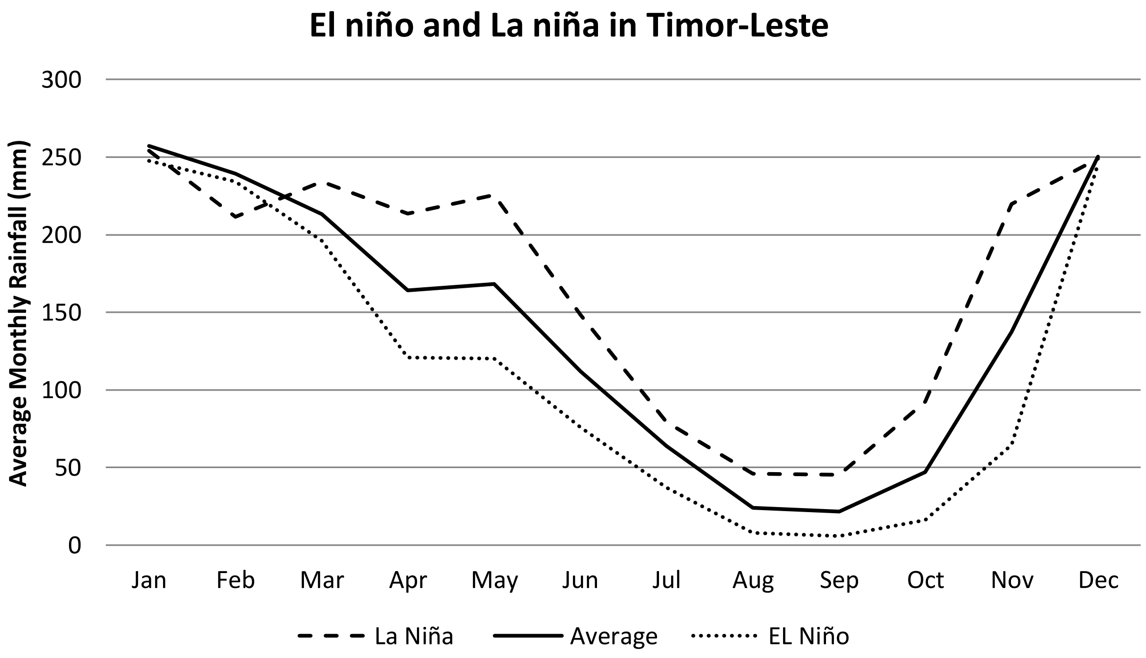


Figure 36. Impact of ENSO on the rainfall in Timor-Leste

From the graph it can be seen that ENSO generally has little impact during the wet season months of December through until March. In April, there are significant differences in rainfall patterns. During El nino the dry season starts earlier, has less rainfall and ends later. During El nino some crops may fail and those regions which depend on a second crop may find it particularly difficult. During La nina, the wet season lasts longer and there is generally more rain. Farmers may find it difficult to dry their crops for storage but may benefit from an extended growing period if they are informed about the La nina conditions.

ENSO appears to affect Timor-Leste in different ways depending on the location. In some areas, such as Same, there is significantly increased rainfall during La niña in the wet season. In Liquica, it seems the greatest impact is felt during the late dry season.

The El niño Southern Oscillation cycle has a significant impact on the weather patterns of Timor-Leste. The District climate change maps provide an opportunity for District MAF personnel to develop and extend to farmers, strategies for managing ENSO and future climate change effects. To do this District staff will need to keep abreast of the current SOI values and ENSO predictions.

7.4 District rainfall distribution mapping

An updated rainfall map has been released with 1km resolution based on newly released modelled rainfall data from Worldclim. This has allowed the production of clearer and more accurate maps which have been incorporated into the District climate posters to promote an understanding among MAF staff and others of rainfall patterns in Timor-Leste. An example from the Baucau poster is shown below:

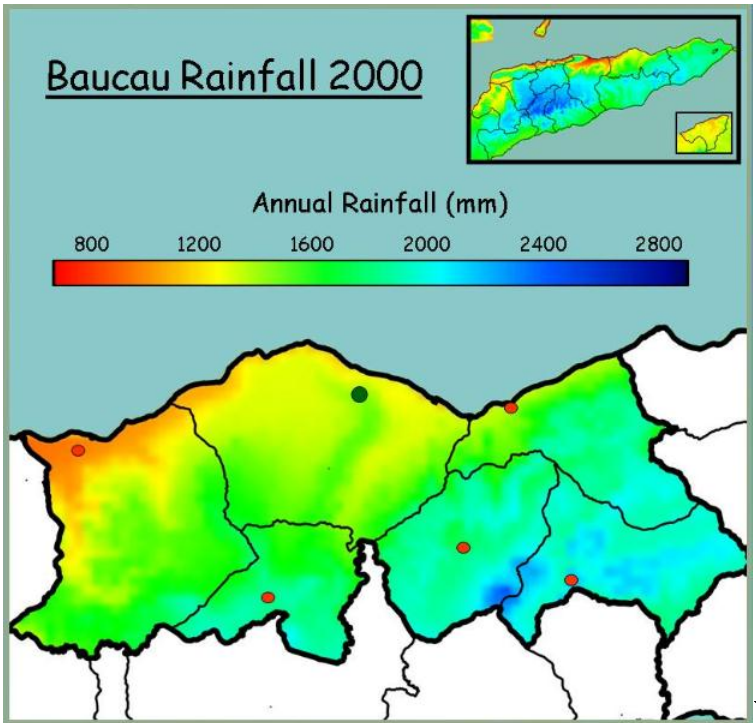


Figure 37. Rainfall distribution in the District of Baucau, 2000

7.5 Mapping climate change impact on rainfall

The same resolution was applied to the future predicted rainfall distribution across Timor-Leste to produce maps of higher resolution. Rainfall is predicted to increase by around 10% by the year 2050. This predicted rainfall pattern shows a greater change in rainfall at higher altitudes.

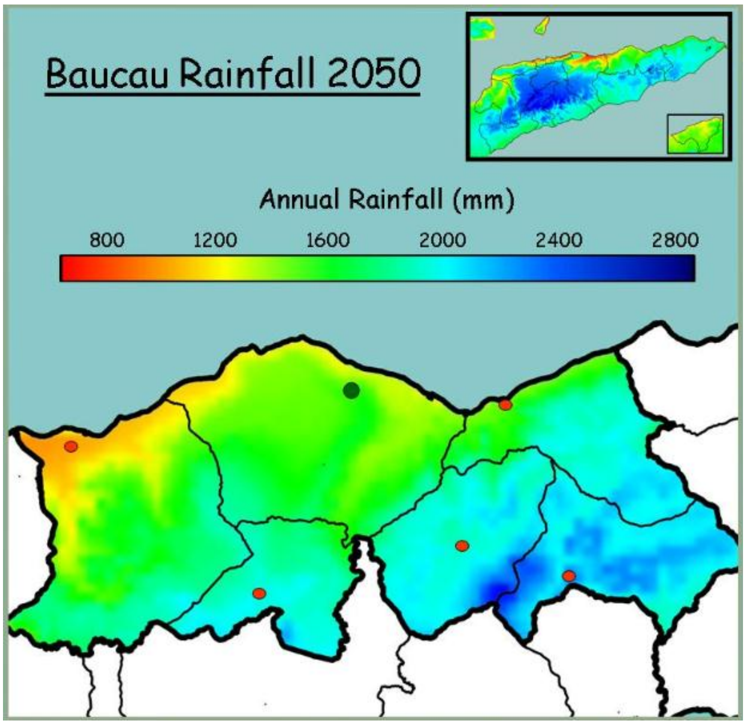


Figure 38. Rainfall distribution in the District of Baucau, 2050

7.6 Mapping soil data for Timor-Leste

Data from the Portuguese soil survey, *Solos de Timor*, and its associated maps were used to assess soil attributes across Timor-Leste. The document does not include information on Oecussi and Atauro. It contains information about soil texture, pH, iron & zinc deficiency, organic matter, vegetation, drainage, parent material, agricultural limitations and other aspects. Data has been arranged in table format and the maps have been digitised so that mapping software can be used to visualise the data. Maps have been prepared on some of the useful information within *Solos de Timor*. "Soil Complexes" are a combination of different soil types which are indicated by percentages. This data has been combined to assign a final value or attribute to the various soil complex categories.

Map of soil texture

Soil texture data exists for the top soil and the sub-soil. A map has been prepared for the soil texture of the top soil. In cases where a range of soil textures were given, an approximation was applied for mapping purposes. For example, "Loam to Sandy-Clay-Loam" was given the texture "Loam". Soil is made up of a mixture of sand, silt and clay (sand is biggest particle size, clay is smallest) as indicated by the standard soil texture triangle.

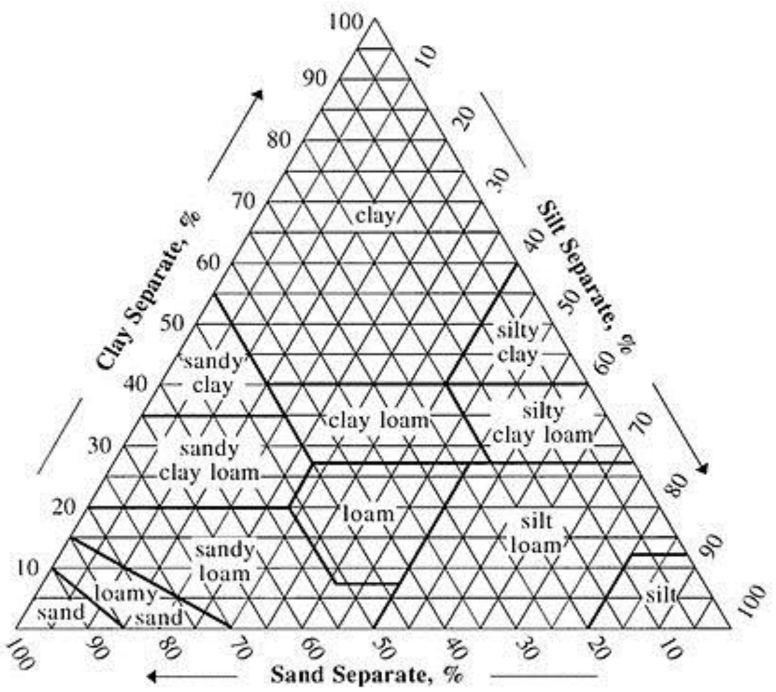


Figure 39. Soil texture triangle to classify soil texture

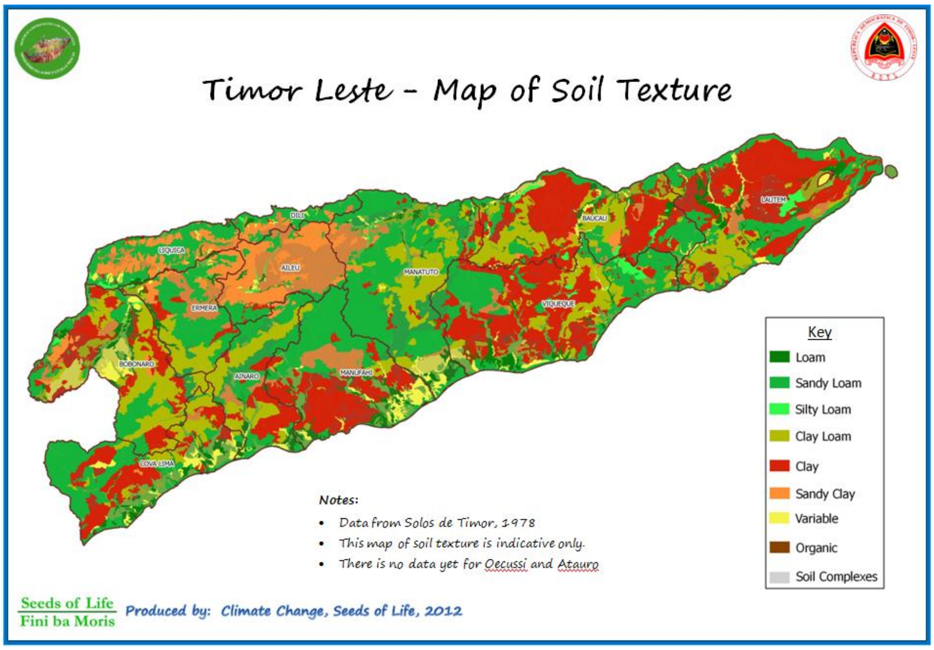


Figure 40. Soil texture map of Timor-Leste

Map of soil pH

Soil has a significant impact on crop yields. The *Solos de Timor* soil survey indicates that the soils in the mountain regions of Aileu, Liquica and Emera are likely to be more acidic (Figure 41). Soils along the coast are generally alkaline. Farmers should not rely solely on the information provided on the map of soil pH but should have their particular soil tested.

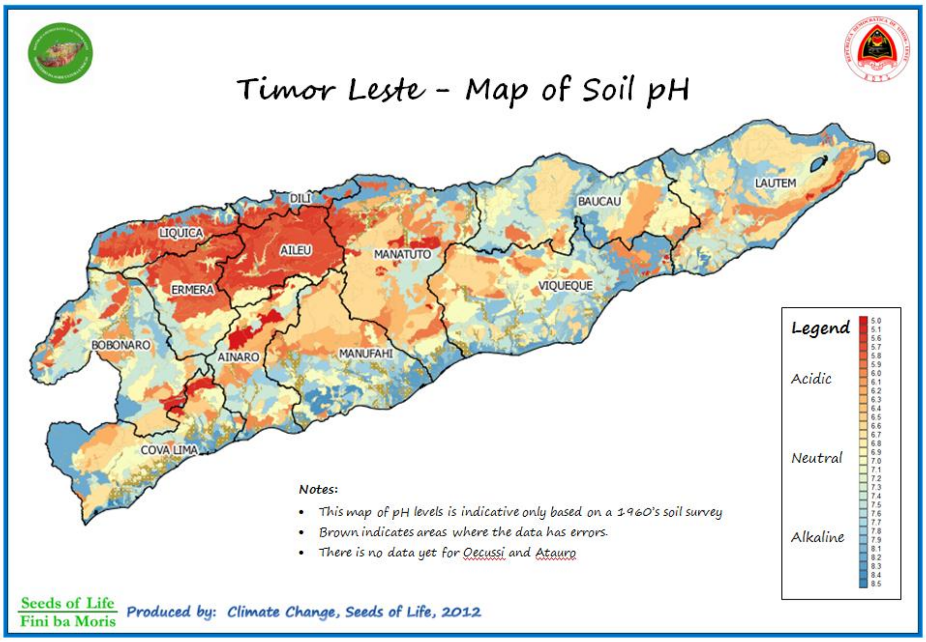


Figure 41. Soil pH map of Timor-Leste

Map of iron & zinc deficiency

A lack of trace elements such as iron and zinc can significantly reduce crop yields. A map prepared by the *Solos de Timor* is presented in Figure 42. The original document did not give values but merely indicated the likelihood of risk of deficiency of these trace elements based on the classification of the soil and its acidity. The *Solos de Timor* document uses phrases for different soil types such as “possible deficiency of Fe and Zn when submerged for prolonged periods” or “high pH induces deficiencies in Fe and Zn”. From this information, combined with the information on pH, the map indicates the risk of Fe & Zn deficiency rather than a map of the actual measured levels of these trace elements. It is important that the impact of Fe & Zn deficiency on farmers’ fields is taken into consideration especially in those areas indicated as having a high risk of this problem.

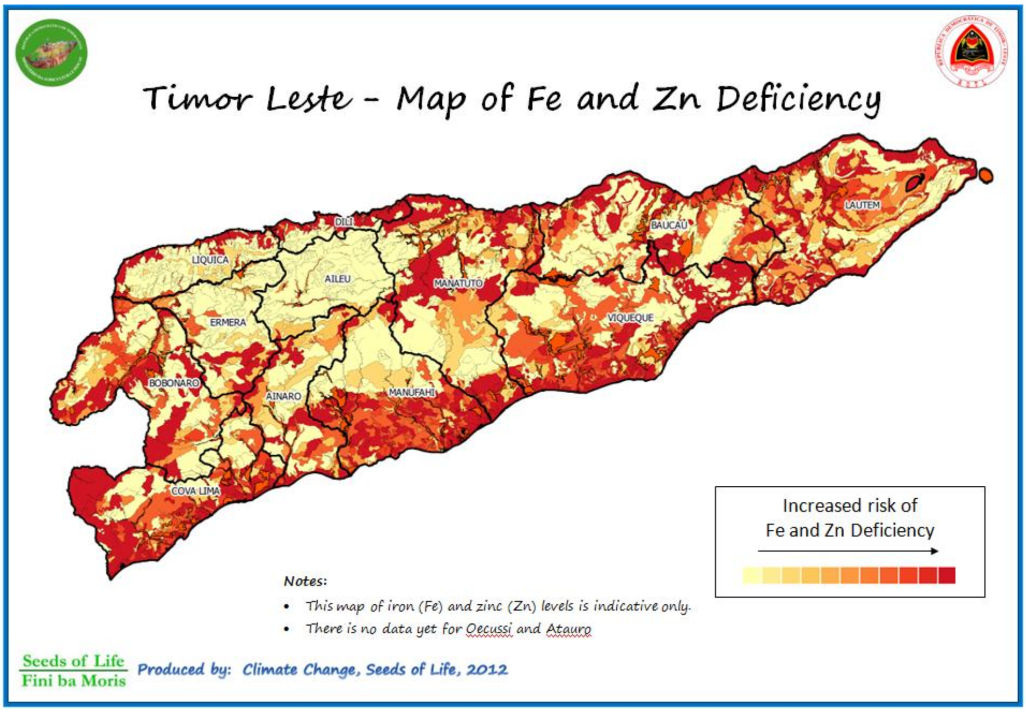


Figure 42. Iron (Fe) and Zinc (Zn) deficiency in Timor-Leste soils

7.7 Terracing

Terracing involves the construction of level garden beds following the contour of a slope. In 2012, terracing in four Districts (Manufahi, Liquica, Emera and Oecussi) was surveyed to identify different types of terraces and the impact this technology had on farmers and crop yields. Examples were found of terraces that had been constructed in Portuguese times as well as those that were constructed out of support from NGOs. Many farmers in Timor-Leste use a technique known as “slash and burn” agriculture where land is cleared and burnt and planted for 2-3 years until fertility decreases before moving on to other land. The land is left fallow for several years so that soil fertility can improve. The population of Timor-Leste is expected to double in the next 30 years and this will impact on the ability to continue slash and burn agriculture. Pressure is increasing on the land as farmers attempt to grow crops on new slopes that are often too steep.

Figure 43. Photograph of old farming terraces in Turascai, Manufahi

The survey indicated that terracing can be successful in areas where farmers are prepared to fertilise their soils with manure or chemical fertilisers. They can also be appropriate where irrigation is available which tends to support a fixed location for cropping.

Figure 44. Terracing in Malabe, Ermera growing cabbages.

Figure 45. Terracing in Maubaralissa, Liquica with associated irrigation pond.

Terracing responds to the problem of erosion by reducing the velocity of water flow in sloping areas. It also benefits crops by holding water in the soil and prevents loss of soil nutrients due to erosion. Trees planted as a fence (eg *Calliandra* and *Gliricidia*) can prevent top soil from being eroded. Terracing enables farmers to cope with population increases as they can use the same field multiple times in the future. It also meets the challenge of a higher rate of evaporation resulting from increased temperature due to climate change. However, terracing is expensive and time consuming to set up and maintain and the system requires frequent nutrient improvement to maintain soil fertility. Deep terrace construction carried out incorrectly may also lead to the thin layer of fertile soil on the slope being dug away and buried by the subsoil as the terrace is cut into the slope.

Figure 46. Extensive terracing in Berau, Atauro, still in use.

Recommendations

- Terrace walls need to be strengthened by planting trees with a strong root system in order to prevent soil erosion. (eg *Calliandra, Gliricidia,* legume trees and vetiver grass)
- Allow mulch crops such as velvet bean to grow through the dry season to add nutrients to the soil.
- Water channel to contour furrow terrace needs to be deepened and stones used for rock wall need to be large.
- Terraces should be planted with high yielding varieties.
- Farmers should understand the ongoing commitment to the need for applying fertilisers (organic or inorganic) to maintain soil fertility.
- Care should be taken in the construction of a new terrace with consideration of the fertility of top soil and subsoil layers.

8. Communication and technology dissemination

During the 2012, SoL information was shared with audiences through a number of channels:

Audience	*Communication medium*
Farmers	• Face-to-face communication with SoL OFDT staff • Farmer field days • District information days • Research results meetings • Informal and formal seed multiplication workshops • Socialisation workshops • Printed materials (posters, brochures, banners, etc.) • Community radio (drama and news programs)
MAF District staff	• Ongoing liaison with SoL District staff & leaders • Communication and Facilitation Skills trainings • Farmer field days • Printed Materials (booklets, flipcharts, etc.) • Research results meetings
NGO & agency partners	• Ongoing liaison with SoL District staff & leaders • Research results meetings • Website • Publications • Social media networks
Timorese public	• Printed materials (posters, brochures, banners, etc.) • Conferences • Tetun-language publications • Information distribution at local and national events
Australian & international public	• Website • Print and radio news stories • International conferences • English-language publications • Social media networks

District information days

SoL District information days were held during 2012 to showcase the research and results of the SoL research program and to hold discussions with District personnel and farmers. During August and September the information days were held in Aileu, Baucau, Viqueque, Bobonaro, Ainaro, Manufahi and Liquica.

Attendance at the information days was high, with many farmers expressing an interest in SoL research and technology. Attending farmers witnessed presentations by SoL research staff about the development and release of viable new seed varieties, and were informed about practicable farming technologies.

Communication and facilitation skills training

MAF-SoL's Communication and Facilitation Skills (CFS) pilot for SEOs was conducted in the targeted Districts of Aileu, Ermera, Baucau and Bobonaro. The two-day training sessions aimed to begin a discussion among SEOs about communication methods to improve their relationships with farmers and the community.

The sessions were driven by MAF-SoL master trainers, but the learning process in CFS focused on self-reflection and idea sharing among participants, rather than top-down rote-learning. Feedback from the CFS pilot was overwhelmingly positive and requests have been made by District staff-members for an expansion of the program in 2013.

Publications

Gusmao, M., Siddique, K., Flower, K.C., Nesbitt, H.J., Veneklaas, E.J. 2012, 'Water Deficit during the Reproductive Period of Grass Pea (Lathyrus sativus L.) Reduced Grain Yield but Maintained Seed Size', Journal of Agronomy and Crop Science, 198, 6, pp. 430-441.

Lacoste, M., Williams, R., Erskine, W., Nesbitt, H., Pereira, L. & Marçal, A. (2012): Varietal Diffusion in Marginal Seed Systems: Participatory Trials Initiate Change in East Timor, Journal of Crop Improvement, 26:4, 468-488

Molyneux, N., Rangel da Cruz, G., Williams, R. L., Anderson, R. & Turner, N. C. (2012). Climate Change and Population Growth in Timor-Leste: Implications for Food Security. AMBIO, 41, No. 3, May, 2012

Spyckerelle, L. (2012). Seeds of Life Baseline Survey. 98p.

Thompson, S. (January, 2012). Geology and Soils in Timor-Leste. 39p.

SoL. Terracing Report Summary. 10p, 2012

Williams, R., Anderson, R., Marcal, A., Pereira, L., Almeida, L. & Erskine, W. (2012). Exploratory Agronomy within participatory varietal selection: The case of peanut in East Timor. 11 p. Expl Agric. 48 (2), 272–282 Cambridge University Press 2012 doi:10.1017/S0014479711001207.

Williams, R.L., Borges, L.F., Lacoste, M.E., Andersen, R, Nesbitt, H.J., Johansen, C. 2012, 'On-farm evaluation of introduced maize varieties and their yield determining factors in East Timor.', Field Cros Research, 137, pp. 170-177.

Williams, R., Soares, F., Pereira, L., Belo, B., Soares, A., Browne, M., Setiawan, A., & Erskine, W. (2012). Sweet potato can contribute to both nutritional and food security in Timor-Leste, Field Crops Research (submitted)

Timor-Leste media coverage

Televisão de Timor-Leste (TVTL) (2012). Visit of Secretary of State for Agriculture and Arboriculture Mr. Marcos da Cruz to Informal seed production groups in Aileu. Televisão de Timor-Leste (TVTL)

Visit of Secretary of State for Agriculture and Arboriculture Mr. Marcos da Cruz to Informal seed production groups in Baucau – TVTL and Timor Post (newspaper)

Minister of Agriculture and Fisheries visits the Betano Research Center – Jornal Nacional Diario (JND – newspaper) and Suara Timor-Lorosa'e (STL –newspaper)

Cooking competition at the Ministry of Agriculture and Fisheries organised by SoL – Jornal Nacional Diario, Timor Post, TVTL, Business Timor (weekly newspaper)

Minister of Agriculture Mr. Mariano 'Assanami' Sabino inaugurates the Loes Research Center – Timor Post and STL TV

STL TV (2012). SoL's improved variety cooking demonstration by Indonesian Master Chef Haidar Sungkar. STL TV

Jornal Nacional Diario (2012). SoL's improved variety cooking demonstration by Indonesian Master Chef Haidar Sungkar. Jornal Nacional Diario

TVTL (2012). Ministry of Agriculture and Fisheries releases new white corn variety "Noi Mutin". TVTL

Business Timor (2012). Ministry of Agriculture and Fisheries releases new white corn variety "Noi Mutin". Business Timor

Maliana local radio station. Regular coverage of SoL activities

Conference presentations

Lopes, M., Nesbitt, H. Improving food security in East Timor with higher yielding crop varieties, Paper presented at the Australian Agricultural and Resource Economics Society Mini Symposium "Food security in the South Pacific, PNG and East Timor", Fremantle, Western Australia, Australia, 8-10 February, 2012

Pereira, L. C. R. Maize in Timor-Leste: A Summary, Poster presented at the International Maize Conference, Gorotalo, Sulawesi, Indonesia, November 22-24, 2012

Williams, R., Aguilar, L., & Correia, M. Maize and Velvet Bean Systems in Timor-Leste, paper presented at the International Maize Conference, Gorotalo, Sulawesi, Indonesia, November 22-24, 2012

Kunwar, B., Marcal, J., Gama, F., Amaral, R., Setiawan, A., Dalton, J. (2012). Timor-Leste's efforts to achieve maize seed security using 'community seed production', paper presented at the International Maize Conference, Gorotalo, Sulawesi, Indonesia, November 22-24, 2012

Australian media coverage

Collis, B. (2012). Healing wounds with seeds and soil. Partners Magazine.

ACIAR (2012). East Timor, PhD graduate. Partners Magazine, Summer 2012.

ACIAR Blog (2012). Researcher honoured for dedication to Timor-Leste agriculture. ACIAR website http://aciar.gov.au/node/14638

AusAID News (2012). Seeds of Life is helping farmers to grow. AusAID website http://www.ausaid.gov.au/HotTopics/Pages/Display.aspx?QID=50

AusAID News (2012). Seeds of Life Researcher received Queens birthday honour. http://www.ausaid.gov.au/HotTopics/Pages/Display.aspx?QID=700&

Giles, M. (2012). Timor-Leste PhD graduate. ACIAR Blog website http://aciarblog.blogspot.com/2012/01/timor-leste-phd-graduate.html

Horta, J. R. (2012). Timor-Leste benefits from our partnership with Australia. Partners Magazine.

Relief Web Updates (2012). Access to crops from Seeds of Life is helping Liquica farmers to grow. Relief Web website http://reliefweb.int/report/timor-leste/access-crops-seeds-life-helping-liquica-farmers-grow

Relief Web Updates (2012). Seeds of Life researcher receives Queen's Birthday honour (2012). Relief Web website http://reliefweb.int/report/timor-leste/seeds-life-researcher-receives-queen%E2%80%99s-birthday-honour

Relief Web Updates (2012). Real life benefits grow from seeds. Relief Web website http://reliefweb.int/report/timor-leste/real-life-benefits-grow-seeds

Salbolt, C. (2012). A day in the life of a SoL researcher. Youtube website http://www.youtube.com/watch?v=wkocGMU9EYU

UWA News (2012). Minister visits Seeds of Life project. UWA website http://www.news.uwa.edu.au/201205034580/undefined/minister-visits-seeds-life-project

UWA News (2012). CLIMA researcher receives Order of Australia. UWA website http://www.news.uwa.edu.au/201206214754/undefined/clima-researcher-receives-orderaustralia-oam

Printed material

Banners

Formal Seed Hare Nakroma Banner, A1, Tetun 4 copies

Habarak Fini Informal Banner, 1m x 3m, Tetun 4 copies

International Maize conference poster, A1, Tetun, 1 copy

Noi Mutin Banner, 1m x 3m, Tetun 1 copy

SoL3 Program Socialisation Workshop Banner, 1m x 3m, 6 copies, Tetun
SoL Photo Competition poster, A1, Tetun, 1 copy

Information booklets and brochures

Guidelines for Maize Informal Seed Production 29p, Tetun 1000 copies, English 500
Informal Seed Production: An Introduction. 6p Tetun 1000 copies, English 500
Noi Mutin Brochure, A4, 1p Tetun 5100 copies
Summary of Recommendations 6p, Tetun 1000 copies, English 500
Climate Change Team, Enso fact sheet, A4, Tetun 200 copies, English 200 copies

Report covers

Annual Research Report 2011 Cover, A4, Tetun 200 copies, English 200 copies
Baseline Survey Annexes, English 150 copies
Baseline Survey Main Report, English 250 copies
Baseline Survey Data Tables, English 150 copies
Strategic Plan Executive Summary, Tetun 55 copies, English 20 copies

Maps

Climate Change Team, Map of Soil pH, English 200 copies
Climate Change Team, Map of Fe & Zn Deficiency, English 200 copies
Climate Change Team, Map of Soil Texture, English, 50 copies
Climate Change Team, Map Annual Rainfall and Temperature, English 50 copies
Climate Change Team, Map of Annual Rainfall 2000, English 30 copies
Climate Change Team, Map of Annual Rainfall 2050, English 30 copies

Posters

Climate Change Team, District Climate Posters, 26 items, A0, Tetun 390 copies, English 117
Fini Nakroma Poster, Tetun 3 copies
Cassava Poster A1, 1p Tetun 35 copies
Maize Poster A1, 1p, Tetun 60 copies
Peanut Poster A1, 1p Tetun 30 copies
Rice Poster A1, 1p, Tetun 70 copies
Sweet Potato Poster, A1, 1p Tetun 40 copies
International Maize Conference Poster, A1, English, 1 copy

Other

Climate Change ENSO Information Sheet, A4, Tetun 1200 copies, English 100
Communications Product Request form, A4, English 100 copies
Group Book Sticker, Tetun 1500 copies
Seed Invoice Booklets, A5, Tetun 15 copies
Seed Request Booklets, A5, Tetun 15 copies
SoL t-shirts, 1000 copies
Stickers for CSPG books, Tetun, 2000 copies
Stickers for Informal Seed Containers, Tetun, 200 copies
Stickers, Labels and Cards for Formal Seed, Tetun, 2900 copies

Website http://www.seedsoflifetimor.org/

9. Capacity building

Capacity building

The key objective of SoL's capacity building program is to "To strengthen and embed the skills, systems and institutional capacity required for the successful and sustainable operation of a national foodcrop variety testing and seed management and distribution system with the MAF". During 2012, SoL followed the principles developed in collaboration with the MAF and presented in the "Training Program Management Strategy 2012-2015 prepared by Dr B R Abdon in November, 2011 (Abdon, 2011). The strategy was developed along the principles of "improved performance which are equitable and sustainable. A Learning Advisory Committee (LAC) was formed to oversee that the approach was proposed to be both participatory, gender sensitive, flexible, program focused and systematic. The strategy taken to achieve these objectives was to a) Strengthen research capacity and knowledge transfer b) Program complementarity with other donor projects working in MAF c) Provide equal opportunities for training d) Use participatory processes in identifying training needs e) Promote the development of a learning culture across the organization and f) Cohesive program implementation. The types of in-country training provided by SoL during 2012 included a) classroom teaching b) on-the job training, study tours, field demonstrations, farmer training. These types of training were supported by short international study tours, field demonstrations and farmer training. In addition, SoL personnel supervised final year students in the Faculty of Agriculture at the University of Timor Lorasai to prepare and report their research programs. These are known as scripsi's. Support was also provided for MAF personnel to study for higher degrees in both Indonesia and Australia. A list of the short courses and summary of the higher degree and scripsi studies during 2012 are presented in Table 135

Table 135. Training summary, 2012

			Number of participants			
Start Date	***End Date***	***Course Title***	***M***	***F***	***Tot.***	***Training days/opportunities***
MScs						
01/07/2009	31/05/2012	MSc. Seed Sci and Tech (Indo.2011)	2	0	2	1066 (2132)
01/01/2010	31/12/2012	MSc. Agron Plant Breed (Aust. 2012)	1	0	1	1096 (1096)
01/01/2010	31/12/2012	MSc. Soc. Sci (Aust.2012)	1	0	1	1096 (1096)
01/01/2011	31/12/2013	MSc. Social Science (Aust)	1	0	1	1096 (1096)
29/08/2012	21/08/2014	MSc. Agronomy - Plant Breeding (Indo)	1	1	2	723 (1445)
		Total MSc students (2009-2012)	6	1	7	
Scripsi at UNTL						
2011		Agronomy scripsi's at UNTL	*7*	*2*	*9*	
2012		Agronomy scripsi's at UNTL	*6*	*2*	*8*	
Short courses						
01/02/2011	*31/12/2011*	***Total for 2011***	*590*	*186*	*776*	*73 (2505)*
2012						
09/01/2012	13/01/2012	English Level 1	25	2	27	5 (135)
16/01/2012	20/01/2012	English Level 4	2	4	6	5 (30)
18/01/2012	20/01/2012	Data Analysis for Temperate Crops	5	0	5	3 (15)
23/01/2012	27/01/2012	Seed System Study Visit (Indonesia)	8	0	8	5 (40)
23/01/2012	27/01/2012	Statistics	16	7	23	5 (115)
25/01/2012	25/01/2012	Informal Seed Production Workshop	43	4	47	1 (47)
26/01/2012	26/01/2012	Rice Seed Prod'n for Seed Growers	16	0	16	1 (16)
30/01/2012	03/02/2012	Statistics	9	2	11	5 (55)
05/02/2012	10/02/2012	Collaborative research training (Philippines)	5	2	7	6 (42)
06/02/2012	10/02/2012	Statistics	12	6	18	5 (90)
15/02/2012	15/02/2012	Gender Workshop	31	13	44	1 (44)
15/02/2012	15/02/2012	Statistics	3	0	3	1 (3)
16/02/2012	16/02/2012	Gender Workshop	11	14	25	1 (25)
16/02/2012	16/02/2012	Post-harvest and Quality Control	9	5	14	1 (14)

16/02/2012	16/02/2012	Rice Seed Prod'n for seed Growers	12	7	19	1 (19)
17/02/2012	17/02/2012	Statistics for M&E/Sosek Researcher	3	1	4	1 (4)
20/02/2012	21/02/2012	Community Skills for SEOs	38	7	45	2 (90)
20/02/2012	24/02/2012	English Level 3 - Class 1	9	4	13	5 (65)
23/02/2012	24/02/2012	Community Skills for SEOs	25	2	27	2 (54)
28/02/2012	28/02/2012	Post-harvest and Quality Control	17	2	19	1 (19)
29/02/2012	01/03/2012	Community Skills for SEOs	33	2	35	2 (70)
02/03/2012	02/03/2012	Post-harvest and Quality Control	19	2	21	1 (21)
06/03/2012	06/03/2012	Post-harvest and Quality Control	22	0	22	1 (22)
12/03/2012	12/03/2012	Post-harvest and Quality Control	11	4	15	1 (15)
13/03/2012	13/03/2012	Gender Workshop	13	4	17	1 (17)
13/03/2012	13/03/2012	Post-harvest and Quality Control	23	2	25	1 (25)
14/03/2012	14/03/2012	Post-harvest and Quality Control	16	1	17	1 (17)
23/03/2012	23/03/2012	Post-harvest and Quality Control	13	2	15	1 (15)
24/03/2012	31/03/2012	Formal and Informal Seed System of Nepal	11	0	11	8 (88)
26/03/2012	30/03/2012	English Level 3 - Class 2	8	8	16	5 (80)
27/03/2012	27/03/2012	Gender Workshop	45	12	57	1 (57)
02/04/2012	04/04/2012	Analysis of Multi Environment Trials	6	3	9	3 (27)
04/04/2012	04/04/2012	Quickbooks Training	4	3	7	1 (7)
10/04/2012	11/04/2012	Mathematics for Agronomists Level 1	11	1	12	2 (24)
12/04/2012	12/04/2012	Gender Workshop	42	14	56	1 (56)
12/04/2012	13/04/2012	Mathematics for Agronomists Level 1	15	5	20	2 (40)
05/05/2012	18/05/2012	Seed Certification Training (Indonesia)	8	2	10	14 (140)
08/05/2012	09/05/2012	Mathematics for Agronomists Level 1	15	6	21	2 (42)
14/05/2012	18/05/2012	English Level 2	17	1	18	5 (90)
14/05/2012	24/05/2012	Seed Science and Technology (Indonesia)	5	0	5	11 (55)
14/05/2012	01/06/2012	Rice:Res. to Pdn Course (Philippines)	1	1	2	19 (38)
28/05/2012	01/06/2012	Maize OFDT Analysis	11	3	14	5 (70)
04/06/2012	08/06/2012	Data Analysis of the 5 Major Crops	8	0	8	5 (40)
26/06/2012	29/06/2012	Report Writing and Presentation Skills	15	4	19	4 (76)
02/07/2012	05/07/2012	Report Writing and Presentation Skills	13	6	19	4 (76)
10/07/2012	13/07/2012	Report Writing and Presentation Skills	26	6	32	4 (128)
16/07/2012	17/08/2012	English (Australia)	4	0	4	33 (132)
23/07/2012	26/07/2012	Data Analysis on Peanut and Sweet Potato	8	3	11	4 (44)
23/07/2012	27/07/2012	English Level 1	18	0	18	5 (90)
06/08/2012	10/08/2012	Interp. and Presentation of Research Results	16	4	20	5 (100)
08/08/2012	09/08/2012	Community Skills for SEOs	16	7	23	2 (46)
13/08/2012	17/08/2012	Interp. and Present'n of Research Results	9	5	14	5 (70)
21/08/2012	24/08/2012	English Level 3 - Class 1	4	5	9	4 (36)
21/08/2012	24/08/2012	English Level 4	2	5	7	4 (28)
27/08/2012	28/09/2012	English (Australia)	3	0	3	33 (99)
03/09/2012	07/09/2012	English Level 3 - Class 2	10	3	13	5 (65)
04/09/2012	05/09/2012	Community Skills for SEOs	17	2	19	2 (38)
13/09/2012	14/09/2012	Mathematics for Agronomist Level 2	7	3	10	2 (20)
17/09/2012	18/09/2012	Mathematics for Agronomist Level 2	8	0	8	2 (16)
27/09/2012	28/09/2012	Mathematics for Agronomist Level 2	9	1	10	2 (20)
02/10/2012	03/10/2012	Community Skills for SEOs	19	1	20	2 (40)
04/10/2012	04/10/2012	Seed Certification Training	9	14	23	1 (23)
08/10/2012	12/10/2012	English Level 2	17	1	18	5 (90)
09/10/2012	10/10/2012	Mathematics for Agronomist Level 2	4	5	9	2 (18)
10/10/2012	11/10/2012	Community Skills for SEOs	18	1	19	2 (38)
22/10/2012	22/10/2012	Seed Certification Training	25	10	35	1 (35)
24/10/2012	24/10/2012	Seed Certification Training	15	3	18	1 (18)
29/10/2012	30/10/2012	Community and Facility Skills Course	6	9	15	2 (30)
30/10/2012	30/10/2012	Seed Certification Training	16	2	18	1 (18)
05/11/2012	09/11/2012	English Level 4	8	10	18	5 (90)
22/10/2012	11/11/2012	Rice: Production to marketing (Phil)	2	0	2	10 (20)
14/11/2012	14/11/2012	Seed Certification Training	23	5	28	1 (28)
16/11/2012	30/11/2012	Agronomy - Plant Breeding (Indonesia)	2	0	2	5 (10)
05/11/2012	13/11/2012	Seed Production Workshop	5	0	5	9 (45)
12/11/2012	14/12/2012	English (Australia)	0	2	2	33 (66)
19/11/2012	23/11/2012	English Level 3	9	4	13	5 (65)
22/11/2012	24/11/2012	Seed production workshop (Indonesia)	7	0	7	3 (21)
26/11/2012	30/11/2012	Agronomy plant breeding conf. (India)	2	0	2	5 (10)
19/11/2012	06/12/2012	Soil analysis for P, pH and EC	3	0	3	18 (54)
	Total		1031	279	1310	381 (3781)

Number of training opportunities for each working day = 15.75

10. Technology recommendations

10.1 Released and potential varieties

Ten improved crop varieties identified by SoL/MAF had been released by the MAF at the end of 2012. 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.

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 Chapter 2) as it did in earlier years (Table 136, Table 137). 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 136. Sele outyielded 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 137).

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 136. 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 137. 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 138). 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 139).

Table 138. 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 139. 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 140) 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 141. Hohrae continued to be included in OFDTs during 2012 as the best performer to date for comparison purposes.

Table 140. 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 141. Select 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 142). Hohrae 3 was included in 41 OFDTs in 2012 and was the equal best performer with CIP83 (Table 143).

Table 142. 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 143. 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) was included in the Aromatic Rice Observational Trials reported in Section 2.4.1 of this report and performed as well as other aromatic rices. Performed extremely well in farmers fields between 2005 and 2010 averaging 31% more yield on 51 sites (Table 144). 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 145).

Table 144. 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 145. 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 continue to be the varieties most preferred by farmers when evaluated at field days (See Section 2.3). No other varieties are yet ready for release.

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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