Annual Research Report
2009

Seeds of Life
Fini ba Moris

Seeds of Life (Fini ba Moris) activities form a program within the East Timor (Timor-Leste) Ministry of Agriculture and Fisheries (MAF). Funding for the program is provided collaboratively by the MAF and the Australian Government through the Australian Agency for International Development (AusAID) plus the Australian Centre for International Agricultural Research (ACIAR). The Centre for Legumes in Mediterranean Agriculture (CLIMA) within The University of Western Australia (UWA) is commissioned to coordinate the Australian funded activities.

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Foreword

Seeds of Life (SoL) is a program within the Ministry of Agriculture and Fisheries (MAF) of the Democratic Republic of Timor-Leste. The program is designed to evaluate, recommend and distribute superior crop varieties to farmers with the aim of improving the nation's food security. This report is the fourth in a series and describes the program's activities for the 2008-2009 year.

This year's research and seed production activities were concentrated in the districts of Manufahi, Alieu, Baucau, Viqueque, Liquica, Bobonaro and Ainaro. However the program's products reached most districts of Timor-Leste. Replicated trials were centred on MAF research centres. The best of the maize, rice, sweet potato, cassava and peanut varieties identified in these trials were then examined on farmers fields spread across a range of agro-ecosystems. Farmers receiving the test material were able to examine the crops under their own conditions and management practices and if acceptable, keep seed for multiplication. In addition to these five core food crops, the number of species under examination was expanded to include potatoes, mung beans and climbing beans.

In August, 2009 it was my pleasure to officially release two new high-yielding, sweet cassava varieties, named Ai-luka 2 and Ai-luka 4. These two varieties were identified after passing through the rigorous SoL evaluation process. Ai-luka 2 and 4 were chosen because of their high yield and good flavour, and the positive response from farmers. They produce a yield 51-65% higher than local varieties, based on replicated and on-farm trials. Planting material is now being multiplied for distribution to farmers. We expect crop yields to increase significantly over the long term as a result of these improved variety yields. Research will continue to increase the diversity of crop variety releases.

MAF has also been active through SoL in strengthening the capacity of the nation to conduct research and improve seed multiplication. Facilities were constructed at Betano, Loes and Darasula research stations and considerable training was delivered during the year in seed production data management and agronomy. Training was in the form of practical exercises, trial implementation and a series of short term courses. Four MAF research staff were provided the opportunity to study in Australia and a further two are studying for masters degrees in Indonesia. Both research station improvement and training will lead to long term sustainability of technology generation in Timor-Leste.

SoL activities during the past year were mainly conducted or supervised by MAF personnel. In addition, a number of NGOs distributed or multiplied seed. Assistance was also forthcoming from the Consultative Group on International Agricultural Research, Australian Centre for International Agricultural Research, Centre for Legumes in Mediterranean Agriculture at the University of Western Australia, Australian National University and personnel plus students from the University of Timor Lorosae. We thank them for their assistance.

The Australian Government is gratefully acknowledged for its financial support through the Australian Centre for International Agricultural Research and the Australian Agency for International Development.

H.E Mariano ASSANAMI Sabino
Minister of Agriculture and Fisheries
Democratic Republic of Timor-Leste June, 2010

Abbreviations and acronyms

ACIAR	Australian Centre for International Agriculture Research
AEZ	Agro-Ecological Zone
ALGIS	Agricultural Land Geographic Information System
ANOVA	Analysis of Variance
ANU	Australian National University
APC	Australian Program Coordinator
ARP	Agriculture Rehabilitation Program
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
CRIFC	Centre Research Institute for Food Crops (Indonesia)
EAS	Early Adoption Survey
FPR	Farmer Participatory Research
g	gram
GPS	Global Positioning System
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICM	Integrated Crop Management
ILETRI	Indonesian Legume and Tuber Root Research Institute (see RILET)
IRRI	International Rice Research Institute
LYDMR	Late Yielding Downey Mildew Resistant (Released as Sele)
M&E	Monitoring and Evaluation
MAF	Ministry of Agriculture and Fisheries
masl	Metres Above Sea Level
MTR	Mid Term Review
NGOs	Non-Governmental Organizations
OCAP	Oecussi Ambeno Community Activation Programme
OFDTs	On-Farm Demonstrations and Trials
PSC	Program Steering Committee
RA	Research Assistant
R/EA	Research and Extension Advisor
RDUs	Research and Demonstration Units
REML	Restricted Maximum Likelihood
RILET	Research Institute of Legumes and Tuber Crops (Indonesia)(see ILETRI)
SoL1	Seeds of Life 1
SoL	Seeds of Life 2
SOSEK	Social Science and Economics
SRI	System of Rice Intensification
t/ha	Metric ton per hectare
TAG	Technical Advisory Group
TL	Timor Leste
UN	United Nations
UNTL	University of Timor Lorosae
UWA	University of Western Australia
VRC	Varietal Release Committee

Personnel

Ministry of Agriculture and Fisheries

H.E Mariano ASSANAMI Sabino	Minister, Ministry of Agriculture and Fisheries
Mr. Marcos da Cruz	Secretary of State for Agriculture & Forestry
Mr. Eduardo de Carvalho	Secretary of State for Fisheries
Mr. Valentino da Costa Varila	Secretary of State for Livestock
Mr. Lourenço Borges Fontes	Director General
Mr. Gil Rangel da Cruz	National Director, Agriculture and Horticulture and Director for Food Crops and SoL Co-Leader
Mr. Adalfredo do Rosario Ferreira	Director of Research and Special Services and SoL Co-Leader
Mr. Joao dos Santos	District Director, Aileu
Mr. Lucio Nunu	District Director, Viqueue
Mr. Donato Salsinha	District Director, Same
Mr. Domingos Savio Cabral	District Director, Baucau
Mr. Gregoriu dos Santos	District Director, Liquica
Mr. Jose Orlando	Regional Director , Maliana
Mr. Moises Lobato Pereira	Research Manager, Fatumaca
Mr. Abril Fatima Soares	Research Manager, Aileu
Ms. Maria Fernandes	Research Manager, Betano
Mr. Teleforo Fernandes Moniz	Research Manager, Loes

Name	*District*	*Sub-District*
Mr. Luis Almeida	Dili	
Mr. Jose Maria Alves Ornai	Dili	
Ms. Armandina Marcal	Dili	
Ms. Anita Ximenes	Dili	
Mr. Modesto Lopes	Dili	
Ms. Dorilanda da Costa Lopes	Bobonaro	Maliana
Ms. Deonisia Raquela Soares Brito	Aileu	Aileu Villa
Mr. Cipriano Martins	Aileu	Aileu Villa
Mr. Salvador de Jesus	Aileu	Remexio, Liquidoe, Laulara
Ms. Odete Ximenes	Baucau	Baucau Villa
Ms. Juliana de Jesus Maia	Manufahi	Betano
Ms. Ermelinda M.L. Hornai	Maliana	Maliana Villa
Mr. Simao Margono Belo	Baucau	Laga
Mr. Antonio Pereira do Rego	Baucau	Venilale
Mr. Rojino Da Cunha	Baucau	Vemasse
Mr. Joao Bosco Pedro C.R. Belo	Baucau	Baucau Villa
Mr. Basilio da Silva Pires	Baucau & Viqueque	Venilale &Ossu
Mr. Marcos Vidal	Manufahi	Betano
Mr. Felisberto Soares	Manufahi	Betano
Mr. Rafael Feliciano	Manufahi	Betano
Mr. Jose da Costa Ronal Freygen	Liquica	Maubara
Mr. Jorge Amaral	Manufahi	Alas
Mr. Armindo Moises	Manufahi, Ainaro	Turiscai, Maubisse
Mr. Leandro C.R Pereira	Liquiça	Maubara
Mr. Mario Tavares Goncalves	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	Baucau	Baucau Villa
Ms. Julieta Lidia	Baucau	Baucau Villa
Mr. Luis Fernandes	Manufahi, Ainaro	Same Villa, Hatudu

Ministry of Agriculture and Fisheries (continued)		
Mr. Amandio da Costa Ximenes	Viqueque	Ossu
Mr. Inacio Savio Pereira	Viqueque	Uatulari
Mr. Tobias Monis Vicente L. Agm	Liquiça	Maubara
Mr. Joao Paulo	Dili	
Mr. Agostinho Alves	Manufahi	Betano, Same, Alas

National University of Timor Lorosae	
Mr. Osorio Verdial	Head of Agronomy Department, UNTL
Mr. Acacio Guterres	Agronomy Lecturer
Mr. Antonio da Costa	Agronomy Lecturer
Mr. Adao Berbosa	Agronomy Lecturer

University of Western Australia

Dr. Harry Nesbitt. Australian Program Coordinator, Seeds of Life
Dr. William Erskine, Director CLIMA

Australian National University

Ms. Angie Bexley, Social Scientist
Dr. Andrew McWilliam, Research Anthropologist

Seeds of Life Office in MAF, Timor-Leste	
Mr. Robert Williams	Seeds of Life Team Leader
Mr. Brian Monaghan	Research/Extension Advisor: Manufahi, Aileu
Ms. Rebecca Andersen	R/E Adviser for Baucau, Liquiça &Maliana
Mr. Mark Vaughan	Office Manager
Mr. Joaquim J.M.R da Cruz	Finance Officer
Mr. Marcelino da Costa	Data Entry Specialist
Mr. Aquilles Barros	Translator / Interpreter
Ms. Miguelina Ribeiro Garcia	Administrative Assistant

Collaborating Organizations

National / Local NGOs	*Contact Person*	*Position*
Caritas Baucau	Mr Nelson da costa Freitas Pr.	Program coordinator
OISCA	Mr. Mirandolino A. Guterres	General Coordinator
	Mr. João da Silva Sarmento	Program Coordinator
Fundasaun Halarae	Mr. Angelino Lemos	Field staff
	Mr. Manuel Ati	Field staff
Santalum	Mr. Helio Jose Antonio da C.	Secretary
Loda	Mr. Ancelmos Mau	Field staff
International NGOs and UN	*Contact Person*	*Position*
Care International	Mr. Buddhi Kunwar	Project Manager LIFT
OXFAM Hongkong	Ms. Maria dos Reis	Program Officer for Timor-Leste
OXFAM Australia	Ms. Lynne Kennedy	Food Security Officer
UNOPS (OCAP – Oecusse)	Mr. Koen W. Toonen	Int'l Program Coordinator (Ocap –Oecusse)
World Vision	Mr. Jim Hooper	Livelihoods Security Manager
CCF	Mr. Carlos S. Basilio	Team Leader
Portuguese Cooperation	Mr. Hugo Trindade	Agronomist
GTZ	Mr. Benjamin Guterres	Farming System Coordinator
Concern	Mr. Bonifase	Field staff
PADRTL	Mr. Mario Assis Tavares	Ermera Component Coordinator
FAO	Mr. Chana Opaskonkul	Representative
Concern	Mr. Pedro Laranjeira	Component 3 Coordinator

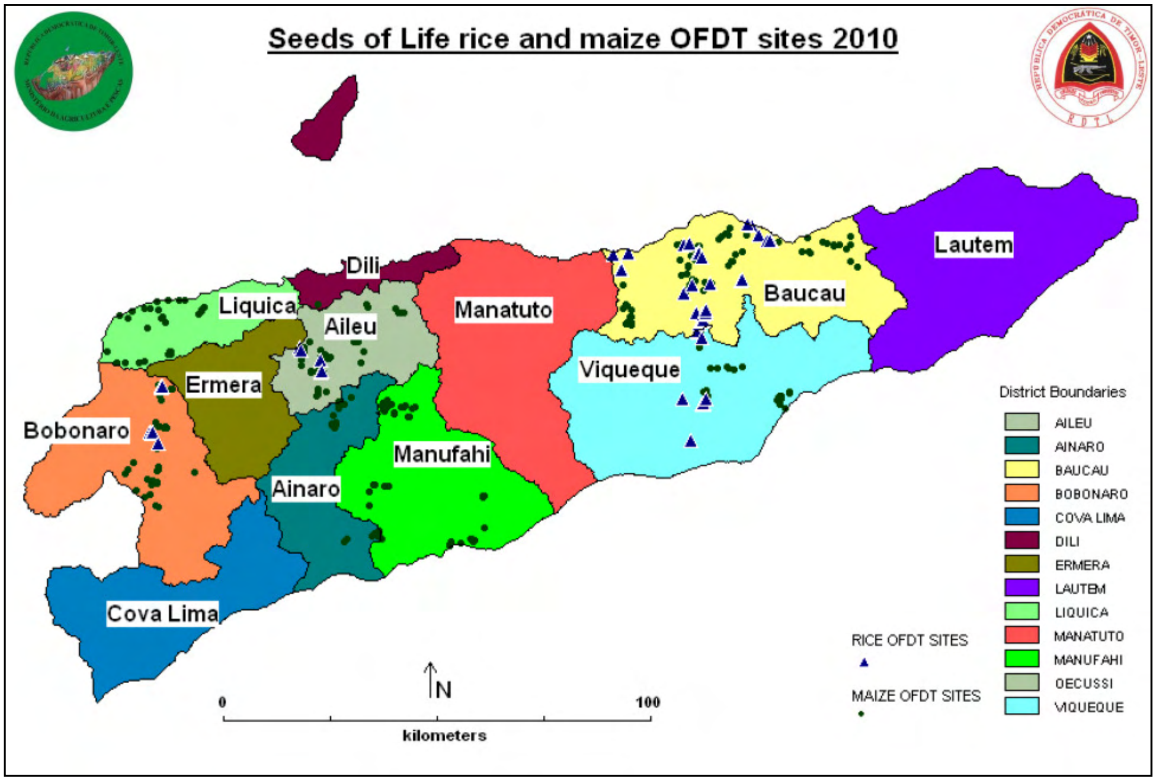

Figure 1. **Map of Timor-Leste (Oecussi excluded) showing rice and maize OFDT sites**

1. Overview of the Seeds of Life program

1.1 Introduction

The "Seeds of Life (SoL)" program addresses food security issues in East Timor (from here on to be termed the official Timor-Leste). SoL is a program within the Ministry of Agriculture and Fisheries (MAF) being implemented under the bilateral assistance program for Timor-Leste. It is jointly funded by the Governments of Australia and Timor Leste. Government of Australia funding is from the Australian Agency for International Development (AusAID) and the Australian Centre for International Agriculture Research (ACIAR). ACIAR manages the joint funding from AusAID and ACIAR through the executing agency, the Centre for Legumes in Mediterranean Agriculture (CLIMA) at the University of Western Australia (UWA).

The current phase of SoL commenced on 01 September, 2005. Annual research reports summarize the research conducted in the previous wet season. This report is the fourth in a series and describes the SoL activities conducted over the period from 01 September, 2008 and 31 August, 2009.

The goal and purpose of SoL is improved food security in Timor-Leste through the use of improved crop varieties and associated technologies which result in increased food production. SoL does not intend on breeding its own material as it is considered that there is sufficient improved germplasm in other parts of the world suitable for introduction into Timor Leste. The main sources of material are crop centres belonging to the Consultative Group on International Agricultural Research (CGIAR). These include the International Rice Research Institute (IRRI) for rice; the International Maize and Wheat Improvement Centre (CIMMYT) for maize; the International Centre for Tropical Agriculture (CIAT) for cassava and beans; the International Potato Centre (CIP) for sweet potato and the International Centre for Research in the Semi-Arid Tropics (ICRISAT) for peanuts (groundnuts). Much of this material is sourced from CGIAR regional centres. For example most sweet potatoes were from Indonesia and cassava was from Thailand and Indonesia. In addition to the CGIAR centres, potential varieties were sourced from the University of Philippines breeding group (maize), Australia (mungbeans) and Ruanda via World Vision (climbing beans).

Potential entries for the trials are selected after considerable discussion with SoL personnel and plant breeders from the various responsible institutions. A short list of approximately 20 breeding line entries are then evaluated under research conditions in replicated trials. Most replicated trials were conducted on research stations but some were established in farmers fields if deemed necessary. For example, potato trials were installed on a farmer's field at high altitude and there are no research stations suitable for rice trials. At least two "local" varieties are included in each of these trials as controls. Replicated trials are conducted on each species across a number of agro-ecosystems and years.

One or two of the best entries from the replicated trials may be evaluated on farmers' fields in unreplicated "on-farm demonstration trials" (OFDTs). Approximately 837 OFDTs were established in 2008-2009 allowing a large number of farmers to observe plant growth, measure yield and taste the resulting material. Researchers were also able to compare the test entries over a range of ecosystems and management practices.

After completion of replicated and on-farm trials, potential releases were recommended to the MAF for release. The MAF released two varieties of maize, three varieties of sweet potato, one rice variety and one peanut variety in 2007. At the time this material had been evaluated for a number of years and proved to be consistently higher yielding and were popular with farmers and consumers. In August, 2009, two cassava varieties were released bringing the total number of released varieties from SoL to nine. Further releases of these major five food crops and others are expected over the next few years.

A lack of good varieties is one of the identified constraints to crop production in Timor-Leste. In addition, the major food crop yields are constrained by a number of other technological factors. Crops suffer from water shortages, high weed populations reduce crop yield potential and soil fertility is low. Storage of seed and grain is problematic. Studies on these constraints during the past year include seed storage research, time of planting trials, planting distance trials, weevil tolerance evaluations and fertilizer trials.

The SoL research program is developed based on a long term strategy for variety release and technology development. Annual plans are discussed with the program's Technical Advisory Group (TAG), MAF personnel and development partners including the Research and Development Units (RDUs) at the district level which include representatives from MAF, Non-Governmental Organizations (NGOs), lead farmers and other members of the community who wish to be involved. Gaining feedback from farmers is a constant process through engagement in a number of field days and through the RDUs. Although most of the research activities were conducted by MAF personnel or staff contracted to MAF, seed was distributed to NGOs, farmers groups and local organizations for multiplication purposes. Research personnel from the Australian National University (ANU) and staff and students from the University of Timor Lorosae (UNTL) were also involved.

Seed and planting material multiplication constituted a major and expanding portion of SoL activities in 2008-2009. Breeder and foundation seed was multiplied on research stations and bulked up on farmers fields. The resulting seed was distributed directly to farmers and via NGOs and the MAF and FAO. The seed multiplication program will expand in 2009-2010.

SoL seed reached all thirteen districts of Timor-Leste (Figure 1) but most of the research and seed production was concentrated in the districts of Manufahi, Aileu, Liquiça, Baucau, Viqueque and Ainaro (Figure 1). The main office is located in the MAF compound at Comoro with many of the staff making regular visits to district offices.

This report provides details of the annual research and seed production program plus gives an outline of the training program. Studies on the impact SoL had on gender, training, economy and the environment were also prepared. Those are available for discussion. The following section provides a summary of program activities for the period from 01 September, 2008 to 31 August, 2009.

1.2 Program summary, 2008-2009

Reporting of SoL activities during 2008-2009 were grouped according the main objectives of the program. These were a) Seed production, storage and distribution, b) Evaluation of germplasm and associated technologies, c) On-farm demonstrations and trials and 4) Program management and coordination. A summary of activities for the year by component are presented below:

Component 1: Seed production, storage and distribution.

Activities in this component include:

- Rehabilitation of Betano, Loes and Darasula research stations
- Utilization of the Aileu research site
- Seed production and storage at MAF stations and Districts
- Training in seed production and storage
- Testing and formulation of a seed certification, seed import and variety release policy

Rehabilitation of research stations advanced considerably over the past year. The main research related buildings at Betano Research Station to be provided through SoL funding were complete and operating at the end of the year. In addition, the MAF constructed a large warehouse, a meeting building, one residential house and tractor repair shed nearby.

One house at Loes Research Station was rehabilitated in 2008. By the end of August, 2009 five, two bedroom houses, one office and one laboratory were almost complete and construction of a generator shed and toilet block commenced. The research site had been hand cleared and MAF funding made available for the construction of a chain link perimeter fence. An Australian volunteer commenced work at the station in May, 2009 to assist with its development.

An Environmental Site Assessment (ESA) was drafted for the development of Darasula research station site. The area was temporarily fenced and will be cleared in 2009-2010 to evaluate its development potential.

All research sites for replicated trials (Aileu, Loes, Maliana, Betano, Fatumaca) were well managed during the period. Replicated trials planted at the sites included maize, cassava, sweet potato and peanuts. Field days were held at Aileu and Betano during which farmer observations of different varieties were recorded. These were supplemented with small field days held by each RA in his/her Sub-District for each crop to introduce the new tested varieties to local farmers.

Seed production and storage training was provided to by SoL personnel in an on-going basis by the R/EAs and the Seed Production Advisor (SPA). Four hundred and fifty nine (459) days of training were presented to seed production staff, MAF personnel, NGOs and farmers during the year.

The Seed Law drafted with the assistance of SoL personnel was under consideration by the MAF during the year. The Ministry must initially develop regulations and staff an appropriate directorate before submitting the law to Parliament. The Seed Production Advisor has offered to work with the MAF during 2009-2010 to develop regulations to complement the Law.

Seven seed production officers operating in six districts worked with the seed officer and advisor to produce 60t Nakroma seed, 25t Sele, 40,000 sweet potato cuttings, one hectare of cassava and 17t Utamua in 2008-2009. Distribution of planting material for the 2009/10 wet season had just commenced at the end of August, 2009. Fifteen ton of Nakroma had been distributed, 13 t of Sele and 15 t of Utamua. FAO will purchase some of the seed on behalf of MAF. Seed dryers and seed cleaning equipment were purchased during the year to improve seed quality for 2009/2010.

Seed was distributed to farmers in a number of ways. SoL personnel provided seed directly to OFDT farmers and neighbours; NGOs purchased seed directly or multiplied seed for distribution and FAO purchased seed from SoL for distribution to farmers. In addition, seed informally changed hands between farmer's friends and family members.

Component 2- evaluation of new germplasm and associated technologies

Activities in component 2 include:

- Introduction, evaluation and maintenance of new varieties
- Development of new technologies
- Development of an inventory of local varieties
- Collection of locally cultivated varieties
- Staff training

New varieties of food crops commonly cultivated in TL were introduced for evaluation in replicated trials. Thirty four replicated varietal evaluation trials were installed, harvested and described in this document. Included were six trials each on maize and peanuts, five on cassava; seven on sweet potatoes; two mungbean; two trials on rice; five on climbing bean and one on potato.

In addition to the varietal evaluations, a number of farming systems trials was installed. These included time of planting/weeding of velvet bean, weevil tolerance in maize varieties, the effect of phosphorus on peanuts, time of planting and insecticide treatment in maize and position of cutting planting in sweet potato.

A Seed Collection Curator was assigned during 2008 to collect and conserve germplasm. In the current collection are 80 cassava entries, 40 sweet potato varieties and 30 peanut varieties. Seed of the released varieties was conserved on the research stations both in the field and stored in warehouses.

Training was a major component of the overall SoL program during 2008-2009. Included in the training program were MAF staff of members from Dili and the districts plus representatives from NGOs and international organizations. There were courses on agronomy, seed production, statistics and English language. Including the 459 days of seed production training mentioned above, a total of 2378 days of training were provided over year. English language training (1443 days) to assist team members with computer work, reading scientific papers and attending training courses abroad was the most popular. Courses were delivered in week long batches and on a daily basis for an hour at a time. Data management (301 days) and agronomy (160) were also well attended courses. Constant on-the-job training was also provided by the R/EAs and visiting scientists. Four national agronomists attended UWA at the end of August, 2009 to improve their English skills in an attempt to gain MSc training in Australia. Two were successful in being awarded John Allwright scholarships and will depart for Australia early in 2010 to commence their English language training prior to starting their MScs. Two SoL/MAF personnel also commenced Masters degree training at Bogor Agricultural University in Indonesia in August, 2009.

Component 3- On-farm demonstrations and trials

Component 3 is comprised of:

- Implementation of OFDTs
- Social science and economics (SOSEK) research
- Research and Demonstration Unit (RDU) training
- Development of improved crop production packages

Eight hundred and thirty seven (837) maize, peanut, cassava, sweet potato and rice on farm demonstrations and trials (OFDTs) were established in 17 Sub-Districts during the 2008/09 wet season (Nov-April). Included were 286 maize, 151 sweet potato, 120 cassava, 194 peanut and 86 rice trials. OFDTs were installed in all major agro-ecological zones (AEZs) to evaluate the new varieties under different conditions. The coordinates of all were logged and mapped as shown in Figure 1.

Household data was collected during the year by the SOSEK team. During this period patterns of household food stocks were followed. Farmers were also interviewed to determine their use and reaction to Nakroma and Utamua. The results of these studies indicated that the farmers who ceased to grow new varieties had no seed because it was lost through drought or other calamities. Data from farmers performing OFDTs were also utilized to determine their state of wealth. Fewer farmers suffered food shortages in 2008-2009 compared with 2007-2008 but those that did, suffered longer. Other wealth indicators such as hand phone ownership pointed towards some farmers being better off overall.

Training of the members of the RDUs continued during the year. Their courses are accounted for in the numbers presented in Section 8 of this report. In addition, each RA held four mini field days in each Sub-District during the cropping season. One field day was held for each species. The crops were harvested during the field day, weighed and results discussed with the farmers and other members of the RDU. Feedback on the crops characteristics were then solicited from the visiting farmers. Approximately 40 RDU meetings were held in farmer's fields during the year.

Development of crop improvement packages included seed storage research, time of planting trials, planting distance trials, weevil tolerance evaluations and fertilizer trials. Sweet potato planting techniques were also examined

Component 4 Program management and coordination and institutionalization of crop research and extension in MAF

Component 4 includes:

- Office staffing
- Coordination of activities
- Development of a national extension strategy
- Progress reviews and planning
- Reporting
- M&E framework

Personnel changes over the past year include the assignment of a long term social scientist, Ms Angie Bexley to assist the SOSEK group with their program. Ms Bexley commenced work on 08 April, 2009 and has been assigned by ANU to work with SoL until the end of August, 2010. Three volunteer positions were also filled. Ms Sally Bolton with the Australian Youth Ambassadors for Development (AYAD) program commenced with SoL on 23 March, 2009 to assist with communications of SoL programs. Ms Bolton developed a new web page http://www.seedsoflifetimor.org/, and other promotion material during the first few months of her assignment. Mr Rowen Clarke commenced work with SoL at the beginning of May, 2009 to mentor personnel on Loes Research Station until the end of August 2010. Mr Wiert Mensinga volunteered three months (February – April, 2009) of his time to mentor personnel on Betano Research Station. Ms Myrtille Lacoste conducted adoption surveys and coordinated OFDTs from May to August, 2009.

Seven seed production officers were assigned during the year to supervise the multiplication of seed in six districts. Two officers are working in the district of Baucau. The seed officers are supervised by a senior seed officer and mentored by the Seed Production Advisor. Some of the seed officers were RAs with SoL who were replaced by new personnel. The MAF also assigned personnel to manage the research stations in Bobonaro, Liquica, Manufahi and Baucau (Corluli, Loes, Betano and Darasula respectively). In the case of Loes and Darasula, their responsibilities will be mainly in station development in the initial year or two.

SoL activities were administered from the office at the MAF compound in Comoro, Dili for the entire year. Initially this building was too small to house all advisors and MAF staff. In April, 2009 an extension was completed which will cater for the program's needs into the future.

Weekly meetings were held on Monday mornings to coordinate activities. Minutes were taken and circulated amongst the staff. These meetings will continue.

MAF has funded the salaries of 32 SoL staff since 01 January, 2008. This move indicates the commitment of MAF to the SoL program. MAF also supports the construction of buildings at Betano research station, fencing at Darasula and Loes plus the assignment of personnel to manage these stations.

SoL personnel kept in close contact with Regional Directors and District personnel, AusAID, ACIAR, and CGIAR centres during the past year. Also with other agricultural based programs through the RDUs and regular meetings (for example the monthly MAF/Donor "Harmonization meetings" and the monthly Sustainable livelihoods meetings) and with the involvement of NGOs in conducting OFDTs. Activities were effectively coordinated between the major stakeholders. Large quantities of maize, peanuts and rice seed was sold to USC Canada, CARE, World Vision and provided free of charge to five other NGOs needing small amounts. CARE commenced a village based seed production system which will be monitored by SoL for future expansion of its own seed production system.

SoL partly funded a consultant to assist develop an extension policy for the MAF. This was drafted at the beginning of 2009 and was completed with EU assistance later in the year.

SoL has also drawn up TOR for a specialist to assist the MAF National Directorate of Research and Special Services its policy. This assignment will commence at the beginning of 2010.

The APC visited the program five times in the period from September 2008 through to August 2009 to monitor progress against the plan and remains in regular contact with the Program Manager at ACIAR. A TAG visit was held in August, 2009 and a Program Steering Committee meeting held was scheduled for September, 2009.

1.3 Rainfall

Daily rainfall figures have been continuously collected from four research stations over 2008 and 2009 from Betano – Manufahi, Kintal Portugal - Aileu, Corluli – Maliana, and Fatumaka – Baucau. From October 2008, rainfall data collection also commenced at the Loes research station in Liquica with the opening of the centre for research in that month.

Rainfall is a determining factor for farmers in Timor Leste, who usually plant after three heavy rainfall incidents which mark the start of the rainy season in each area. The activities on the research stations reflect the chosen planting seasons as adopted by the farmers on adjacent farms each year.

All stations had less total annual rainfall in 2008-2009 than the long-term averages excluding Fatumaka and Loes.

In Aileu, the rainy season started in November 2008, as with Betano, Corluli, and Loes. However at Fatumaka, rains started earlier in October 2008.

Monthly rainfall in December 2008 was higher than the long-term average at all research stations. Flooding and landslides were experienced throughout Liquica as a result of the extreme downfall (receiving over 1200mm over December 2008 to February 2009). Individual research stations are discussed further below.

Table 1. Monthly rainfall at SoL research stations. Sept 2008- Aug 2009

Month	Year	Kintal Portugal, Aileu		Betano Research Station		Corluli, Maliana		Fatumaka, Baucau		Loes, Liquica	
		Lat 08.70s Long 125.56e Alt. 972masl		*Lat 09.16s Long 125.68e Alt. 3masl*		*Lat 08.93s Long125.17e Alt. 140masl*		*Lat 08.56s Long 126.39e Alt. 500masl*		*Lat 08.44s Long 125.08e Alt. 20masl*	
		Rain (mm)	LTA* (mm)	Rain (mm)	LTA* (mm)	Rain (mm)	LTA* (mm)	Rain (mm)	LTA* (mm)	Rain (mm)	LTA* (mm)
September	2008	0	*24.3*	0	*26.2*	0	*12.6*	0	*10.7*	nd	18.2
October	2008	9	107	0	29	0	64.3	73.5	54.1	0	20.9
November	2008	213.5	238.3	71.9	68.3	240	216	298	147.4	282	79.4
December	2008	475.5	395.3	356	159.3	569	332.4	624	143.2	198	172
January	2009	103	305	224.9	179.5	291	437.5	357	160	374	229
February	2009	241	239.6	58.7	143.7	407	372.5	248	162	413	185
March	2009	331.5	203.2	137.1	127.2	223	296	379	115.4	66	163
April	2009	7.5	97.2	32	101.5	72.3	140.8	50.5	97.9	50	123
May	2009	0	73.2	393.5	210.6	93	91.9	0	57.9	75	166
June	2009	0	26.6	12.1	147.3	1	49.7	0	28.3	0	119
July	2009	0	18.4	9	112.2	1.5	23.1	0	10.9	0	46.1
August	2009	0	16.9	3	24.4	0	16.3	0	7	0	28.2
TOTAL		1381	1745	1298	1329	1898	2053	2030	995	1458	1350

*Legend. * Long Term Averages (LTA) for monthly rainfall were calculated from data collated by the Indonesia-Australia Development Cooperation Agricultural Regional Assistance Program East Timor (ARPAPET, 1996) presented in Fox, J, 2003. Means calculated over 11, 12, 22, 19 and 34 years for Aileu, Betano, Maliana, Liquica and Baucau respectively.*

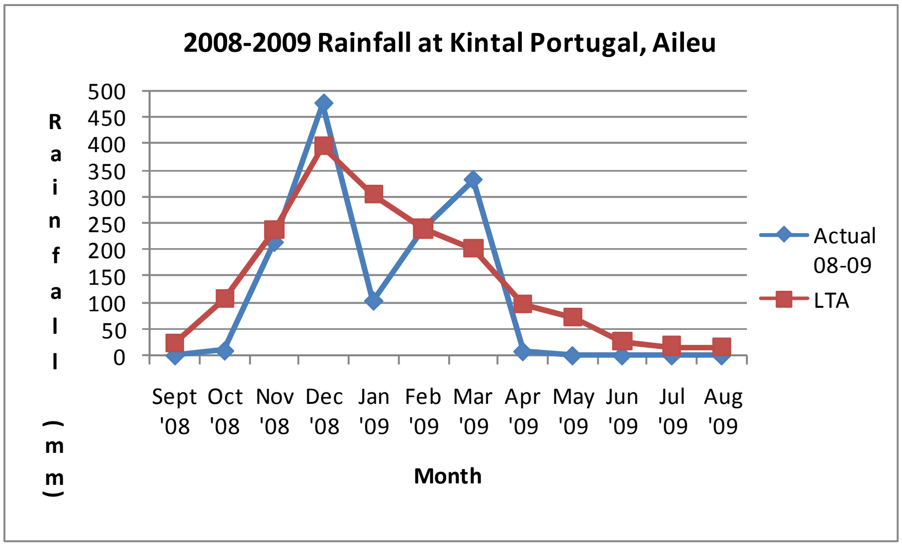

Figure 2. Rainfall at Kintal Portugal, Aileu, 2008-2009.

The monthly rainfall at Kintal Portugal was generally less than the long-term average excluding the months of December 2008 and March 2009.

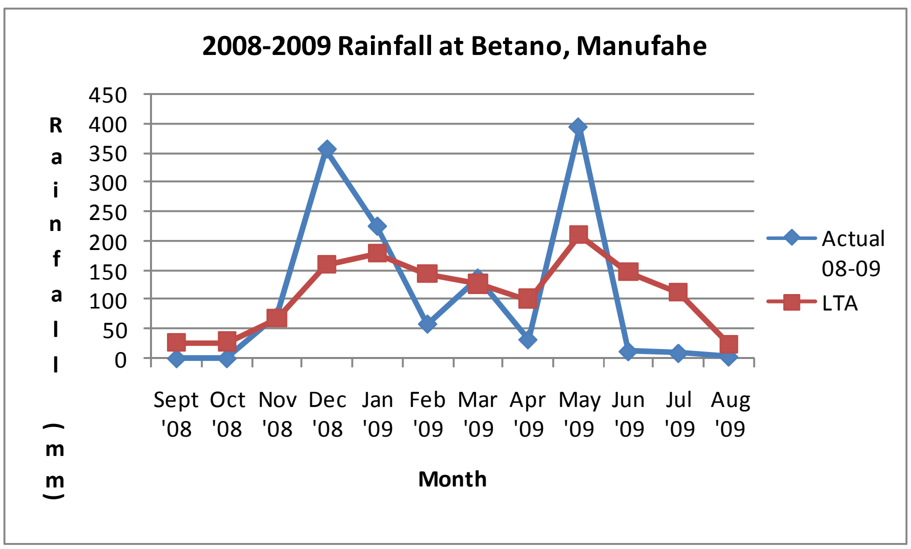

Figure 3. Rainfall at Betano, Manufahi, 2008-2009

The bimodal seasons at Betano on the south coast are distinctly shown in Figure 3, with the highest monthly rainfall figures recorded in December 2008 and even higher in May 2009 in the south coast's second rainy season.

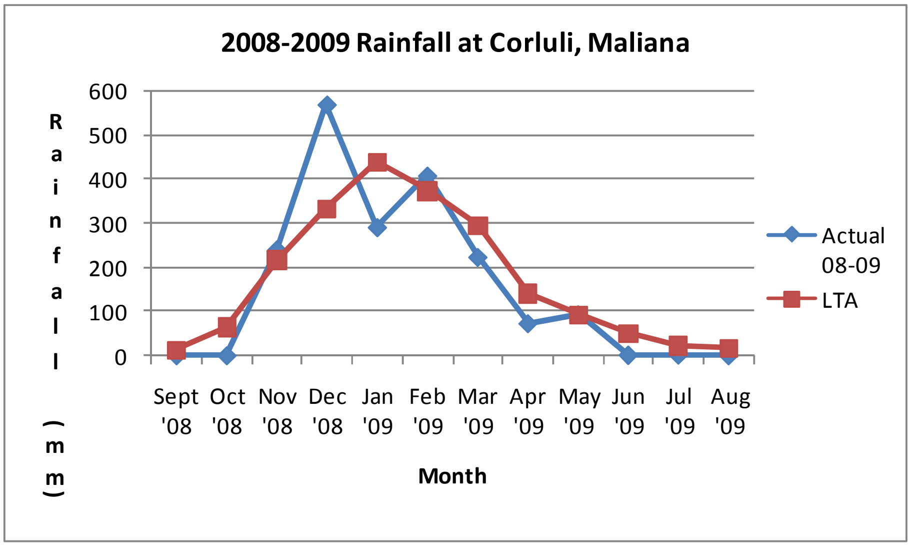

Figure 4. Rainfall at Corluli, Maliana, 2008-2009

At Corluli, monthly average rainfall totals were higher than the long-term average in December 2008 and slightly higher in February 2009. The trends generally followed the long-term data.

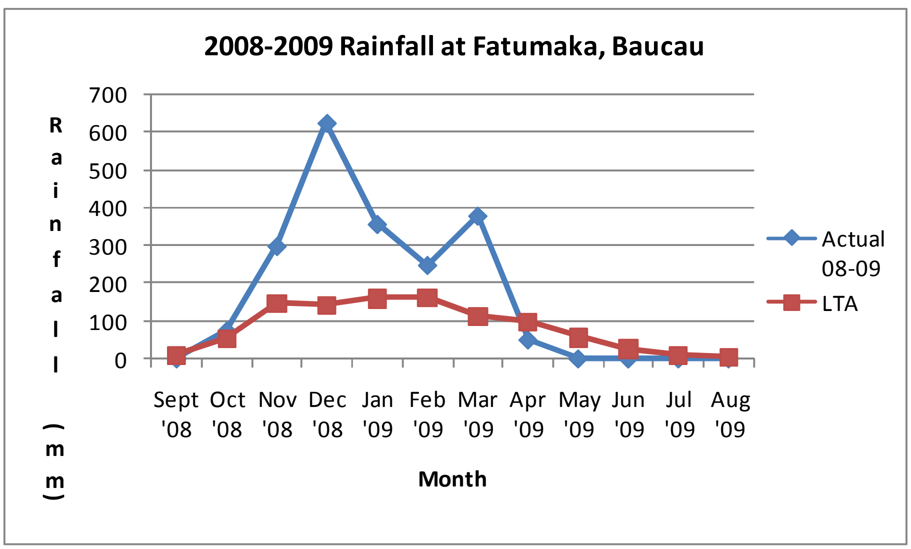

Figure 5. Rainfall at Fatumaka, Baucau, 2008-2009

A different scenario was noted at Fatumaka in Baucau in the 2008/09 season. The rainfall at Fatumaka was higher than the long-term average from November 2008 through until March 2009.

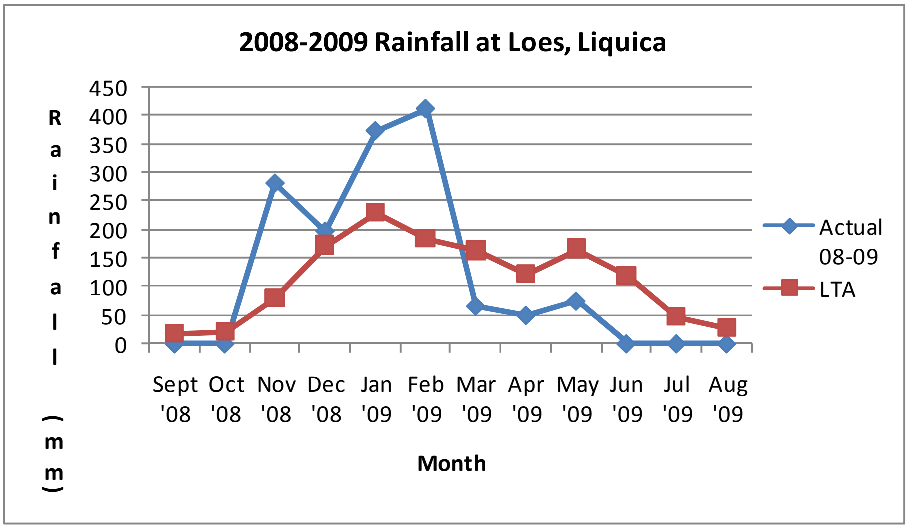

Figure 6. Rainfall at Loes, Liquica, 2008-2009

The long-term average for Figure 6 is taken from Liquica rainfall data in order to compare the Loes rainfall over the 2008/09 rainy season. The rainfall at Loes is higher than long-term averages for the district from November 2008 until February 2009.

2. Evaluation of new germplasm

2.1 Maize

2.1.1 Replicated maize trials, 2008-2009

Maize (*Zea mays*) varieties with potential for improving yields were tested in replicated trials at different agro-ecological zones across Timor Leste during 2008-2009. An additional trial was conducted at the newly opened research station in Loes, Liquica. The varieties were sourced from Zimbabwe, Thailand, Indonesia, India and the Philippines. These introduced maize populations were tested in order to identify suitable germplasm for further evaluation in farmer's fields. Three local varieties were also included in the trials. Five trials were implemented during the wet season of 2008-2009 (a dry season trial was also conducted in Betano following the 2008 wet season).

Materials and methods

Replicated maize trials were conducted at five locations in 2008/09. Each trial was a randomized block design with three full replicates. The first crops were planted starting in late November 2008 and subsequent sites planted in December 2008 (depending in rainfall). Harvested commenced in March and continued into April 2009. One trial was also planted in the dry season at Betano. This site was unirrigated and received approximately 418mm or rainfall during the growing period. A summary of the sites, planting dates and amount of rainfall received during the trial period is presented in Table 2.

Table 2. Planting and harvest details at maize trial locations, 2008/09

Location	*Season*	*Number of entries*	*Planting Date*	*Harvest Date*	*Days to maturity*	*Rainfall (mm)**	*Mean yield (t/ha)*
Baucau (Fatumaka)	Wet	20	11-13/11/08	17/03/09	127	1783	1.4
Maliana (Corluli)	Wet	20	13-14/11/08	16-17 /03/ 09	123	1560	1.2
Betano (Manufahi)	Wet	20	16/12/08	1/04/09	107	620	2.7
Betano (Manufahi)	Dry	20	18/5/09	22/09/09	127	418	0.9
Aileu (Kintal Port)	Wet	20	17/11/08	22/04/09	157	1304	0.9
Liquica (Loes)	Wet	20	5/12/2008	17/4/09	164	1101	0.9

*Total rainfall calculated for planting until harvest dates for each research station

Plot dimensions were 5m by 5m with a 50-60cm walkway between each plot.

Six or seven rows were planted per plot with 75cm between-row spacing and 25cm between hills. One seed was planted per hill and later gaps were reseeded to achieve maximum plant stands at initiation.

At harvest, cobs were removed from the central rows to exclude the two outer rows. Cobs were threshed, dried and weighed to determine grain yield.

Farmer field days were conducted at Baucau and Betano at harvest time in order to assess the farmer's preferences of maize varieties and to determine the traits that farmers use to value the varieties under evaluation. During the field day, farmers participated in the harvest of cobs and weighing of varieties. Taste testing of selected varieties was also conducted.

A selection of 20 open pollinated maize varieties was evaluated during the wet season. A description of the entries is presented in Table 3. The Philippine varieties were tested again, either under the second and third evaluation. All Philippine test varieties were white in colour and downy mildew resistant. Standard varieties in the evaluation were the high yielding released yellow varieties Suwan 5 and Sele plus the Indonesian variety Arjuna, which was handed out by the MAF to many farmers for seed in 2008. Three local varieties were included in all trials (excluding Baucau where only two were used), which were selected local varieties from Manatuto, Maliana, and Viqueque.

Table 3. Population details of maize trials, wet season 2008/09

Code	*Name*	*Source*	*Colour*
Har05	DMRSSyn024/DMRSSyn021	Zimbabwe CIMMYT	White
Har12	V036=PopDMRSRE(MOZ)F2	Zimbabwe CIMMYT	White
M 02	Suwan 5	Thailand	Yellow
M 03	Sele (LYDMR)	India	Yellow
M 24	Arjuna	Indonesia	Yellow
M 45	*Local Fatulurik*	*Manatutu (Timor)*	*Mixed*
M 47	*Local Kakatua*	*Maliana (Timor)*	*White*
M 49	*Local Viqueque*	*Viqueque (Timor)*	
M 50	AMCAP	Natabora (Philippines)	White
M 51	Nai	Suwan 5 and Arjuna cross	Yellow
P 01	IPB Var 4	Philippines	White
P 02		Philippines	White
P 03	USM Var 10	Philippines	White
P 06		Philippines	White
P 07	CMU Var 12	Philippines	White
P 08	IES 8906	Philippines	White
P 09	Tupi White	Philippines	White
P 10	Syn White	Philippines	White
P 11	CMU Var10	Philippines	White
P 12	Takro	Philippines	White
P 13		Philippines	White

For data analysis of the yield component data, datasets for each location were analysed independently. A test for row and column affects was first conducted, and then the most appropriate model chosen. For sites with no location affects, a balanced Analysis of Varience (ANOVA) was used in Genstat Edition 3, however Restricted Maximum Likelihood (REML) regular grid analysis was used in Genstat Edition 2.

A farmer field day was held at two research stations, and the protocol included inviting local farmers to observe, test, and taste selected varieties. Farmers were then asked to rate and rank the varieties based on their individual preferences.

Results

Rainfall

Table 4. Rainfall per maize cropping season over two years

Location	*2007-2008*	*2008-2009*
Baucau (Fatumaka)	1077	1783
Maliana (Corluli)	1728	1560
Betano (Manufahi)	165	620
Aileu (Kintal Port)	1245	1304
Liquica (Loes)	No data	1101

Rainfall at Baucau was about 700mm greater than the previous season and Betano rainfall during the 08-09 season was triple the previous season. There was little difference between rainfall at Maliana and Aileu over the two seasons. As no location suffered less rainfall than the previous year, the rainfall data is not considered to be a limiting factor in the 2008-2009 maize season as it was in Betano, for example, in 2007-2008.

Baucau

Analysis of the Fatumaka replicated maize data indicated that there was significant variation for yield from different rows and columns at the site. This was due to fluctuating micro-environmental conditions sloping down the land at Fatumaka. Figure 7 shows the affect of column differentiation on the maize yields.

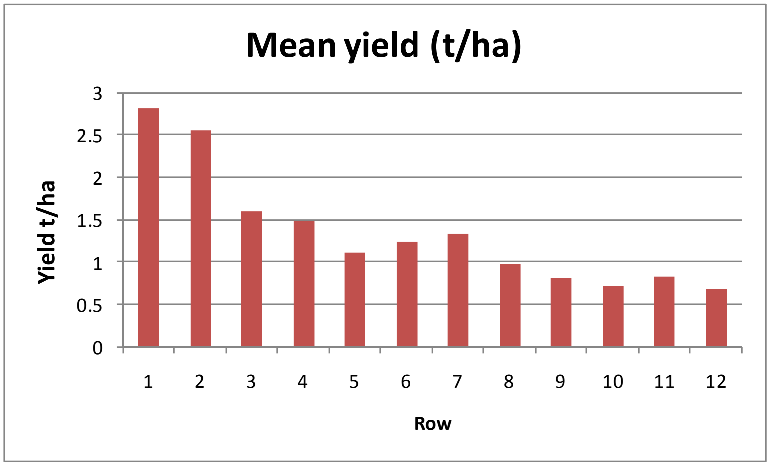

Figure 7. Mean maize yields per row at Baucau, 2008/09

The row variation at the site affected the results for germination rates, cob height, total height and consequently yield (t/ha). There was also variation between the columns at the site, which further affected the plants/m^2, number of cobs per plant and lodging data. (The row estimate was divided by the row standard error to determine if it was 2 times greater than the standard error. Those row estimates greater than 2 times the standard error are considered to have significant differences between rows).

Due to the row and column effects at the site, REML analysis was used to analyse the data in Genstat Discovery Edition 2. Various models were tested and the regular grid spatial model, Auto Regressive 1 (AR1) selected. The AR1 model uses a 'nearest neighbour' analysis to show the significant differences between the yields of each variety. The results of the analysis using the optimal model are shown in Table 5 below.

Table 5. Yield and yield components of maize observational trial, Baucau, 2008/2009

Population	*Plants/ m^2*	*Cobs/ plant*	*Cob weight (g)*	*Yield (t/ha)*	*Seed weight (g/100)*	*Plant height at harvest (cm)*	*Cob height at harvest (cm)*	*Height from cob to flower top (cm)*	*Lodging (% fallen plants)*
Har05	3.6	0.6	36	1.4	20	127.2	36	95	4.6
Har12	4.8	0.5	29	1.4	19	163.9	65	107	11.3
Suwan 5	3.9	0.6	39	2.2	23	173.9	60	121	5.2
Sele	4.5	0.9	24	1.9	21	165.6	45	110	24.1
M 24	3.4	0.6	33	1.2	19	125.5	45	80	6.1
M 47	*4.1*	*0.5*	*17*	*1.2*	*25*	*170.5*	*61*	*111*	*11.9*
M 49	*3.9*	*0.5*	*19*	*1.1*	*18*	*185.4*	*63*	*120*	*18.1*
M 50	3.8	0.5	21	1.0	24	161.3	53	107	11.3
M 51	4.1	0.5	30	1.2	23	175.3	69	109	19.6
P 01	3.9	0.6	23	0.9	25	152.0	44	106	12.6
P 02	3.8	0.6	18	1.4	20	148.6	38	101	11.8
P 03	3.9	0.6	17	1.0	19	132.0	32	97	10.7
P 06	3.1	0.8	14	1.2	22	134.6	32	100	7.2
P 07	2.7	0.8	38	1.3	26	138.7	45	88	5.4
P 08	3.7	0.4	29	1.8	24	134.6	39	97	15.3
P 09	4.4	0.6	29	1.0	23	164.1	66	109	9.3
P 10	3.5	0.5	43	1.8	26	119.5	31	85	8.3
P 11	4.1	0.8	34	1.8	24	147.0	53	105	7.7
P 12	3.2	0.6	26	1.8	17	166.5	43	116	12.5
P 13	3.0	0.4	17	1.1	22	131.5	38	96	11.2
Chi-sq prob code	*<0.001*	*<0.001*	*0.22*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*0.008*	*0.007*
LSD	*0.6*	*0.2*	*ns*	*0.96*	*4.0*	*22.3*	*14.03*	*16.02*	*7.4*

The yield component graphs (Figure 8) show the regressions between the various yield components and the total yield in t/ha. The strongest correlation at Fatumaka was observed between cob weight (R^2 0.39) and cobs per plant (R^2 0.34), similar to the previous year.

At Fatumaka, data analysis indicated that there were observed significant differences between varieties for all yield components except cob weight. Plant heights were also significantly different between varieties.

The average plant stand at Baucau was 3.7 plants/m^2. All varieties ranged between 3 and 4.8 plants/m^2 (Har12), with the exception of P07 which had a density of only 2.7 plants/m^2. Har12, Sele and P09 had the highest densities (4.4 to 4.8 plants per m^2). Figure 8 demonstrates how weak the correlation between yield and plant stands was at this site.

The number of cobs per plant differed significantly between varieties tested. The average number of cobs was low, at 0.6 per plant. Sele, and Philippine varieties P06, P07 and P11 had the highest number of cobs per plant (0.8-0.9). All other varieties had between 0.5 and 0.6 cobs per plant excluding P08 and P13 which were significantly lower than the majority of varieties.

Cob weights measured did not show any varietal differences, however seed weights (per 100 seeds) differed. The average seed weight per 100 seeds was 22g across all varieties. As in last year's trials at Fatumaka, M27 had a significantly higher seed weight (25g) than 50% of the testers. The Zimbabwe varieties Har05 and Har12 had significantly lower than 50% of the varieties (20g and 19g consecutively).

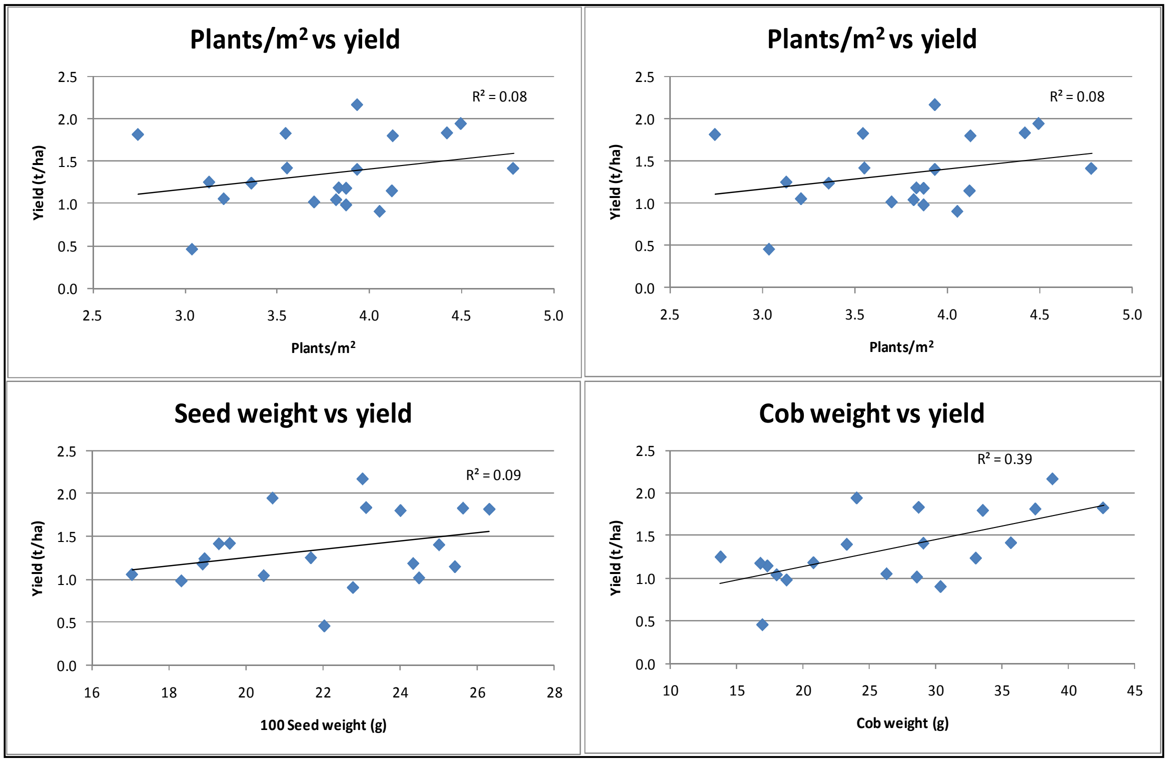

Figure 8. Maize yield component graphs, Fatumaka, 2008/09

The differentiation of lodging resistance (%) between varieties was large. M03 had 24.1% fallen plants at harvest time, significantly more than all varieties except M51 and M49 which were statistically similar with high lodging rates. P07, Suwan 5 and Har05 had the lowest rate of lodging, all less than 6% of the plant stand.

Plant height ranged from 119.5 to 185.4cm at harvest. The lodging of plants was correlated with the height of the plants (as seen in Figure 9), and was indicated by the tallest plants M51 and M49 also having the highest rates of lodging. Suwan 5 was statistically taller than 45% of the varieties tested, however had a very low lodging rate demonstrating good resistance to wind and rain damage.

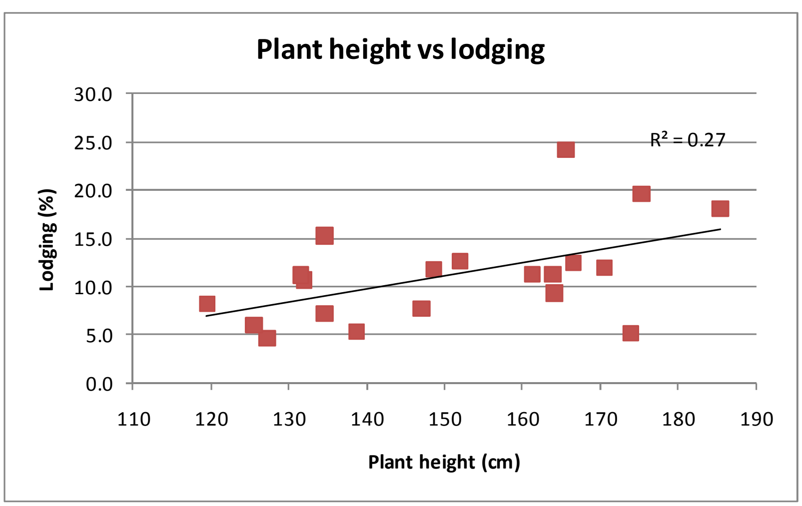

Figure 9. Correlation between maize plant height and lodging

The highest yielding varieties were Suwan 5, Sele and four Philippine varieties (P08, P10, P11 and P12), all with yields between 1.8 and 2.2 t/ha. Har05 and Har 12 had yields of 1.4t/ha, which were significantly lower than the varieties mentioned at Baucau. P01 was the only variety yielding less than 1t/ha (0.9). The average yield for the population was 1.4t/ha, as in the previous season.

Maliana

Maize data from the Maliana research site indicated that there were significant variations between rows and columns at the site. Row variation affected the germination rates, the cob heights and the total height of the maize, while column affects gave error to the plants/m^2, lodging and cobs per plant data. The yield data was also impacted by the variation within rows and columns. Therefore, REML analysis was used, as with the Baucau data, using the Auto Regressive 1 (AR1) model. However, the REML model did not fit the data set for maize plant height; therefore a balanced ANOVA was used for this particular analysis.

Results of data analysis are presented in Table 6.

Table 6. Yield and yield components of maize populations, Maliana, 2008/09

Population	*Plants/ m^2*	*Cobs/ plant*	*Cob weight (g)*	*Yield (t/ha)*	*Seed weight (g/100)*	*Plant height at harvest (cm)*	*Cob height at harvest (cm)*	*Height from cob to flower top (cm)*	*Lodging (%)*
Har05	8.7	0.7	37	1.4	24	190.0	68	114.3	2.8
Har12	10.3	0.6	37	1.4	23	193.7	81	118.0	5.2
Suwan 5	13.1	0.7	27	1.4	25	210.7	74	124.3	3.9
Sele	11.3	0.6	32	1.3	25	190.3	89	112.3	6.4
M 24	9.0	0.4	35	0.7	25	175.7	63	106.7	2.4
M 45	*8.6*	*0.6*	*29*	*0.8*	*24*	*228.7*	*115*	*122.0*	*4.9*
M 47	*9.6*	*0.6*	*29*	*0.9*	*25*	*206.0*	*87*	*113.7*	*7.2*
M 49	*7.9*	*0.6*	*38*	*1.0*	*27*	*231.0*	*109*	*122.0*	*6.2*
M 50	11.9	0.7	34	1.4	27	222.0	106	123.3	10.0
M 51	11.3	0.7	32	0.9	26	248.0	118	118.3	24.4
P 01	8.3	0.7	34	0.9	24	191.3	85	109.7	4.3
P 02	4.3	0.9	51	1.1	24	194.7	78	120.3	7.0
P 03	10.3	0.6	39	1.6	26	190.3	66	119.7	1.8
P 06	4.5	0.8	53	1.4	27	189.3	72	119.7	3.1
P 07*	2.0	1.2	*	*	*	*	78	149.7	4.2
P 08	7.4	0.7	50	1.2	24	311.7	102	236.0	4.2
P 09	9.7	0.8	8	0.7	21	213.3	69	134.3	6.4
P 11	8.0	0.7	55	1.7	27	215.0	86	129.3	8.6
P 12**	*	*	*	*	*	*	*	*	*
P 13	4.1	0.7	49	1.1	27	193.7	73	127.3	4.2
Chi-sq prob code	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	-	-	-	*<0.001*
F prob	-	-	-	-	-	*0.348*	*<0.001*	*0.507*	-
LSD	*3.5*	*0.2*	*14*	*0.7*	*2*	*ns*	*18*	*ns*	*6.0*

*P07 has only two reps of data as one rep died and not enough seed for re-seeding

**P12 had initially very poor plant stands and there was insufficient seed for re-seeding so the monitoring was abandoned.

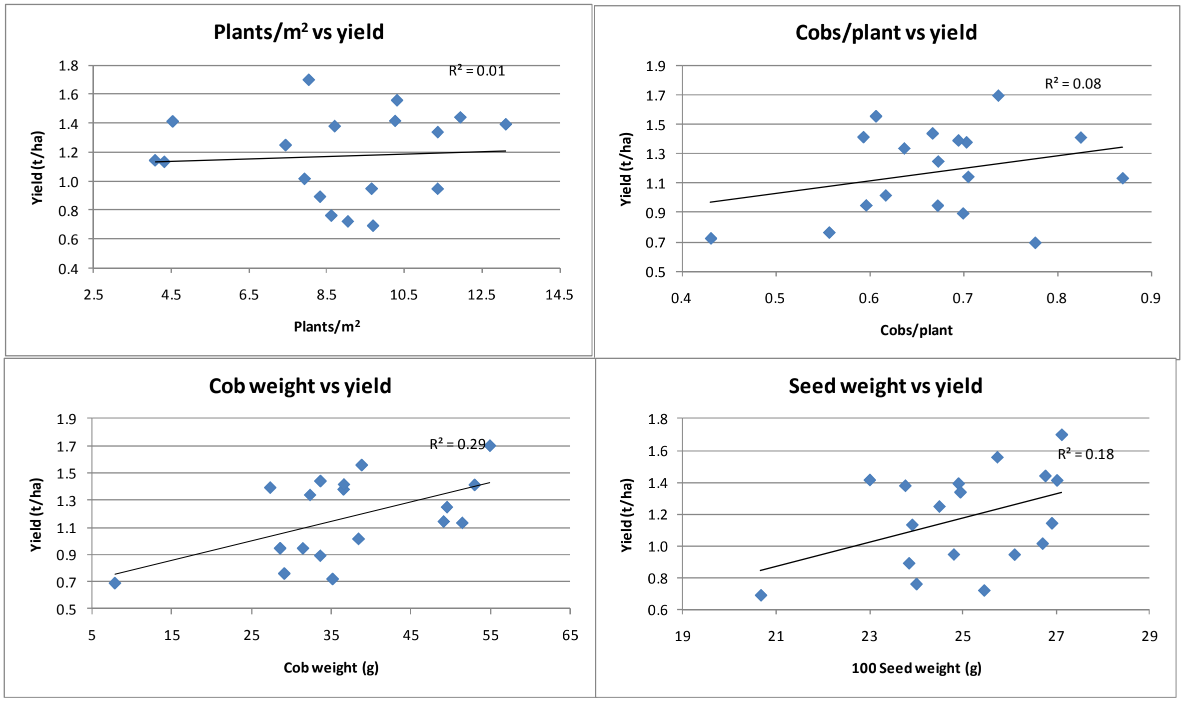

Figure 10. Yield component graphs, Maliana, 2008-2009.

Figure 10 shows that cob weight and seed weight were the yield components most correlated to production (t/ha) of the varieties tested at Maliana, although no yield components showed as strong correlations as in the previous year for plant stands at Maliana (R^2=0.55). This may be attributable to the better establishment at planting in 2008-2009, with less impact on yields.

Suwan 5, Sele, M50 and M51 had the highest number of plants/m^2. Har12 and P03 were statistically similar. Four Philippine varieties had significantly lower plant stands of between 2.0 (P07) and 4.5 (P06) plants/m^2. The average plant stand was 8.5 plants/m^2, and plant stands were much higher than in 2007-2008.

Most varieties had a statistically similar number of cobs per plant (an average of 0.7), however P07 had a statistically higher number (1.2), likely due to its low plant densities, and M24 a much lower number (0.4) as it did in the previous year.

Total height of the plants and the length from the cob to the flower-top did not show any significant difference between varieties. The average total height was 211cm. Cob height varied significantly amongst the varieties tested however. Generally the Philippine varieties were shorter than the other varieties, which could be a result of their lesser plant stands and reduced competition for light in the plots. M51 and M45 had significantly higher cob heights than most other varieties (118cm and 115cm consecutively), and also higher plant stands.

The percentage of lodged plants within the plots at Maliana ranged from 2.4% (M24) to 24.4% (M51). M51 had the highest number of fallen plants, also being the tallest of the varieties. M50 also had a high percentage of lodging (10%). As at Baucau, Har05 and Suwan 5 had low percent lodging values (2.8 and 3.9%).

There was significant difference amongst the yields of the varieties at Maliana. The average yield for the site was 1.2 t/ha. The highest yielding varieties at Maliana were Philippine varieties P03 and P06 (1.6 and 1.7 t/ha). M24 and P09 had significantly lower yields when compared to the other highest yielding varieties M50, Suwan 5, Sele and the two Zimbabwe varieties H05 and H12 which were all above average yield for the site.

Loes

Testing of the data from the maize trials at the Loes site indicated an affect of plant stands on the yields of the varieties. This was due to flooding of the site, which impacted plant establishment, and hence appeared as a row affect at the lower end of the site (there was 0.7m fall of the surface). A balanced ANOVA model was used with plants/m^2 as a co-variate.

Table 7 below shows the results of the analysis.

Table 7. Yield and yield components of maize populations, Loes, 2008/09

Population	*Plants/ m^2*	*Cobs/ plant*	*Cob weight (g)*	*Yield (t/ha)*	*Seed weight (g/100)*	*Plant height at harvest (cm)*	*Cob height at harvest (cm)*	*Height from cob to flower top (cm)*	*Lodging (%)*
Har05	2.4	0.9	85.6	1.5	29	173	86	87	9
Har12	2.4	1.2	73.2	0.9	27	146	52	93	8
Suwan 5	3.4	1.7	66.2	1.5	36	181	87	94	17
Sele	2.0	0.9	84.7	1.0	35	173	58	115	11
M 24	2.0	1.0	70	0.8	36	140	56	84	8
M 45	*1.5*	*0.9*	*38.1*	*0.6*	*27*	*180*	*91*	*89*	*9*
M 47	*3.4*	*1.0*	*36.4*	*0.8*	*30*	*218*	*100*	*118*	*37*
M 49	*2.9*	*1.1*	*39.5*	*0.2*	*32*	*184*	*77*	*107*	*16*
M 50	2.1	0.9	66.5	0.9	40	179	71	108	14
M 51	2.9	0.8	65.8	0.5	36	187	110	77	18
P 01	2.0	0.9	56.3	0.5	38	142	55	86	14
P 02	3.0	1.0	77	1.8	28	195	104	91	25
P 03	2.6	0.9	93.7	0.6	45	169	57	113	7
P 06	1.3	1.3	71.3	0.9	34	173	71	102	20
P 07	0.8	0.8	107.5	1.5	31	235	118	117	30
P 08	1.2	0.7	79.9	0.7	32	150	53	97	20
P 09	3.7	1.0	57.9	0.1	31	147	42	106	13
P 11	1.1	1.0	86.5	0.9	31	117	46	72	33
P 12	*	*	*	*	*	*	*	*	*
P 13	1.6	0.7	34.7	0.9	38	129	57	72	16
F prob	*0.023*	*0.65*	*0.3*	*<0.001*	*0.143*	*0.159*	<.001	*0.927*	*0.045*
LSD	*1.7*	*ns*	*53*	*0.75*	*ns*	*ns*	73.2	*ns*	*18.45*

* No data

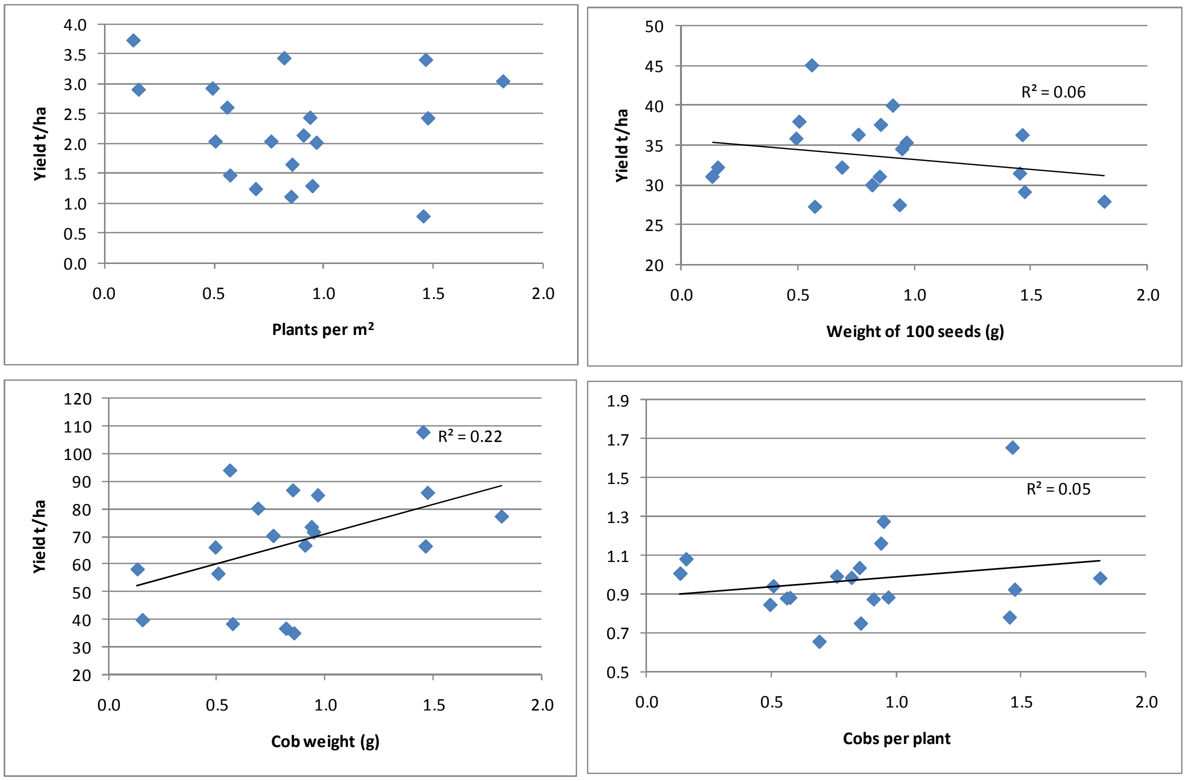

Figure 11. **Maize yield component graphs, Loes, 2008/09**

There was a lot of variation amongst the plots (and consequently among the varieties) due to flood damage at Loes. Plants per m^2, seed weight and cobs per plant did not show any correlations. Cob weight did however have some correlation (R^2=0.22) indicating that an increase in cob weight was linked with an increase in yield.

Plant stands differed significantly amongst the varieties tested. The average plant stand was low, at only 2.2 plants per square meter. High rainfall and flooding of the site early in plant establishment impacted the numbers established. Suwan 5 had the highest plant stand, and M47, each at only 3.4 plants/m^2. P07 had particularly low stands of less than one plant per m^2.

There was no difference amongst the number of cobs produced per variety, with the average number of cobs being one per plant, slightly higher than cob rates under closer planting spacing. Cob weights were also statistically similar. The average cob weight was 68g. Seed weight did not differ significantly among varieties.

Yields differed among varieties tested. Using plants/m^2 as a co-variate assisted in reducing some of the error caused to the data by flooding. All Philippine varieties yielded less than 1t/ha excluding P02 and P07 (1.8 and 1.5 t/ha). Local varieties were also below 1ton/ha. Har05 and Suwan 5 were among the highest yielding, both with 1.5t/ha.

Total plant height was statistically similar among the varieties tested at Loes, however the height of the cobs was significantly different. The varieties with the highest cobs were M47, M51, P02 and P07 (between 100 and 118cm high). Higher cob height varieties were also the ones most likely to be affected by lodging, despite the similar total plant height. Lodging rates were generally high due to the flooding, and affected all varieties. M47 was particularly vulnerable at 37% lodging, followed by P07 at 30% lodging, although the statistical difference among varieties was not large. Further research in the following year at Loes will assist in confirming lodging traits of the varieties.

Betano wet season

Maize data from the Betano Research Station showed significant variation between varieties. There was neither row nor column impacts to the different yield component of the varieties, indicating consistent conditions across all plots. This improvement was largely due to the establishment of an appropriate soil ploughing system amongst the research plots at Betano, which allows for flat and even plots. Consequently, a balanced ANOVA was used, with results presented in Table 8. Yield correlations of the various yield components follow in Figure 12.

Table 8. Yield and yield components of wet season maize trial, Betano, 2008/09

Population	*Plants /m²*	*Cobs / plant*	*Cob weight (g)*	*Seed weight (g/100)*	*Yield (t/ha)*	*Plant height (cm)*	*Cob height (cm)*	*Cob to top flower (cm)*	*Lodging (%)*
Har05	4.6	0.79	74	26	2.8	231	52	118	0.4
Har12	5.2	0.91	75	25	3.6	238	58	117	2.8
Suwan 5	5.1	0.81	86	28	3.5	237	58	114	1.4
Sele	5.2	0.85	85	27	3.8	264	58	142	1.0
M 24	5.0	0.83	73	29	3.1	229	57	121	0.4
M 45	*4.7*	*0.78*	*37*	*24*	*1.3*	*281*	*52*	*76*	*14.7*
M 47	*4.4*	*0.87*	*59*	*31*	*2.3*	*267*	*55*	*130*	*1.8*
M 49	*5.0*	*0.78*	*51*	*26*	*2.0*	*270*	*56*	*120*	*39.2*
M 50	5.3	0.88	77	26	3.6	263	59	125	3.0
M 51	5.1	0.76	61	28	2.5	295	57	137	2.8
P 01	4.1	0.84	79	29	2.7	228	48	118	1.3
P 02	3.9	0.87	88	28	3.0	238	44	131	1.8
P 03	4.6	0.72	90	28	2.9	241	51	135	1.1
P 06	1.9	0.92	100	30	1.7	236	19	131	0.7
P 07	0.4	1.00	118	32	0.5	232	8	131	0
P 08	3.9	0.83	74	26	2.3	225	43	123	6.7
P 09	5.2	0.88	84	24	3.8	275	58	147	2.7
P 11	3.8	0.81	83	29	2.5	251	42	118	2.4
P 12 *	-	-	-	-	-	-	-	-	-
P 13	2.3	0.97	120	34	2.6	223	26	128	2.4
F prob	*<.001*	*0.012*	*<.001*	*<.001*	*<.001*	*<.001*	*<.001*	*0.10*	*<.001*
LSD	*0.6*	*0.13*	*22*	*3.7*	*1.1*	*24*	*6*	*ns*	*12.5*
CV%	*8.4*	*9.3*	*17.5*	*8.0*	*24.6*	*5.8*	*7.8*	*15.9*	*166*

** No data due to insufficient seed for replanting*

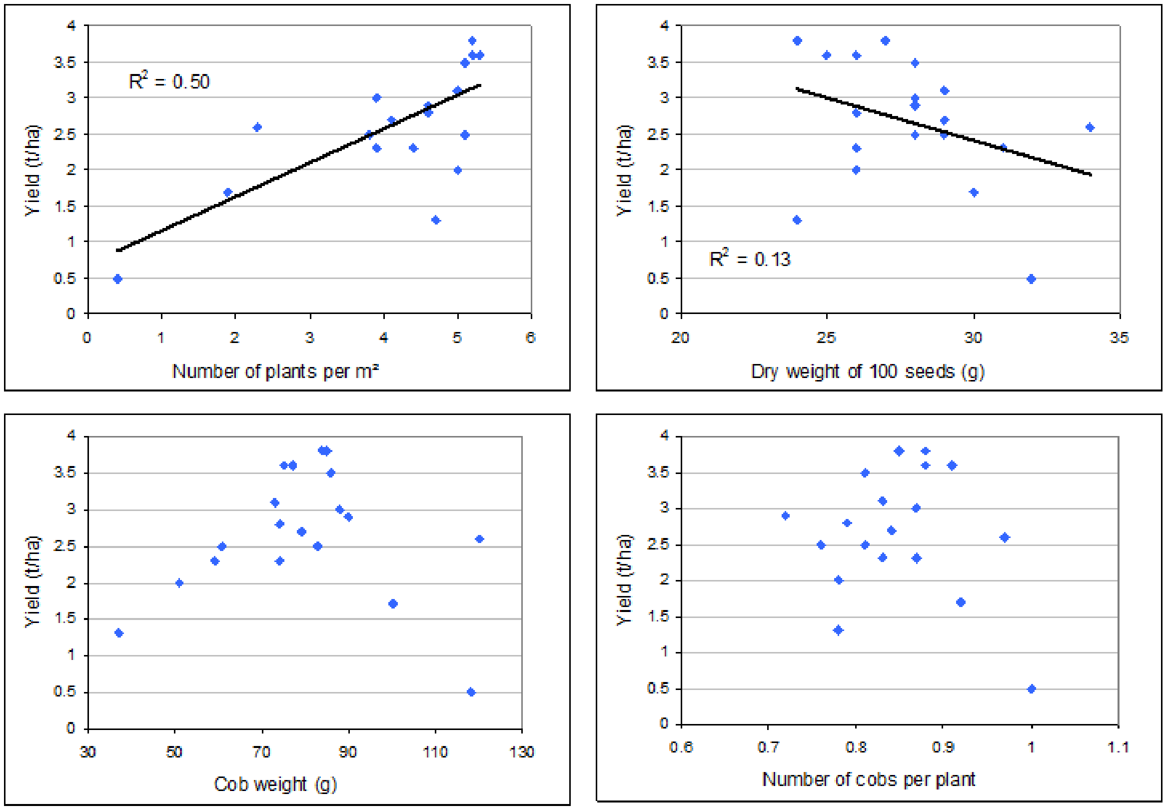

Figure 12. **Maize yield component graphs, Betano**

Yields at Betano were significantly different amongst the varieties tested with an average yield of 2.7 t/ha, higher than the Fatumaka trial average. The two released varieties (Sele and Suwan 5) and Har12 performed well as they ranked among the 5 highest yielding varieties. The highest yielding varieties also included two populations from the Philippines. Sele and Tupi White (P09) both yielded 3.8 t/ha, Har12 and AMCAP (M50) yielded 3.6 t/ha and Suwan 5 3.5 t/ha. The three local varieties had yields below the station average, while the only variety performing under 1 t/ha was P09 even though this variety had one of the highest plant stands.

All the varieties characteristics were found to be significantly different, with the exception of cob to flower-top length. Plant density ranged from 0.4 to 5.2 plants/m², with a highly variable resistance to lodging: the M49 and M45 varieties (both local) showed a percentage of fallen plants of 39 and 15% respectively, significantly more than most of the other varieties (generally showing 0 to 3% of fallen plants). No correlation was found between the percentage of fallen plants and the density of plants. None of the varieties had more than one cob per plant (maximum of 1 for P07), while seed weight per cob and weight of 100 seeds averaged 79.6g and 27.8g respectively.

The three local varieties had average plant density but their other yield components generally ranked low (with the exception of M47 performing quite well in terms of number of cobs per plant and weight of seeds). The three Philippine varieties P13, P07 and P06 consistently ranked among the three or four best performing varieties in terms of number of cobs per plants, cob weight and weight of 100 seeds. Their poor yields (P13 was average while P06 and P07 were among the three lowest) are largely explained by their low density of plants (2.3-0.4 plants/m² against an average of 4.2). Comparatively, the four best yielding varieties (Sele, Har12, P09 and M50) showed an opposite pattern: they were the four varieties presenting the highest densities whilst their other yield components ranked randomly. When P07, P06 and P13 are removed from the set of data, the strongest correlation found was between the yield and the cob weight (R^2=0.6). This is consistent with farmers' comments, as they very often praise "varieties with big cobs".

Plant height ranged from 223 to 295 cm at harvest. The lodging of plants was slightly correlated with the height of the plants (R^2 = 0.13, Figure 13). Nai (M51), Tupi White (P09), M47 (local), Sele and AMCAP (M50) were respectively statistically taller than 89%, 67%, 61%, 56% and 56% of the varieties tested, however had a low lodging rate demonstrating good resistance to wind and rain damage.

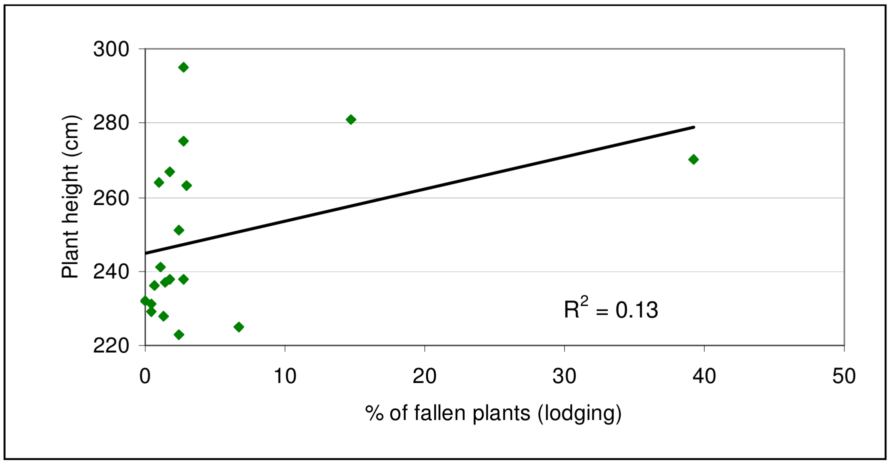

Figure 13. Correlation between maize plant height and lodging

Betano dry season maize

A maize variety trial was conducted in Betano research station between May and September 2009. As for the wet season trials, the same varieties were used and planted in randomized plots with 3 replicates. Plots dimensions were 5m x 6m with spacing of 75 cm x 25 cm resulting in 8 rows of 20 plants each per plot. One seed was planted per hill and later gaps were reseeded during the first two weeks after planting to achieve maximum plant stands at initiation. Neither fertilizer nor irrigation was applied. Only the 4 central rows were harvested.

Maize data from the Betano Research Station showed significant variation between varieties. A significant column effect was also found. Consequently, a REML test was used which included a random column term with an AR1 model. Results are presented in Table 8 (degrees of freedom are included between 33 and 35). Some animal damage occurred to some plots however this did not have any significant affect on yields.

Table 9. Yield and yield components of dry season maize trial, Betano, 2009

Population	*Yield (t/ha)*	*Plant density (/m²)*	*Cobs /plant*	*Average weight/ cob (kg)*	*Average weight/ non empty cob (kg)*	*% of empty cobs*	*Weight of 100 seeds (g)*	*Plant height after 2 months (cm)*
H05	0.8	4.2	1.0	0.02	0.04	45.8	19.2	134
H06	1.1	4.6	1.0	0.03	0.05	35.3	21.7	197
H12	1.3	4.7	1.0	0.04	0.05	27.6	23.7	172
Suwan 5	1.5	5.0	1.0	0.04	0.05	25.0	24.2	188
Sele	1.1	4.7	1.0	0.03	0.05	34.1	22.7	177
M24	1.0	3.8	0.9	0.04	0.06	30.9	27.1	170
M45	*0.7*	*4.3*	*0.9*	*0.02*	*0.03*	*32.0*	*20.7*	*197*
M47	*0.9*	*4.6*	*1.0*	*0.03*	*0.04*	*39.0*	*24.4*	*188*
M50	1.0	4.9	0.9	0.02	0.04	34.5	24.8	163
M51	1.3	4.8	1.0	0.03	0.04	30.6	24.5	203
M52	1.0	4.6	0.9	0.03	0.05	30.4	20.7	195
P01	*	*	*	*	*	*	*	*
P02	0.7	4.8	1.0	0.01	0.01	37.8	20.9	157
P03	0.7	4.5	1.0	0.02	0.02	35.6	21.4	188
P05	1.0	4.1	1.0	0.04	0.06	37.5	21.3	198
P06	0.8	4.9	1.0	0.01	0.02	48.4	20.8	141
P07	1.0	4.7	0.9	0.03	0.04	38.9	24.3	183
P08	0.9	3.7	1.0	0.02	0.05	43.1	24.3	197
P09	0.6	4.6	1.0	0.03	0.04	28.6	16.3	181
P13	0.6	2.8	0.9	0.05	0.08	33.9	26.4	183
Prob	0.001	<0.001	0.889	<0.001	<0.001	0.48	0.002	0.001
l.s.d.	0.6	0.7	n.s.	0.0	0.0	n.s.	5.1	34
Deviance	-13	0	-158	-265	-243	231	141	288

* No data

Grain yields were very low but they and the yield components were found to be significantly different among the varieties except for the number of cobs per plant (average of 0.95 cobs per plant compared to the wet season average of 0.9).

The average yield of the trial was of 0.9 t/ha, with half the varieties yielding not significantly differently above this average except Suwan 5, yielding 1.5 t/ha. P13 didn't give any production as a result of very poor germination, while the other Philippine varieties didn't perform very well on average.

The average plant density was 4.4 plants /m², while the average weight of 100 seeds was 23g. The average weight of the cobs was only 28g, and 43g for the seed producing cobs. 35% of the cobs were empty on average, as effect of the lack of rain during filling phase.

The whole experiment was damaged by dogs which damaged 4-5% of all plants but no variety was affected more than another. Animal damage to maize plants is the main problem encountered during the dry season: there was little wind and no lodging issues in 2009.

Correlation between the yield and the yield components proved to be weak (R^2=0.10 to 0.15) but significant (Regression analysis: $p < 0.001$) except for the plant density component. The strongest correlation found was between a decreasing yield and the number of empty cobs.

Aileu

Analysis of the replicated maize data in Aileu indicated that there was significant variation between data collected from different rows and columns within the blocks at the site. The column effect was particularly strong, due to observed pH differences and soil colour differences amongst the plots. Figure 14 shows the affect of column differentiation on the maize yields in Aileu.

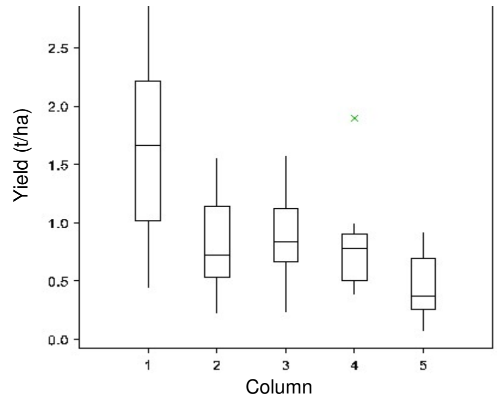

Figure 14. Mean yields and yield variation per column at Aileu, 2008/09

In order to adjust the row and column effects impacting the Aileu maize data, its analysis was conducted using a REML regular grid spatial model (AR1xAR1 in Genstat Discovery 2, degrees of freedom = 33). This model reduced the row and column impacts at the site and gave significant differences between the yields of each variety. The same model was used to predict the other parameter means, as shown in Table 10.

Table 10. Yield and yield components of maize populations, Aileu, 2008-2009.

Population	*Plants /m^2*	*Cobs/ plant*	*Cob weight (g)*	*Yield (t/ha)*	*Seed weight (g/100)*	*Plant height at harvest (cm)*	*Lodging (%)*
Har05	3.9	0.31	30.6	0.4	27.8	152	5.4
Har12	3.9	0.52	28.1	0.8	24.4	196	6.6
Suwan 5	4.1	0.51	32.9	0.7	33.0	184	3.8
Sele	4.0	0.66	34.2	1.2	32.1	174	1.1
M 24	3.7	0.53	35.0	0.9	36.2	162	0.0
M 45	*3.5*	*0.53*	*29.4*	*0.6*	*32.0*	*238*	*23.2*
M 47	*3.9*	*0.52*	*34.3*	*1.0*	*41.2*	*199*	*18.4*
M 49	*3.7*	*0.40*	*41.6*	*0.7*	*35.3*	*197*	*41.5*
M 50	4.0	0.63	38.9	1.2	37.1	238	2.8
M 51	3.4	0.68	38.1	1.2	35.8	225	12.1
P 01	4.0	0.65	43.8	1.5	35.1	220	8.1
P 02	3.8	0.40	29.6	0.7	33.0	148	12.1
P 03	4.0	0.44	26.2	0.7	30.3	159	5.4
P 06	3.7	0.38	38.0	1.0	38.5	138	12.5
P 07	2.5	0.56	30.2	0.4	39.5	154	16.4
P 08	3.8	0.40	45.4	0.8	37.7	147	11.1
P 09	3.9	0.58	30.7	1.1	32.6	197	8.9
P 11	3.9	0.63	47.6	1.7	36.7	167	9.6
P 12*	-	-	-	-	-	-	-
P 13	3.9	0.50	29.5	0.9	32.3	204	8.4
F prob	*<0.001*	*0.038*	*0.595*	*0.001*	*<0.001*	*<0.001*	*<0.001*
l.s.d.	*0.6*	*0.25*	*ns*	*0.7*	*4.9*	*60*	*15.3*
deviance	*-21.9*	*-74.4*	*245.9*	*1.4*	*149.5*	*339.1*	*231.3*

** No data due to insufficient seed for replanting*

As in Betano, that there is none or very little correlation between yield and plant density at harvest, nor with the seed weight. As expected, however, there was a relationship between cob weight and the number of cobs per plant and yield.

The Aileu research site had an average yield of 0.9 t/ha, lower than the previous years (1,5 t/ha in the 2007-2008 replicated trials and 3.5 t/ha in the 2006-2007 ones). All the parameters measured in Aileu proved to be significantly different across varieties, except the cob weights.

The average plant stand was medium, with 3.8 plants per square meter. However, the average number of cobs per plant was quite low (0.5 cobs per plant), with no variety presenting more than 0.7 cobs per plant. Cob weights were statistically similar (average of 35g per cob), unlike seed weights (average of 34g per 100 seeds).

Yields differed among varieties tested. The six best yielding varieties (ranging from 1.7 t/ha to 1.1 t/ha with no statistical difference) were P11, P01, M50 (AMCAP), Sele, M51 (Nai) and P09. Har12 and Suwan 5 yielded averagely with 0.8-0.7 t/ha. M45 (local Fatulurik) and P09 yielded the least with 0.4 t/ha. The average yield of the Philippine varieties was 1t/ha.

Total plant height was statistically different among the varieties tested at Aileu, as was the percentage of lodging. However, no correlation was found between the two parameters.

Yield means of wet season trials in 2008 -2009

The mean variety yields from each of the five research stations were compared to evaluate the populations across the five wet season trial locations. Average yield advantages over local varieties were compared for each station, and a general yield advantage calculated (see Table 11).

Table 11. Mean maize grain yields and yield advantages at 5 sites, 2008/09

Population	*Wet-Season 2008/09*						*Yield advantage above local*					
	Aileu	*Loes*	*Maliana*	*Betano*	*Baucau*	*Mean (t/ha)*	*Aileu*	*Loes*	*Maliana*	*Betano*	*Baucau*	*Mean yield advantage %*
HAR 05	0.5	1.5	1.4	2.8	1.4	1.5	-34.8	184.9	57.1	46.8	33.2	57.4
HAR 12	0.8	0.9	1.4	3.6	1.4	1.6	4.3	81.3	56.0	90.3	32.6	52.9
M 02 (Suwan 5)	0.8	1.5	1.4	3.5	2.2	1.9	4.3	183.0	58.1	85.7	103.4	86.9
M 03 (Sele)	1.4	1.0	1.3	3.8	1.9	1.9	82.6	86.9	52.2	101.2	82.4	81.0
M 24 (Arjuna)	0.9	0.8	0.7	3.1	1.2	1.3	17.4	47.1	-16.1	64.4	16.3	25.8
M 45	0.6	0.6	0.7	1.3	*	0.8	-21.7	11.0	-16.7	-28.6	*	-14.0
M 47	1.0	0.8	0.9	2.3	1.1	1.2	30.4	58.5	4.2	22.0	7.7	24.6
M 49	0.7	0.2	1.0	2.0	1.0	1.0	-8.7	-69.5	12.5	6.7	-7.7	-13.4
M 50	1.2	0.9	1.4	3.6	1.2	1.7	56.5	75.5	57.6	90.5	11.2	58.3
M 51	1.2	0.5	1.0	2.5	0.9	1.2	56.5	-4.5	8.4	32.6	-15.0	15.6
P 01	1.6	0.5	0.9	2.7	1.4	1.4	108.7	-2.0	2.0	45.8	31.5	37.2
P 02	0.6	1.8	1.1	3.0	1.0	1.5	-21.7	250.8	27.2	58.3	-2.0	62.5
P 03	0.7	0.6	1.5	2.9	1.2	1.4	-8.7	8.4	72.5	55.7	10.7	27.7
P 06	0.9	0.9	1.4	1.7	1.3	1.2	17.4	83.2	60.4	-11.4	17.6	33.4
P 07	0.3	1.5	*	0.5	1.8	1.0	-60.9	180.9		-72.8	70.2	29.4
P 08	0.7	0.7	1.2	2.3	1.0	1.2	-8.7	33.6	40.8	25.0	-4.5	17.2
P 09	1.1	0.1	0.7	3.8	1.8	1.5	43.5	-74.1	-20.6	104.1	72.0	25.0
P 10	*	*	*	*	1.8	1.8	*	*	*	*	71.4	71.4
P 11	1.7	0.9	1.7	2.5	1.8	1.7	121.7	64.7	90.0	34.4	68.7	75.9
P 12		*	*	*	1.1	1.1	*	*	*	*	-0.9	-0.9
P 13	0.8	0.9	1.1	2.6	0.5	1.2	4.3	65.7	29.5	41.0	-56.8	16.7

There was a lot of variation between the average yield advantages for each variety (-0.9 to 86.9 % advantage). The maize varieties with a minimum average yield advantage of 50% over local varieties are summarised in Table 12.

Table 12. Maize varieties yielding 50% or more than local varieties, 2008-2009.

Variety	*Mean yield advantage (%)*
Suwan 5	86.9
Sele	81.0
P 11	75.9
P 10	71.4
P 02	62.5
M 50	58.3
HAR 05	57.4
HAR 12	52.9

Suwan 5, Sele, and the two Zimbabwe varieties had in excess of 50% yield advantage over the local varieties as did P11, P10, and P02, although P10 was only tested in one location.

Multi-year, multi location analysis

Ten maize varieties were planted continuously over three years, at Maliana, Baucau, Aileu and Betano research stations. These include two local varieties, four Philippine varieties, the two Zimbabwe varieties and the two released varieties.

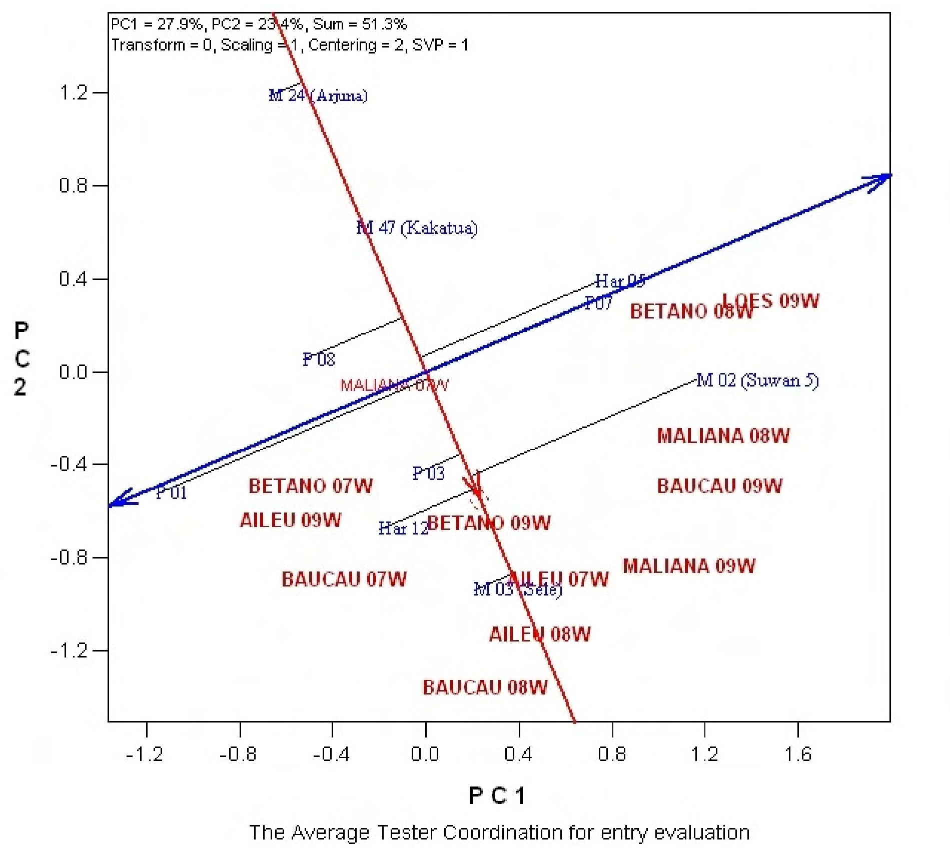

Figure 15. Biplot analysis of entries and testers from 10 varieties, 2006-2008

Figure 15 shows that the testers (the research station locations) did not give similar results over 2007 to 2009, shown by some negative correlations (the presence of the location tester titles on either side of the centre mean tester line which dissects the plot vertically). Some distances are noted between the testers over the three years, however these are expected to follow a trend over time, becoming closer with the addition of future years data, reducing the variation.

The local varieties in the biplot, Kakatua and Arjuna, are below average yield as expected, and show consistently poor results across the testers. The most consistent variety with the best performance was Sele, followed by Har12 which is also very stable across locations. Suwan 5 is the next highest yielding variety across the years however it shows trends to better performance at Maliana than Baucau and Aileu. P03 is another good variety which appears on the biplot as consistent and above average yields over the different testers.

To look at the performance of a larger number of maize varieties, Figure 16 shows the biplot analysis of 14 varieties, however only across data from two years, 2007 and 2008.

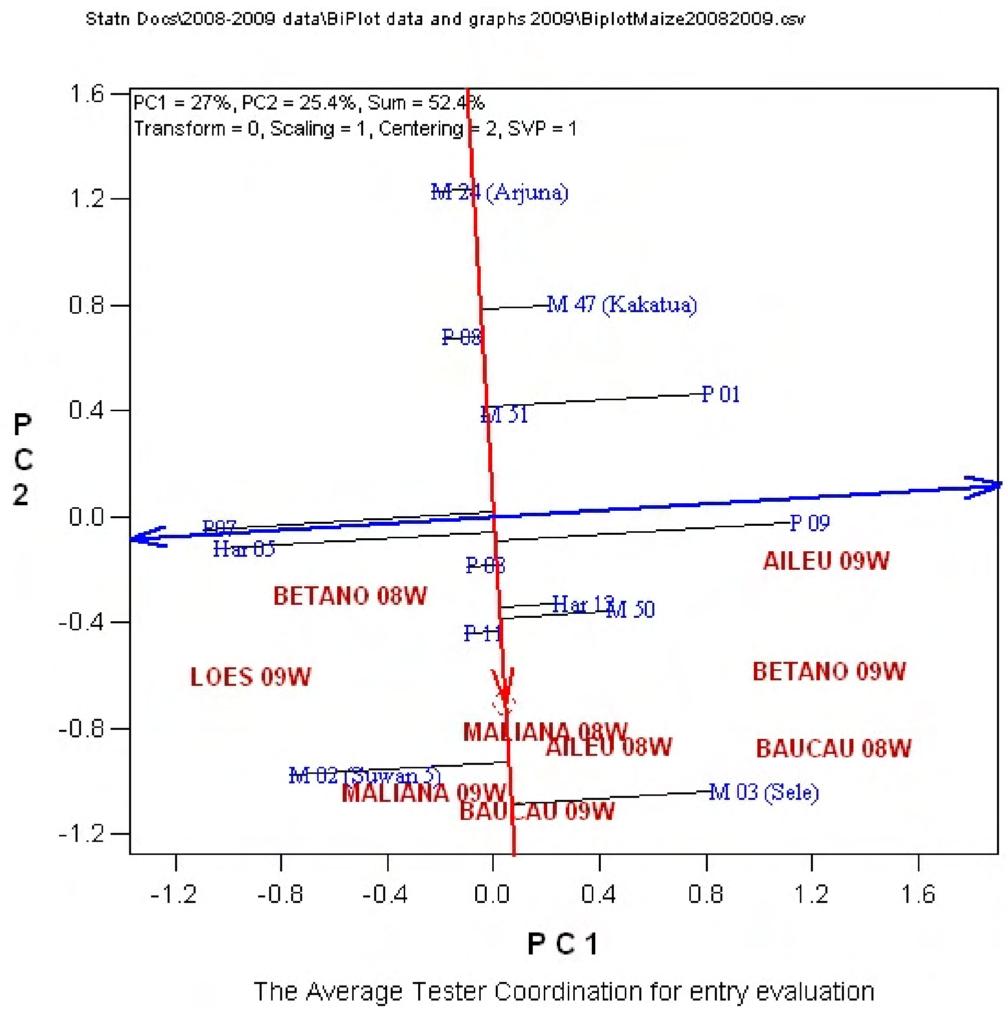

Figure 16. Biplot analysis of entries and testers from 14 varieties, 2007-2008

The biplot of 2008 and 2009 testers above shows the results of more Philippine varieties across two years. The two local varieties were consistently poor across the testers, as were P08 and M51. The variety P01 was also below average in performance however showed different results at different locations. P07 was about average in performance across the two years, with varying yields at different testers.

Of the two Biplots, across three years and across two years, neither plot has a total principal component value of greater than 70%. The biplots show trends in the data, however the total principal component values are only 51.3 and 52.4 consecutively. This indicates that there is still a large amount of inconsistency between the genotypes (entries) and the environments (the testers). Further testing in future years will likely assist in reducing the external variation affecting these values.

Farmer evaluation

To further assess the qualities of the maize varieties aside from yield, Farmer Field Days were held at Baucau and Betano research stations. Dates and gender details are following in Table 13.

Table 13. Male and female attendance at farmer field days

Research Station	*Betano*	*Baucau*
Date conducted	*21/4/09*	*18/03/09*
Male farmers	30	24
Female farmers	3	13
Total farmers	33	37

Baucau participants included 54% women, however at Betano only 9% were women. At Betano, 8 varieties were tested for eating quality, and 19 varieties were tested for farmer characterisation of the plant traits. At Baucau, 10 varieties were selected for taste testing and 20 varieties for characterisation of plant traits.

The varieties were selected by the Research Assistants as the highest yielding varieties or the varieties with potential for on-farm testing. Arjuna and M47 (Local Kakatua) were included at both locations as 'local' checks (see Table 14).

Table 14. Taste and characteristic tests at Betano and Baucau research stations

Research Station	*Betano*		*Baucau*	
Varieties tested	*Taste test*	*Plant characteristic*	*Taste test*	*Plant characteristic*
HAR 05	-	✔	✔	✔
HAR 12	✔	✔	✔	✔
Suwan 5	✔	✔	✔	✔
Sele	✔	✔	✔	✔
M 24 (Arjuna)	✔	✔	✔	✔
M45	-	✔	-	-
M 47	✔	✔	✔	✔
M 49	-	✔	✔	✔
M 50	✔	✔	✔	✔
M 51	-	✔	✔	✔
P 01	-	✔	✔	✔
P 02	✔	✔	✔	✔
P 03	✔	✔	✔	✔
P 06	-	✔	✔	✔
P 07	-	-	✔	✔
P 08	-	✔	✔	✔
P 09	-	✔	✔	✔
P 10	-	-	✔	✔
P 11	-	✔	✔	✔
P 12	-	✔	✔	✔
P 13	-	✔	✔	✔

Gender differences in characterisation and taste perceptions

At the Betano farmer field day, male and female farmers generally voted similarly on the different traits of the maize varieties. There was also no significant difference between the farmers choices of which varieties were sweet, bland, or fragranced. However, there was disagreement on male and female farmers' opinions of large cob and very tall plant traits. The farmer's preferences for selected varieties that they would like to plant also differed amongst male and female farmers.

Table 15. Differences between male and female farmers preferences

Maize trait		*Significant difference in preferences between male and female farmers*	
		Betano	*Baucau*
Plant habit	Like	NS	Significant
	Large Cob	Significant	NS
	Tight sheath	NS	Significant
	Sheath quality*	NS	Significant
	Very tall	Significant	NS
	Short	NS	Significant
Easting quality	Soft	NS	NS
	Hard	NS	NS
	Sweet	NS	Significant
	Bland	NS	NS
	Fragranced	NS	Significant
	Preferred variety	Significant	Significant

*Farmers rate sheath quality on the ability to tie up the cobs for traditional storage, i.e. the sheath length.

At Baucau, there was more differentiation between male and female farmer's characterisation and preferences of the varieties. In particular, female farmer's opinions of tight sheaths, and cobs that can be tied up differed to the male farmers. There were also differences in perception of sweet and fragranced taste qualities of the varieties. These are discussed further below in Table 16 and Table 17 below.

Hard and soft characteristics were agreed upon by male and female farmers.

Table 16. Farmer's preferences (%) 'softness' of tested maize varieties, 2008-2009

Variety	*Betano*		*Baucau*	
	Soft	*Hard*	*Soft*	*Hard*
HAR 12	87	13	-	-
Suwan 5	76	24	87	13
Sele	70	30	70	30
M 24 (Arjuna)	61	39	32	11
M 47	*24*	*76*	*78*	*22*
M 50	88	15	-	-
M 51	-	-	3	54
P 02	94	6	-	-
P 03	67	33	-	-
P 07	-	-	38	11
P 08	-	-	-	-
P 09	-	-	59	41
P 10	-	-	32	60
P 11	-	-	35	65
P 12	-	-	41	3

There were no significant differences amongst male and female choices for 'softness' of the varieties at either research station. At both research stations the majority of farmers considered the popular varieties Suwan 5, Sele and Har12 to be 'soft'. At Betano, most farmers considered M47 (Local Kakatua) to be 'soft' however this was contradicted at Baucau, where most considered it 'hard'. M50 was also considered to be soft while M51 hard.

The majority of the Philippine varieties were voted soft more often than hard, with the exception P10 and P11. (It is noted that the total votes don't total 100%, due to some farmers being indifferent in their options and choices).

In regards to sweetness of the maize varieties, farmers at Betano did not record any significant differences between the varieties. At Baucau however, there were recorded differences between varieties and also between male and female farmer's perceptions of sweetness.

Table 17. Farmer's preferences for 'sweetness' of maize varieties, Baucau, 2008-2009

Variety	*Sweetness (%)*	
	Male	*Female*
Suwan 5	67	100
Sele	75	69
M 24 (Arjuna)	50	31
M 47	*54*	*63*
M 51	29	8
P 07	29	54
P 09	46	79
P 10	50	15
P 11	79	62
P 12	42	0

The majority of male and female farmers considered the two released varieties to be sweet, however with a female preference for Sele and a male preference for Suwan 5. Female farmers also like eating P09 whereas male farmers enjoyed P11.

Farmers at Baucau also voted the quality of 'Beli Kesi, or 'Can Tie' (a trait of long sheaths) values of the different varieties. Female farmers voted differently to male farmers, as in Table 18 below.

Table 18. Farmer's preferences for 'Long sheaths' maize varieties, Baucau, 2008-2009

Variety	*Long Sheath (%)*	
	Male	*Female*
HAR 05	13	31
HAR 12	21	31
Suwan 5	63	31
Sele	50	69
M 24 (Arjuna)	50	38
M 47	*71*	*23*
M 49	*83*	*54*
M 50	67	38
M 51	38	54
P 01	79	23
P 02	50	46
P 03	67	31
P 06	25	38
P 07	29	62
P 08	79	38
P 09	71	31
P 10	38	38
P 11	58	38
P 12	71	54
P 13	75	69

Female farmers considered the varieties Sele, P07 and P13 to be the best cobs with long sheaths that could be tied up for storage. Male farmers were stronger in their agreement and considered M47, M49 (two local varieties and P01, P12 and P13 to have the best cob qualities for such traditional storage.

Farmers attending the field day were also asked to consider the various factors contributing to a good variety of maize, and then to select between 1-3 varieties from the available varieties that they would like to plant themselves. Table 19 shows the farmers selections.

Table 19. Preferences of farmers for maize varieties, Baucau, Betano.

Variety	*Betano*		*Baucau*	
	Percent of farmers preference	*Yield (t/ha)*	*Percent of farmers preference*	*Yield (t/ha)*
HAR 05	-	-	7	1.4
HAR 12	13	3.6	7	1.4
Suwan 5	17	3.5	14	2.2
Sele	10	3.8	23	1.9
M 24 (Arjuna)	4	3.1	6	1.2
M 47	10	2.3	2	1.1
M 49	-	-	4	1.0
M 50	10	3.6	3	1.2
M 51	-	-	5	0.9
P 01	-	-	4	1.4
P 02	6	3.0	3	1.0
P 03	6	2.9	0	1.2
P 06	-	-	2	1.3
P 07	-	-	4	1.8
P 08	-	-	4	1.0
P 09	-	-	2	1.8
P 10	-	-	2	1.8
P 11	-	-	7	1.8
P 12	-	-	3	1.1

The Baucau farmers variety preference votes were correlated to yield ($R2= 0.3$) as shown in Figure 17. The same correlation at Betano was 0.2, however if M47 (the local variety) is removed, the correlation increases in strength ($R2=0.5$). Ten percent of farmers selected the local variety as a preferred type, indicating the farmers' appreciation of local varieties despite the associated lower yields. M47 had a significantly lower yield than most other varieties tested (see Table 19. Preferences of farmers for maize varieties, Baucau, Betano.Table 19).

At Baucau, farmers preferred Sele to Suwan 5, and their next preferences were for the white Zimbabwe varieties Har05 and Har12. At Betano, the most preferred varieties were Har12 and Suwan 5.

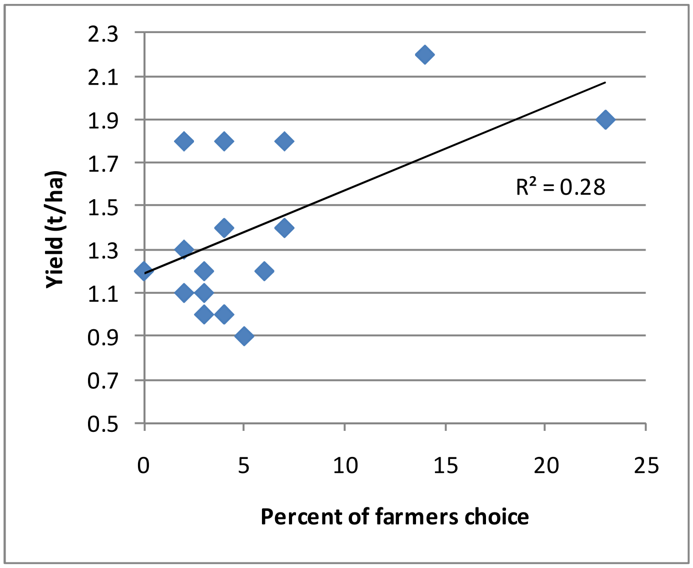

Figure 17. Correlation of maize yield and farmer's choice at Baucau

Discussion

Data analysis involved different tools due to environmental impact on the plots at several research stations.

The highest overall yielding varieties across the research stations over 2008-2009 were Suwan 5, Sele, P11, P10, P02, M50, Har05 and Har12. However not all farmers considered the yield to be detrimental to the variety value. Farmer's preferences did correspond to yield however other traits were also very influential in selecting their favorite varieties.

There were noted to be different perceptions of maize qualities amongst men and women. Suwan 5 and Sele and Har12 were considered to be 'soft', as well as most Philippine varieties. Sele and Suwan 5 were also considered 'sweet', along with P09 and P11 (the Zimbabwe varieties were not tested for sweetness).

Sheath qualities were rated differently, with Sele, P07 and P13 selected by female farmers, and the local varieties and P01, P12 and P13 selected by male farmers. This trait preference must be considered in light of new seed storage technologies where tying up cobs is not necessary.

Conclusions

Much environmental variation impacted the results and the analysis of the maize yield data from the five research stations. Techniques must be employed to minimize this affect in the future. Seedling nurseries for direct transplanting to gaps, and the possible use of fertilizers evenly applied to all plots should be considered to reduce the variation between plots and replications. Rows and columns within replications also need to be prepared in a similar manner (same laborers, same plowing system, and same weeding system across the site).

Generally, farmer preferences were for the varieties Sele, Suwan 5, Har05 and Har12 however field-day data indicated that farmers still value local varieties despite lower yields.

BiPlot analysis showed some potential Philippine varieties (such as P03), with Sele and Har12 performing most consistently of all the varieties tested.

More OFDT testing of Har12 would help in determining the value of this variety for release by MAF.

2.1.2 Maize On-farm Demonstration Trials 2008-2009

A large number (286) On Farm Demonstration Trials (OFDTs) were established in 17 Sub-Districts of Timor Leste in the 2008/09 wet season. The objective of the trials was to determine if elite populations identified on research stations maintained an increase in yield, compared with local varieties, when cultivated in farmer's fields using local agronomic practices.

Varieties tested in the 2008-2009 wet season included a local variety and four test varieties. All varieties are open pollinated. The test varieties included Sele (coded as M03), a yellow open pollinated maize variety originally from CIMMYT India, and released by the MAF in 2007. The other three have white seeds, and are downy mildew resistant populations from CIMMYT Zimbabwe and Central Mindanao University in the Philippines. The two populations from CIMMYT were DMRSSSyn024/DMRSSSyn021, coded as Har05 and V036=PopDMRSRE(MOZ)F2, coded as Har12. The population sourced from the Philippines was CMU Var12 coded as P07.

Materials and methods

OFDTs were established in all the Agro ecological zones in Timor Leste, incorporating 17 Sub-Districts in the Districts of Aileu, Ainaro, Baucau, Bobonaro, Liquica, Manufahi and Viqueque. One or two researchers worked in each Sub-District and their target was to establish 15 maize OFDTs within each Sub-District.

Each researcher used their own contacts to identify participating farmers. This was often through consultations with the Chefe de Suco, with MAF extension and other staff, or farmers that were already known to the staff.

MAF staff explained to farmers that the SoL program would not be giving away seed or fertilizer, but aimed only to trial the new varieties. The researchers were careful to explain that the evaluations were one of the stages of research and they were not sure how the varieties would perform. Hence limited amounts of seed were to given to farmers.

The researchers gave 200g seed packets of the test maize varieties to the farmers. Local varieties used at each site were chosen by collaborating farmers, and were generally the normal full season maize variety grown on that farm. Local variety seed was supplied by the collaborating farming family, and therefore was unique to each test location.

Each OFDT site was marked out by string or bamboo by the researchers so that each variety was planted in a 5m x 5m plot. These plots were arranged side by side along contour lines. The order in which they were planted at each site was allocated randomly and there was no replication.

Generally, the researchers were present with farmers during planting. This was a goal but was not always possible to achieve due to the number of sites for which each researcher was responsible, but for the majority of sites it was realized.

After planting, researchers re-visited the site an average of 6.6 times from planting to harvest. At each visit they recorded different information about the OFDT. These data collection protocols monitored progress of the trial/demonstration. In-season measurements included plant height, identification of pests and diseases in each plot, wilting and other plant symptoms.

At harvest, staff recorded the fresh weight of cobs from the whole plot ($25m^2$). 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.

Site characterization

All sites were located (latitude, longitude and elevation) with a Garmin ETrex. The ETrex is a 12 channel GPS receiver, which allows accuracy of measurement of plus or minus 6m. In addition, the slope of the land was defined at each site as was the aspect 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 lowland of the north coast to 6 in for the lowlands of the south coast (Table 20).

Table 20. Definition of the 6 agro-ecological zones in Timor Leste (ARPAPET, 1996).

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

All sites for OFDTs in the 2008/09 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. Sieving removes 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 color of the indicator, and pH value identified by comparing that colour with a standard colour sheet.

Soil texture (Table 21) was estimated using a field based ribbon test method. Prior to testing, a handful of surface soil (below 10cm) 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.

Table 21. Determining soil texture characteristics.

Texture	*Description A*	*Length of soil ribbon B*
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).

Analysis

Data from the protocols were entered into an MS Excel spreadsheet database before being transferred to GenStat. Data entry occurred twice during the growing season, once just after the OFDTs were established and once at the end of the season when all of the harvest data was complete. Yield data were analyzed by ANOVA (Unbalanced Model) in a range of methods. Firstly, main effects and interactions between variety and District, Sub-District, AEZ were tested.

Further to this main analysis, the influence of a wide range of factors on maize yield was tested using an unbalanced ANOVA design. The model of the analysis always included variety and AEZ as factors in the model. As elevation was shown to have an impact on crop yield between sites, elevation was included as a co-variate in all the analyses. In turn, a range of factors were 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

Testing environments

Maize 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 1,733m in Maubisse. Compared to previous years, in 2008-2009 there were a greater proportion of sites at lower elevations. This is because of the addition of a small number of trials in the high elevation Sub-Districts of Uatolari and Ossu. (Table 22). Forty two percent of trials were conducted below 350m compared with 23% in the previous year.

Table 22. Distribution of maize OFDT sites by elevation, 2007/08 and 2008/2009.

Elevation (masl)	*Locations 2007/08 (%)*	*Locations 2008/09 (%)*
0-150	16	27
150-350	7	15
350-550	20	12
550-750	14	12
750-950	13	12
950-1150	14	10
1150-1350	8	7
1350-1550	5	3
>1550	3	2

Soil pH, elevation and texture

The average soil pH across the OFDT test sites was 6.8, ranging from 4.5 to 9.0. Approximately 14% of sites can be defined as acid soils (pH 5.5 or less) and approximately 19% of the sites described as alkaline soils (Ph 8.0 or above). The remainder of the sites (66%) had soil pH values between 6.0 to 7.5 inclusive (Table 23).

Table 23. Distribution of soil pH across maize OFDT sites 2007/2008, and 2008/2009

Soil pH	*Locations 2007/08 (%)*	*Locations 2008/2009 (%)*
4	0.5	0
4.5	2.1	1
5	2.7	2
5.5	8.5	12
6	10.8	18
6.5	13.3	18
7	23.7	14
7.5	9.4	14
8	14.7	16
8.5	11.8	9
9	2.7	2

Soil pH differed statistically (LSD 0.46) between District and Sub-District, as in other years (Table 24).

Table 24. Soil pH and elevation of maize OFDT locations, 2007/08 and 2008/09

District	*Sub-District*	*Elev 2007-08*	*Soil pH 2007-08*	*Elev 2008-09*	*Soil pH 2008-09*
Aileu	Aileu	1048	6.2	1030	6.1
Aileu	Liquidoe	1169	6.3	1195	5.6
Aileu	Remexio	993	6.0	962	5.7
Ainaro	Hatudo	246	7.6	218	7.4
Ainaro	Maubisse	1523	7.0	1550	7.2
Baucau	Baucau	483	7.6	499	4.0
Baucau	Laga	394	7.8	311	8.3
Baucau	Quilicai	570	7.4	na	na
Baucau	Vemasse	505	7.1	454	6.6
Baucau	Venilale	630	7.3	799	7.8
Bobonaro	Maliana Kota	na	na	268	7.5
Bobonaro	Cailaco	na	na	113	7.0
Liquica	Liquica	471	6.9	352	6.3
Liquica	Maubara	474	6.4	277	6.8
Manufahi	Alas	125	7.7	48	7.5
Manufahi	Fatuberliu	42	7.5		
Manufahi	Same	928	6.2	314	6.4
Manufahi	Turiscai	1197	6.5	1197	6.2
Manatuto	Natarbora	142	7.2	na	na
Viqueque	Ossu	na	na	610	6.1
Viqueque	Uatolari	na	na	na	na
LSD (P<0.05)					

na Not available

There was a general trend of the higher altitude Sub-Districts having lower soil pH values. The regression (Figure 18) suggests that the higher the elevation, the lower the pH. The rate of the decline in pH was approximately 1 unit of pH per 1000m of elevation. Of all Sub-Districts, Maubisse and Venilale were the most distant from the regression line. Maubisse has the highest elevation of any Sub-District, but possesses neutral soil pH (pH 7.2). This soil pH was higher than expected based on elevation. The more neutral pH in Maubisse and Venilale was probably due to the large number of limestone outcrops in those areas, reducing the acidifying effect of high rainfall. Omission of Maubisse and Venilale from the regression results in mean elevation of each Sub-District explains 55% of the variation in soil pH across Sub-Districts.

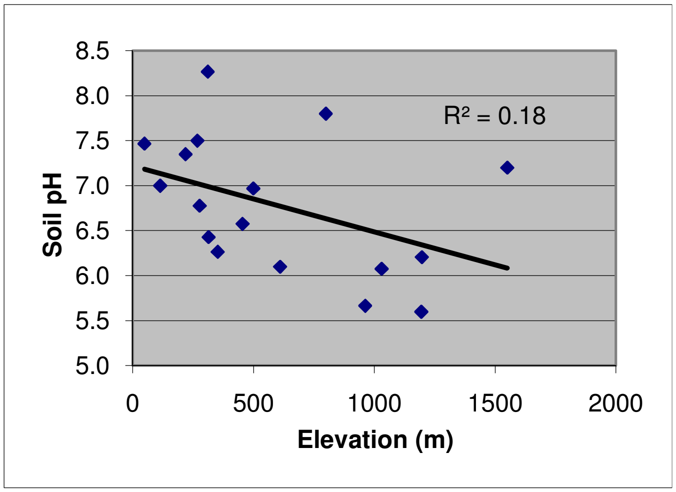

Figure 18. Effect of elevation on soil pH for maize OFDT sites, 2008/09.

The majority of test locations (approximately 69%) were clay loams or heavier soils. Sandy soils were rare, accounting for only 2% of the sites (Table 25).

Table 25. Distribution of soil texture of maize OFDT, 2007/08 and 2008/09

Soil texture	*Location 2007/08 (%)*	*Locations 2008/09*
Sandy	6	2
Sandy Loam	8	10
Loam	20	19
Clay Loam	20	30
Fine Clay	33	27
Heavy Clay	14	12

Trial losses

OFDT trial losses (17%) in 2008/09 were similar to the last 3 years of testing cropping seasons (25% in 2005/06, 18% in 2006/07 and 17% in 2007/08). Table 26 gives a breakdown of the reasons for the trials not being completed. As in other years, animal predation on crops was the reason for most crop losses and large animals were the most significant single factor. A number of trials (6) were drought affected and the trials with no cobs (7) could also be drought affected.

Table 26. Maize OFDTs planted and reasons for non-harvest, 2007/08.

Trials	*Trial number*
Total OFDT	286
Trials harvested	235
Trial losses by reason	
Animals (Cows)	11
Harvested and mixed by farmers	9
Maize died (drought)	6
No cobs at harvest	7
Pig damage	2
Mixed planting	4
Dog damage	1
Road cut	1
Eaten prior to maturity	1
No reason given	9
Total losses	*51*

Variety

Grain yields of Sele, Har12 and P07 were significantly higher than local maize populations averaged over all Districts (Table 27). This data is clear evidence that if farmers change from growing their current traditional maize populations to modern varieties such as Sele Har12 and P07, there would be a dramatic increase in food production. There was no need for added inputs of fertilizer, pesticides etc to produce such dramatic increases.

Table 27. Yield components for OFDT maize varieties over all OFDTs, 2008/09

Variety	*Yield (t/ha)*	*Density (plants/m^2*	*Cobs/plant*	*Seeds/cob*	*Cob weight (g)*	*Seed weight (g/100)*
Local	1.4	4.5	0.79	149	37	25.1
Har05	1.6	4.2	0.84	178	46	26.5
Har12	1.9	4.5	0.80	187	50	25.4
P07	1.7	4.9	0.77	153	40	25.8
Sele	2.2	4.6	0.83	188	56	29.4
LSD ($p \leq 0.05$)	*0.24*	*ns*	*ns*	*24*	*6.7*	*1.4*

As in all previous testing years, Sele produced significantly more yield than the local populations, through having a larger number of seeds per cob and larger seeds resulting in large cob weights (Table 27).

Har12 performed better in 2008/09 than in 2007/08 in the OFDT trials. In the previous year, Har12 yielded only slightly higher than the local populations, but in 2008/09 it was significantly higher (0.5t/ha higher). In 2007/8, the comparison between Sele and HAR12 was confounded by the low plant density of Har12. In 2008/9, all varieties were evaluated while possessing similar plant densities allowing improved comparisons.

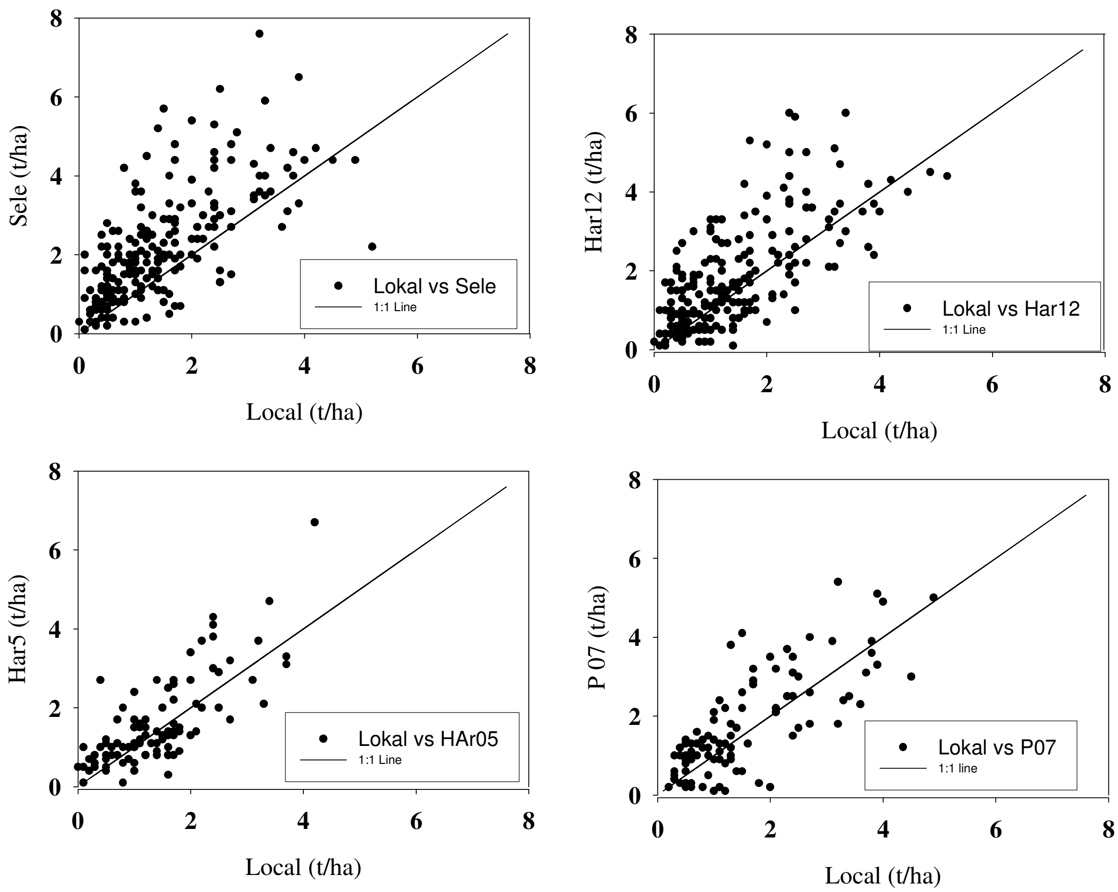

Figure 19. Yield of 3 test populations versus the local population at all sites in 2008/09

Maize yield increased for all varieties as plant density increased from 1 to 4 plants/m^2, and reached a plateau at approximately 4-6 plants/m^2. Generally yield reductions were observed at plant densities above 6 plants/m^2 (Table 28) for all varieties.

There was no interaction between plant density and variety for grain yield, suggesting that all varieties performed in a similar rank order across a range of plant densities. The yield advantage of Sele compared to the other populations was consistent at all plant densities (Table 28). There is no reason therefore to recommend different planting densities for these tested varieties.

Table 28. Effect of crop density on yield for OFDT maize varieties, 2008/09

Plant density (plants/m²)	*Har05*	*Har12*	*Local*	*P07*	*Sele*
1	1.0	1.5	1.0	1.3	1.4
2	1.5	1.6	1.2	1.0	2.0
3	1.6	1.7	1.1	1.6	2.2
4	2.1	2.4	1.9	2.1	2.4
5	1.5	1.8	1.3	1.8	2.8
6	2.7	1.8	2.3	2.4	2.5
7	1.3	3.0	1.5	2.1	1.9
8	1.2	1.5	1.4	1.5	1.9
9	1.1	1.2	2.0	*	1.5
10	0.9	1.2	1.3	2.5	*
11	*	1.2	1.0	0.3	2.0

* No data

Districts

Yields of all varieties trialed in OFDTs were highest in Laga and Maubara Sub-District and lowest in Liquidoe Sub-District (Table 29). There was no significant interaction between variety and Sub-District. This suggests that the higher yield of Sele is consistent across Sub-Districts and there is no reason to recommend different varieties for different Sub-Districts.

Table 29. Maize OFDT grain yield (t/ha) by Sub-District 2008/09

District	*Sub-District*	*Local*	*Sele*	*Har05*	*Har12*	*P07*
Aileu	Aileu	1.3	2.5	1.3	2.0	3.3
Aileu	Liquidoe	1.2	2.0	1.3	1.4	
Aileu	Remexio	1.5	2.0	1.3	1.7	
Ainaro	Hatudo	0.7	1.4		1.3	1.5
Ainaro	Maubisse	0.8	1.6	0.8	0.9	1.0
Baucau	Baucau	0.8	1.3	1.0	1.0	1.3
Baucau	Laga	2.6	2.6	0.6	2.1	2.7
Baucau	Vemasse	2.4	4.0	3.1	3.2	2.1
Bobonaro	Venilale	1.2	1.9	1.0	1.4	1.1
Bobonaro	Maliana	1.3	2.4	2.3	2.8	2.4
Bobonaro	Cailaco	2.3	3.5	2.6	3.2	3.6
Liquica	Liquica	1.6	2.6	1.6	2.5	2.5
Liquica	Maubara	2.2	3.0	1.7	2.3	2.4
Manufahi	Alas	2.3	2.8		2.4	2.4
Manufahi	Same	0.7	1.1		1.2	1.2
Manufahi	Turiscai	0.8	1.7	1.0	1.2	0.7
Viqueque	Ossu	1.1	1.1		0.9	0.6
Viqueque	Uatulari	2.1	2.7		2.4	2.5
Average		*1.4*	*2.2*	*1.6*	*1.9*	*1.7*

Sele clearly showed a significant yield increase above local maize populations in all Sub-Districts tested excluding Laga and Ossu, where it yielded the same as the local varieties (Table 29). This confirms the yield advantage of Sele above the local populations measured in the previous 3 years of on-farm testing. The yield advantage of Sele in 2008 (57%) was slightly higher than that recorded in previous years (2006 40%, 2007 36%, 2008 44%). This may be a random fluctuation, or could be a result of the higher quality seed now being produced by the Seeds of Life pure seed scheme.

Har12 and P07 had a significantly higher yield than the local maize populations except at a few locations (Table 30).

Table 30. Yield advantage of SoL varieties by Sub-District, 2008/09

District	*Sub-District*	*Sele*	*Har05*	*Har12*	*P07*
Aileu	Aileu	86%	-2%	47%	148%
Aileu	Liquidoe	72%	8%	17%	
Aileu	Remexio	31%	-12%	12%	
Ainaro	Hatudo	94%	-100%	79%	109%
Ainaro	Maubisse	96%	-1%	14%	27%
Baucau	Baucau	68%	32%	31%	69%
Baucau	Laga	-2%	-76%	-19%	2%
Baucau	Vemasse	65%	28%	33%	-13%
Bobonaro	Maliana	78%	77%	111%	84%
Liquica	Liquica	62%	4%	55%	61%
Liquica	Maubara	34%	-22%	6%	10%
Maliana	Cailaco	56%	13%	41%	59%
Manufahi	Alas	21%	-100%	5%	2%
Manufahi	Same	58%	-100%	73%	64%
Manufahi	Turiscai	122%	32%	48%	-5%
Viqueque	Ossu	4%	-100%	-19%	-45%
Average		*57%*	*14%*	*36%*	*21%*

Agro Ecological Zones (AEZ) and yield

Yield results for each variety in each AEZ are presented in Table 31. Yields for all varieties were greatest at low altitudes (AEZ 1, 2 and 6). There was no statistically significant interaction between variety and AEZ. As such, Sele can be recommended as a high yielding variety in all AEZs.

Table 31. Maize OFDT mean yield by AEZ, 2008/09

AEZ	*Number of test locations*	*Local (t/ha)*	*Sele (t/ha)*	*Har12 (t/ha)*	*Har05 (t/ha)*	*P07 (t/ha)*
1 Northern coast (0-100m altitude)	27	2.3	3.6	3.2	2.5	3.1
2 Northern slopes (100-500m altitude)	46	1.7	2.6	2.5	2.3	2.1
3 Northern uplands (>500m altitude)	94	1.2	1.9	1.4	1.2	1.3
4 Southern upland (>500m altitude)	14	1.0	1.2	1.0	1.2	0.7
5 Southern slopes (100-500m altitude)	18	1.2	1.3	1.2		1.2
6 Southern coast (<100m altitude)	27	1.4	2.7	2.4		2.4
Total	*226*					
LSD (P<0.05)			*Interaction ns*			

As with the analysis of across sub-districts, Sele had a consistent yield advantage above the local across all AEZs (Table 32), confirming the results from the last 4 years. Generally all test varieties had a lower percent yield increase on the south coast (AEZ 6) than at other zones.

Table 32. Yield advantage of SoL improved varieties by AEZ 2008/09

AEZ	*Yield advantage of Sele (%)*	*Yield advantage of Har12 (%)*	*Yield advantage of Har05 (%)*	*Yield advantage of P07 (%)*
1 Northern coast (0-100m altitude)	55	36	6	32
2 Northern slopes (100-500m altitude)	54	49	36	29
3 Northern uplands (>500m altitude)	54	22	3	12
4 Southern upland (>500m altitude)	27	-2	22	-34
5 Southern slopes (100-500m altitude)	47	34		37
6 Southern coast (<100m altitude)	25	11		12

Agronomic factors affecting yield

Although the overarching purpose of the OFDT system is to test possible candidates for variety release for use on farmers' fields, the process of measuring and comparing yields also provides an opportunity to collect data on agronomic factors and analyze the effect of these factors on yield. This analysis is described in the Materials and methods section above.

The influence of a wide range of characters was tested for affecting the yield of maize in the complete data set. A large number of characters were found to have an influence on grain yield, and these include Variety, AEZ, Sub District, soil colour, soil texture, seeds planted per hole, soil texture and the style of planting (lines or random). The slope of the land, the gender of the head of the household and whether the crop was mono cropped or not had no effect on grain yield (Table 33).

Table 33. Significance of management factors affecting maize yield

Factor	*Significance P<0.05 2007/2008*	*Significance P<0.05 2008/2009*
Variety	✓	✓
Sub-District	✓	✓
AEZ	✓	✓
Soil pH	✓	✓
Soil colour	✓	✓
Number of staff visits	✓	ns
Plant density at harvest	✓	✓
Elevation	✓	✓
Soil texture	ns	✓
Number of seeds per hill	ns	✓
Random or line planting	ns	✓
Number of weeding times	ns	ns
Slope of land	ns	ns
Mixed planting or monoculture	ns	ns
Gender of the head of the household	ns	ns

Seeds per hill

The average yield of all varieties was significantly affected by the number of seeds planted per hill. When one seed per hill only was planted, yields were much lower compared to 2-4 seeds per hill. (Table 34). Planting recommendation should remain at 2-3 seeds per hill for all varieties.

Table 34. Influence of seeds per hill on OFDT maize yields, 2008/09.

Seeds per hill at planting	*Average yield of four tested varieties (t/ha)*
1	0.6
2	1.9
3	1.9
4	1.6
LSD (P<0.05)	*0.46*

Soil pH

Soil pH did not significantly impact maize yield in 2008/2009. This is in contrast to 2007/2008 (Table 35) where soil pH did have a significant effect on maize yield. Although the differences are not significant (due to low numbers of crops in acid soils) the data suggests a lower yield in acid soil (pH <5.5) but no yield reduction in basic soils.

Table 35. OFDT yield by soil pH for all maize varieties, 2008/09

Soil pH	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0
% of OFDTs	1	1	10	15	20	17	16	9	9	1
Mean yield (t/ha)	1.4	1.5	1.6	1.4	1.9	2.2	1.9	2.0	2.0	2.1
	ns									

Soil Colour

Soil colour had a significant effect on maize yield across the test sites. In general as the soil became darker in colour, the yield increased (Table 36). Having black soil (rai metan) is a common way of saying fertile soil in Tetun, so this observation confirms the farmer's experience.

Table 36. Effect of soil colour of maize yield 2008/09

Soil colour	*Yield (t/ha)*
White	1.6
Red	1.6
Black	1.8
Yellow	1.9
Dark brown	2.0
Light Brown	2.0
LSD (P<0.05)	*0.25*

Soil texture

In general, maize yield increased with heavier soil texture (Table 37). Crops grown on sandy loam and silty loam soils had significantly lower yields than crops grown on soils with heavier texture (i.e., Loams and clays)

Table 37. Impact of soil texture on maize yield 2008/09

Soil texture	*Yield (t/ha)*	*Percent of crops (%)*
Sandy Loam	1.1	7
Silty loam	1.4	9
Loam	2.0	19
Clay loam	2.0	19
Fine clay	2.2	34
Heavy clay	1.8	13
LSD (P<0.001)	*0.25*	

Staff visits to OFDT

In previous years, maize yields increased with increasing number of staff visits. The number of visits to each OFTD ranged from 1 to 10, averaging 6.6 visits (Table 38). There was no correlation between the number of visits and maize yield. This is in contrast with other years where there has generally been a correlation between staff visits and maize yields. Although the reason between the correlation between visits and yield were never identified, it is encouraging to see that the yields are not dependent on the actions of the researchers.

Table 38. Effect of number of staff visits on farm maize yield, 2008/09

Number of visits	*Average yield (t/ha)*	*Percent of crops*
1	1.8	1
2	1.4	2
3	0.6	2
4	1.7	8
5	1.9	13
6	1.6	21
7	1.8	21
8	2.0	14
9	1.3	16
10	0.7	2

Planting method, lines or random

In this data set, planting in lines produced a significantly higher yield than planting in a random design (2.0 t/ha compared to 1.7 t/ha). . Generally, crops planted in rows are easier to weed but this relationship has not been noticed in past years and will be further investigated in the future.

Use of fertilizer

No farmers included in the maize OFDTs in 2008/09 reported the use of fertilizer, either organic or non-organic.

Weeds

Over 90% of farmers involved in the maize OFDTs reported weeds as a problem in their fields. Researchers recorded 87 different weed names across all OFDTs.

The weeds representing over 30% of all occurrences are listed below (Table 39). The four most prevalent weeds were Fahi Fulun (*Cyperus rotundus*), Hitubitu (*Eupatorium adenophorum*), Funan mutin (*Chromolaena odorata*), and Manulain (*Imperata cylindrica*). This is a similar list of species that has been observed in previous years.

Table 39. Weed type in maize OFDT, 2008/09

Weed name (local name)	*Weed species (Latin)*	*% of Sites*
Fahi fulun	*Cyperus rotundus*	13
Hitubuti	*Eupatorium adenophorum*	6
Funan mutin	*Chromalena odorata*	6
Manu lain	*Imperata cylindrica*	6

Farmer's preference for maize populations

Field days were held at OFDT sites during the year and farmers were interviewed regarding the maize varieties under evaluation. They were asked to provide information on what characteristics were found in the local and test varieties that would encourage them to re-plant. Farmers preferred to grow each of the test varieties for different reasons (Table 40). From all the OFDT, more than 170 farmers gave reasons why they would chose to re-plant each variety another year. Those who wanted to grow Sele a second time preferred it because of the high yield (59%), taste (15%) and wind tolerance (5%). Of the three white varieties tested (Har12, Har05 and P07), there was little discrimination between the varieties. The yield advantage of the white populations was less than Sele, and therefore farmers preferred these varieties less because of their lower production. On taste also, it seems Sele was slightly more preferred for its taste than any of the white populations, but the white varieties were desired, just based on the colour of the grain. Local maize was preferred because it was the maize variety that they knew best.

Table 40. Reasons farmers (%) for replanting test maize varieties, 2008/09.

Characteristic	*Local*	*Sele*	*Har12*	*Har05*	*P07*
Local maize	49%	0%	0%	0%	0%
Tastes good	30%	15%	25%	27%	22%
High yield	11%	59%	42%	42%	40%
Large seeds	1%	13%	3%	1%	12%
Colour	0%	0%	11%	4%	10%
Wind tolerant	3%	5%	5%	6%	4%
Can fill you	3%	1%	1%	1%	0%
Weevil tolerant	3%	0%	1%	0%	4%
Total respondents	*155*	*175*	*153*	*75*	*73*

In addition, a number of farming families in Baucau reported that they preferred the variety P07 because of its large seed and its ability to be cooked as a popcorn. This was an unexpected outcome and will need to be investigated further.

Only a small number of respondents ascribed negative attributes to the three maize populations under test (Table 41). There were more negative comments (low yield and tough to eat) for the local maize than for the other populations. In fact, Sele attracted no negative comments. The few comments about low yield on the test populations of Har12, Har05 and P07 suggest that these populations are not as widely adapted as Sele across the test locations due to non consistent performance.

Table 41. Reasons farmers (%) gave for not planting test maize varieties.

Characteristic	*Local*	*Sele*	*Har12*	*Har05*	*P07*
Poor yield	80	0	30	80	100
Small seeds	10	0	40	20	0
Hard to eat	5	0	0	0	0
Wind susceptible	5	0	30	0	0
Total respondents	*20*		*7*	*5*	*3*

Conclusions

A further year of testing continued to show the high level of adaptation of the released maize variety Sele in all parts of Timor over many years. The yield advantage of Sele was consistently 40-50% across all agro-ecological zones of Timor Leste and across different seasons. Sele is a high yielding maize variety that is valued by farmers not just for its consistent high yield but also its good taste, large seeds and wind resistance. However there is still a need to identify a high yielding and suitable white seeded maize variety.

Among the white seeded maize varieties, Har12 and P07 had yields, significantly greater than the local check varieties. All three white seeded maizes had a similar level of acceptance in terms of taste and desirability.

2.2 Sweet potato

2.2.1 Sweet potato replicated trials, 2008-2009

Materials and methods

All sweet potato (*Ipomoea batatas (L.) Lam.*) clones tested by SoL were introduced from CIP in Indonesia as part of the program's previous phase, SoL1. Sweet potato variety trials have been conducted on a set of 12 clones (including 2 local checks) for a number of years with varying success. However, previous results allowed selecting three varieties for release in 2007 (CIP 01, 06 and 07 under the names of Hohrae 1, 2, 3 respectively), while discarding three others from further experimentations (CIP 2, 3, 5).

In the 2008-2009 wet season, sweet potato replicated trials including CIP 1, 4, 6, 7, 8, 15, 17, Local Mean ("Red") and Local Mutin ("White") (Table 42) were implemented in Betano, Baucau, Aileu, Maliana and, for the first time, Loes. In the latter station, three other local varieties were also tested.

Table 42. Population characteristics, sweet potato replicated trials, 2008/09

Name	*Leaves general outline*	*Leaves lobes type*	*No of lobes*	*Central lobe shape*	*Tuber skin colour*	*Tuber flesh colour*
Hohrae 1 (CIP 1)	Lobed	Moderate	5	Semi-elliptic	White	Pale yellow
Hohrae 2 (CIP 6)	Lobed	Moderate	5	Semi-elliptic	Cream	Yellow
Hohrae 3 (CIP 7)	Chordate	No lateral	1	Toothed	Red	Orange
CIP 4	Chordate	Very slight	3	Triangular	Red	Orange
CIP 8	Lobed	Moderate/Deep	5	Semi-elliptic	Red	Pale yellow
CIP 15	Lobed	Deep	5-7	Triangular	Red	Yellow
CIP 17	Lobed	Moderate	5-7	Semi-elliptic	Brown	Orange

Trials consisted of 3 or 4 replicates with randomized plots, each at 5m by 5m in size. Stems for planting were all sourced from Aileu. Cuttings were spaced 1m x 0.5m apart. No fertilizer was applied and the sites were not irrigated except under extreme drought. Trials were planted between November and January and harvested at the beginning of the dry season in May-July 2009 (Table 43). All introduced sweet potato clones produced a harvestable yield much quicker than local sweet potato clones, which led to adjusted harvested dates in some cases (almost two months later for the local varieties in Baucau).

At harvest, the number of plants, the number of tubers and the total production were recorded for each plot. A few other parameters were also measured in some sites (number of tubers and related weight), such as the marketable and non marketable tubers (too small or damaged ones), the average weight of the biggest and smallest tubers, the production from the main root or from secondary roots, the ground cover, the number of nodes per plant, and a record of disease impact.

Farmer field days were conducted at Betano, Maliana and Loes during which farmer's preferences of cooked sweet potato samples were recorded.

Table 43. Planting and harvest details of sweet potato trial locations, 2008/09

Location	*Season*	*Number of entries*	*Number of replicates*	*Planting date*	*Harvest date*	*Days to maturity*	*Rainfall (mm)**	*Mean yield (t/ha)*
Betano (Manufahi)	Wet	9	3	20 Jan. 2009	12 Jun. 2009	143	730	15.6
Loes (Liquiça)	Wet	10	3	23 Dec. 2008	22 Jun. 2009	181	995	13.9
Baucau (Fatumaka)	Wet	9	4	15 Jan. 2009	8 Jun. 2009	144	980	4.0
Maliana (Corluli)	Wet	6	3	5 Dec 2008	26 Jun. 2009	203	1480	3.7
Aileu (Kintal Portugal)	Wet	8	3	11 Jan 2009	13 July 2009	183	750**	14.8

* Total rainfall calculated for planting until harvest dates for each research station. Additional irrigation may have been applied during particularly dry periods.
** Rainfall records were not available for the month of May. The data presented above includes an approximation of 50 mm, estimated from nearby locations.

The data of each site was analysed separately using GenStat Discovery 3 in order to determine varietal effects. As no row nor column effect was detected in any of the trials, all the results presented were analysed using balanced ANOVAs (One-way ANOVA in Randomized Blocks). Yield advantages were calculated over the local variety means. The existence and degree of correlation between the predicted means of the yields and the other parameters were then identified using a Simple Linear Regression.

In Betano, the plots were divided in half to allow a later harvest on the 26th of July, i.e. 17 days after the first harvest. The results were analysed using a Two-way ANOVA in Randomized blocks.

To analyse palatability tests, a cross-site analysis was conducted over the results of each location using an unbalanced ANOVA.

Results

Data in Table 44 presents the yields achieved at each site for all tested varieties, as well as the yield advantages over the local checks.

Variation among sites was noticeable with Loes, Betano and Aileu trials yielding twice more on average than Baucau and Maliana (about 15 t/ha as average site yields against 4 t/ha for the others). The ANOVAs revealed that the tested varieties yielded significantly differently at each site, even though the coefficient of variations were high. For instance, Local Mutin was the highest yielding variety in Betano and Aileu but almost the poorest in Loes and Baucau. Nevertheless, among the CIP varieties, Hohrae 3, CIP 4 and Hohrae 2 performed consistently well, Hohrae 3 even yielding significantly higher than most of the other varieties in Betano, Loes and Baucau. CIP 15 and 17 had poor to medium yields in all sites.

Table 44. Sweet potato yields and yield advantages, 2008-2009

Variety	Betano	Loes	Baucau	Maliana	Aileu	Arithmetic means	St. dev	Overall	No. of locations
	Yields (t/ha) - Balanced ANOVAs							*Yield advantages (%) over local Mean and local Mutin*	
Hohrae 3	30.2	35.9	6.6	4.8	20.4	19.6	13.9	121	5
CIP 04	18.1	30.0	9.7	4.4	10.2	14.5	10.0	63	5
Hohrae 2	15.6	24.3	4.8	5.6	18.7	13.8	8.5	56	5
Hohrae 1	12.5	7.3	2.8	5.3	18.1	9.2	6.2	4	5
CIP 08	11.6		3.6		10.5	8.6	4.3	-3	3
CIP 15	10.3		3.1		2.7	5.4	4.3	-39	3
CIP 17	4.4	9.7	3.9	1.6	11.1	6.1	4.1	-31	5
Loc. Aileu		*0.6*				*0.6*	-	*-93*	*1*
Loc. Atabae		*20.1*				*20.1*	-	*126*	*1*
Loc. Loes		*6.7*				*6.7*	-	*-24*	*1*
Loc. Mean (ref)	5.2	3.5	0.5	0.6		2.4	2.3	-72	4
Loc. Mutin(ref)	32.9	0.9	0.7		26.7	15.3	17.0	72	4
F prob	<.001	<.001	<.001	0.030	0.009				
l.s.d.	11.4	6.9	2.0	3.3	10.9				
%CV	42	29	35	49	42				
Mean site	15.6	13.9	4.0	3.7	14.8	10.2	6.0	-	
Mean new var	14.7	16.8	4.9	4.3	13.1	10.4	5.8	17.8	
Mean locals Mutin & Mean	19.0	2.2	0.6	0.6	26.7	8.9	9.6	-	

Local yield advantages showed variations ranging from -90% to +1550%, mostly because of the very variable yields obtained in each site from the two local varieties used as references (0.5 t/ha to 27 t/ha), and because of the range of yields itself (0.5 t/ha to 33 t/ha). Overall yield advantages across all sites give a more balanced picture of the new varieties performances over the local ones, with the released Hohrae 3 ranking highest at +120%, followed by CIP 4 and Hohrae 2 (+63% and +56% respectively). Hohrae 1 and CIP 8 showed little difference with the local varieties, while CIP 15 and 17 yield 25% and 30% lower.

The local varieties of sweet potato are said to need more time than the new varieties to mature. This effect was examined at Betano where half the plot was harvested 17 days apart. Results (Table 45) confirmed that some varieties would have continued to grow but neither of the local varieties yielded higher after a further 17 days. However, the interaction between the time of harvest and the variety was significant, indicating that varieties do have different patterns of maturation speed.

The results were re-examined to exclude non marketable tubers (too small and damaged tubers) but the trends were similar.

Table 45. Two-way ANOVA on sweet potato yields (t/ha). Betano, 2009

Variety	*Harvest 1*	*Harvest 2*	*Means*
Hohrae 1	12.5	15.0	13.8
Cip 15	10.3	17.6	14.0
Cip 17	4.4	8.6	6.5
Cip 4	18.1	19.8	18.9
Hohrae 2	15.6	13.1	14.3
Hohrae 3	30.2	20.9	25.6
Cip 8	11.6	16.1	13.8
Lokal Mean	5.2	2.7	4.0
Lokal Mutin	32.9	12.6	22.8
Means	15.6	14.0	14.8

Variety	*F prob*	<0.001
	l.s.d.	6.6
Harvest	*F prob*	0.304
	l.s.d.	n.s.
Variety/Harvest	*F prob*	0.005
	l.s.d.	9.4
	%CV	38.1

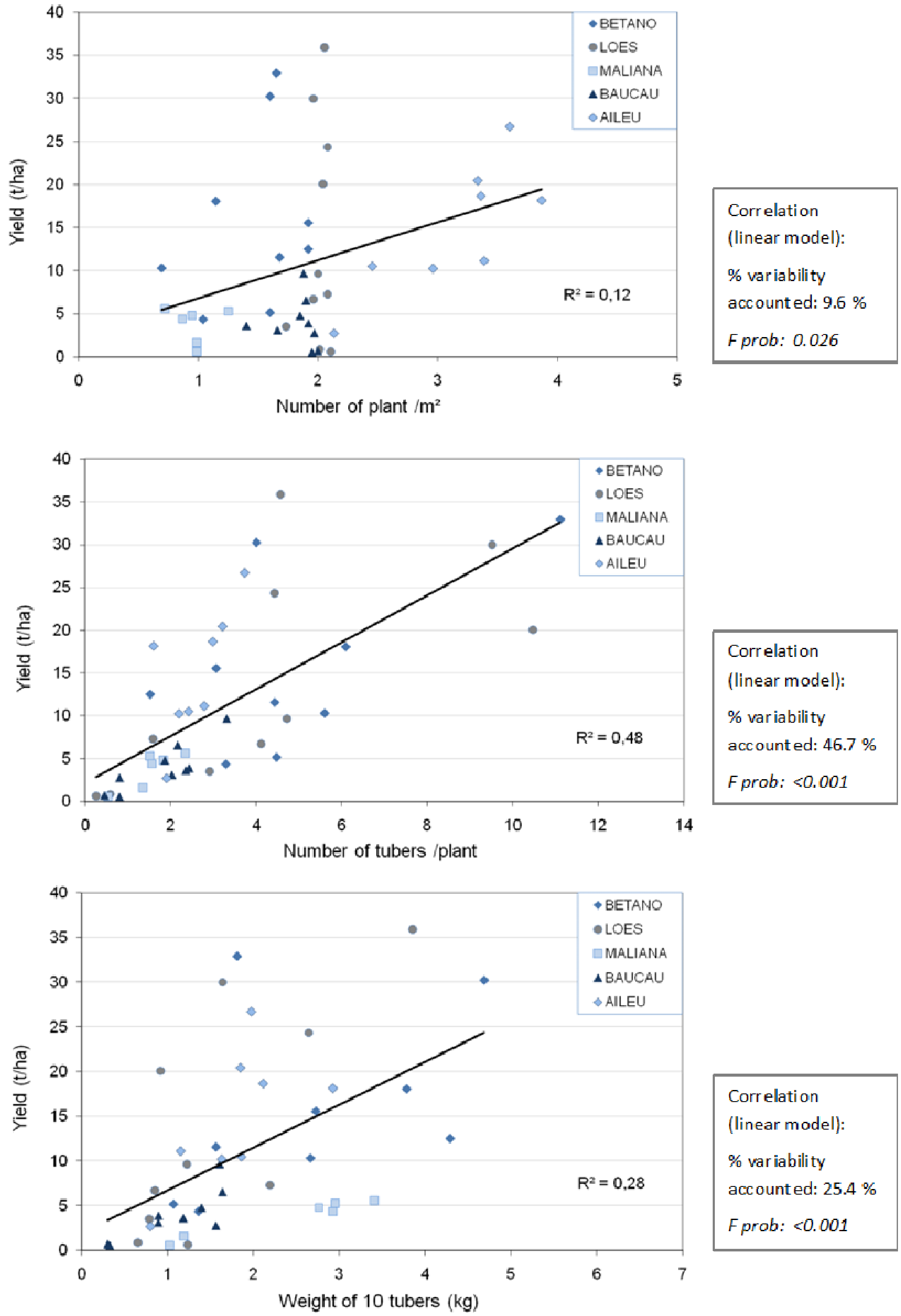

Figure 18. Correlations between sweet potato yields and yield components.

Yield components and other parameters

ANOVA means were calculated for yield components and several other parameters for each variety, within and across stations. The site means of the yield components are presented in Table 46. Main results as well as output after regression analysis (linear model) are detailed in the graphs presented in Figure 20 above.

Plant density at harvest, number of tubers per plant and weight of tubers all appear to be significantly correlated to the yield, but to different levels. The number of tubers per plant is by far the most explanatory variable, accounting for more than 45% of the yield variability, whilst weight of tubers and plant density accounted for 25% and 10% respectively.

A number of other parameters were also measured at some sites. For example, the number and weight of big and small tubers, production from the main root (a characteristic appreciated by farmers as it facilitates harvest), marketable production (excluding damaged and small tubers), ground cover, occurrences of diseases. Most of the correlations between the yields and those additional parameters did not prove to be significant after regression analysis.

Table 46. Two way ANOVA on sweet potato yield components, Betano, 2009

Station	*Plants/m² at harvest*	*Number of tubers/plant*	*Weight of tubers (kg/10)*
Betano	1.5*	4.8*	2.7*
Loes	2.0**	4.3**	1.6**
Baucau	1.8**	1.8**	1.1*
Maliana	1.0	1.5	2.4*
Aileu	3.1	2.6	1.8*
Grand Mean	1.9**	3.0*	1.9**
Correlation with yield (%)	*9.6**	46.7**	25.4**

ANOVA on varieties and Linear regression: ** significant F prob<0.001 * significance at F prob <0.050

Palatibility tests

Taste tests were organised during farmer field days at the time of harvest in Loes, Maliana and Betano. The potatoes were boiled at each site. At Betano, an extra set were also fried before evaluating.

The participants were asked if they liked the variety. A positive answer was considered to be synonymous with willing to plant the variety. The questionnaire also included questions about sweetness, which is the most general characteristic used to define the eating quality of a sweet potato variety. A summary of the survey results acrosss the four taste tests are presented in Table 47.

Most of the test entries had been selected for their eating qualities and performed well. The most preferred entries were Local Mutin, CIP 15 Hohrae 2 and Hohrae 1. The least preferred entries across the four tests were Local Mean, CIP 4 and Hohrae 3.

Table 47. Farmers' preferences (%) across all four sweet potato taste tests

Variety	*Like*	*Sweet*	*Very sweet*	*Moist*	*Fragrant*
Local Mutin	100	96	15	40	75
CIP 15	77	78	22	75	47
Hohrae 2	74	88	25	60	77
Hohrae 1	72	82	23	23	40
CIP 17	67	80	23	81	30
CIP 08	65	91	32	45	43
Local Mean	60	59	13	25	28
CIP 04	54	73	25	15	30
Hohrae 3	40	63	14	62	23
F prob	*0.019*	*0.007*	*0.201*	*0.004*	*<.001*
l.s.d.	*29*	*19*	*15*	*31*	*19*
%CV	*29*	*16*	*47*	*43*	*26*
Correlation (linear model) with "Like":		*Sweet*	*Very sweet*	*Moist*	*Fragrant*
F prob		*0.016*	*0.953*	*0.879*	*0.009*
% variability accounted		52.7	-	-	59.8
s.e.		*11.4*	*17.8*	*17.7*	*10.5*

Desirability (Like) and "Sweetness" proved to be highly correlated (53% of variability explained (Figure 20). In comparison, the size of the tuber had a significant but small impact on farmers preferences (correlation between "Like" and "Weight of 10 tubers": 14%, F prob = 0.025). No correlation was found between the weight of tubers and their sweetness.

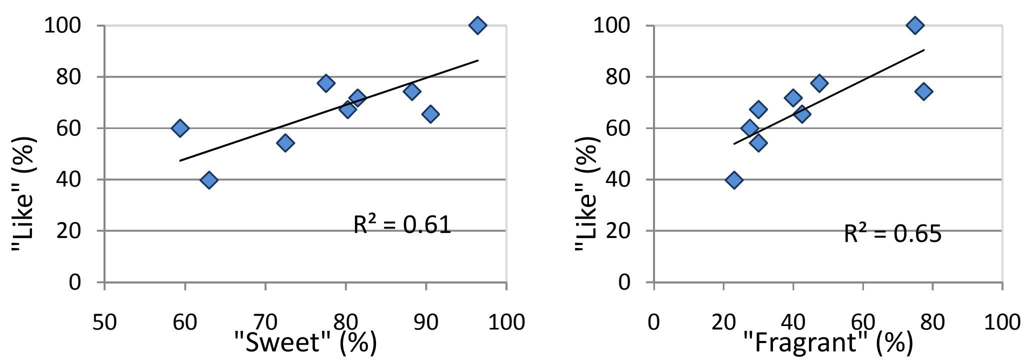

Figure 20. Correlation between farmer's preferences at field days

In some stations, other palatability criteria were investigated, namely Moist/Dry and Fragrant/Bland. The latter proved to be significantly and highly correlated (60%) with the general approval for a variety. Hohrae 2 and Local Mutin illustrate this by being recognized as the most fragrant varieties while being among the most appreciated.

Contrary to this, the Moist/Dry criteria did not appear to be a decisive factor for farmer's preference. This may be due to the fact that Moist can refer to an appreciated softness but also to a watery or mushy consistence not much valued, while Dry can become a desirable eating quality when it approaches a crumbly texture.

All taste test results were segregated by gender. No significant gender impact on preferences for different varieties were observed.

Conclusions for 2008-2009 trials

The results of this season's trials conducted across five sites indicated that there was a trend of a reduction in the farmers preference with increasing yield. Farmers appeared to consider that the higher yielding varieties scored lower in eating quality. Hohrae 3 and CIP 4 presented the highest yields (20 t/ha and 15 t/ha respectively across the five sites) but ranked lowest in farmers' preferences. Conversely, CIP 15 and 17 presented the poorest average yields (5-6 t/ha), but were quite highly regarded during the farmers field days. CIP 8 presented rather medium characteristics in every way.

Three varieties did not follow this trend. The released varieties Hohrae 2 and 1 were both among the most appreciated varieties and among the highest yielding with 14 t/ha and 9 t/ha (only Hohrae 3 and CIP 4 yielded significantly differently). Hohrae 2 was even appreciated, in addition to its sweetness, as a particularly fragrant variety, a highly regarded selection criteria. Local Mutin showed very similar results, being on average high yielding (but with greater variation among sites), and high scoring for eating qualities (including fragrance). Local Mean was both poor yielding and scored poorly in the taste test.

2.2.2 Sweet potato replicated trials, multi-year and multi-location analysis

Materials and methods

Cross-site analysis over all trial years were conducted using BiPlots (GGE BiPlot program) in order to evaluate the performances and consistency of the tested varieties across years and location (genotype / environment). Only sites without missing data were kept in the data set, the procedure being very sensitive to missing data.

Results

Fifteen sweet potato trials were implemented over the period from the wet season of 2005/06 through to 2008/09 (4 years) at 5 different sites (Betano, Loes, Baucau, Maliana and Aileu), testing the performances of 12 varieties. Some varieties were not included in all trials and some trials were not performed at every site every year. Mean yields by available site are presented in Table 48.

Table 48. Mean yields and yield advantages by trials 2005/06-2008/09

Variety	*No trials*	*Mean yield*	*St. dev*	*% Yield advantage*
CIP 04	12	13.9	11.5	66
Hohrae 3	15	13.6	11.5	63
Hohrae 2	15	11.9	8.8	42
CIP 08	15	11.2	9.4	34
Loc. Mutin	10	11.1	13.3	33
Hohrae 1	13	10.5	9.7	25
CIP 15	10	8.9	8.9	6
CIP 17	8	8.2	11.7	-2
Loc. Mean	10	4.8	5.6	-42
CIP 3	9	-	-	-43
CIP 2	8	-	-	-47
CIP 5	7	-	-	-48
Mean locals	*17*	*8.4*	*10.0*	
Mean site		*9.0*	*7.0*	

Mean site performances varied enormously (from 1.3 t/ha in Betano and Maliana in 2007 to 21 t/ha (Aileu in 2007 and 2008) and with only a third ranging within 4-9 t/ha. As a result, missing data impacted heavily on the overall yields and yield advantages. These are therefore only to be taken as indications of the overall performances of the varieties.

CIP 2, 3 and 5 were discarded early in the evaluations due to poor performance. Overall average performances of the local varieties also indicate frequent crop failures which led to less than 10 successful trials over 4 years (13% of the 132 entries). In addition, Local Mutin showed the highest standard deviation, revealing an unreliable performance. In comparison, the released varieties Hohrae 1, 2 and 3 were successful on every trial and all yielded over 10 t/ha on average. This corresponded to a yield advantage of about +25 to +65% over the local checks for the 4 trial years. CIP 4 seemed to perform even better, but missing data for years where site means were particularly low, artificially increase its overall performance. CIP 8 performed similarly well with an overall yield advantage of about +35% while CIP17 and CIP15 showed average yields similar to the locals.

In order to assess more precisely the performances and the consistency of the sweet potato varieties across years and locations, a BiPlot was conducted over a set of data free of missing data. As a consequence, the most extensive selection included 7 varieties and 7 environments (location/year) (Table 49).

Table 49. BiPlot data set #1: sweet potato yields from replicated trials

Variety	*Year and location of replicated trials - Yield (t/ha)*									*Yield advantage (%) **
	Bet 09	Bau 09	Ail 09	Bet 08	Ail 08	Mal 07	Ail 07	*Mean*	*St. dev*	
Hohrae 1	12.5	2.8	18.1	14.2	30.1	0.1	29.6	15.3	11.8	102
Hohrae 2	15.6	4.8	18.7	8.1	23.7	2.7	23.9	13.9	8.8	83
Hohrae 3	30.2	6.6	20.4	23.3	20.5	1.9	26.5	18.5	10.4	143
CIP 04	18.1	9.7	10.2	11.4	28.4	0.3	34.9	16.1	11.9	112
CIP 08	11.6	3.6	10.5	17.0	26	1.3	16.7	12.4	8.5	63
CIP 15	10.3	3.1	2.7	11.0	28.5	2.3	18.5	10.9	9.7	44
CIP 17	4.4	3.9	11.1	0.5	17.9	0.3	42.4	11.5	15.0	51

* over average local variety yields = 7.6 t/ha for those environments

Figure 21 gives a visual representation of the varieties means stability (sloping down left to right) versus the environments (sloping up from left to right). Results shows that the research sites included in the BiPlot did not given similar results from 2007 to 2009, in particular at Aileu.

The most consistent yielding varieties for the 7 tested environments (location/year) were Hohrae 1 and Hohrae 2, followed by CIP 4. Hohrae 3 showed less consistency but significantly higher performances than all the other varieties analysed here. Hohrae 3 performed the best at Betano in 2009. In comparison, CIP8, 17 and 15 performed the least and were inconsistent across the environments. This confirms that the released varieties were a good choice (high yielding and consistent), while CIP 4 could become a possible candidate if it had been selected by farmers for its palatability characteristics.

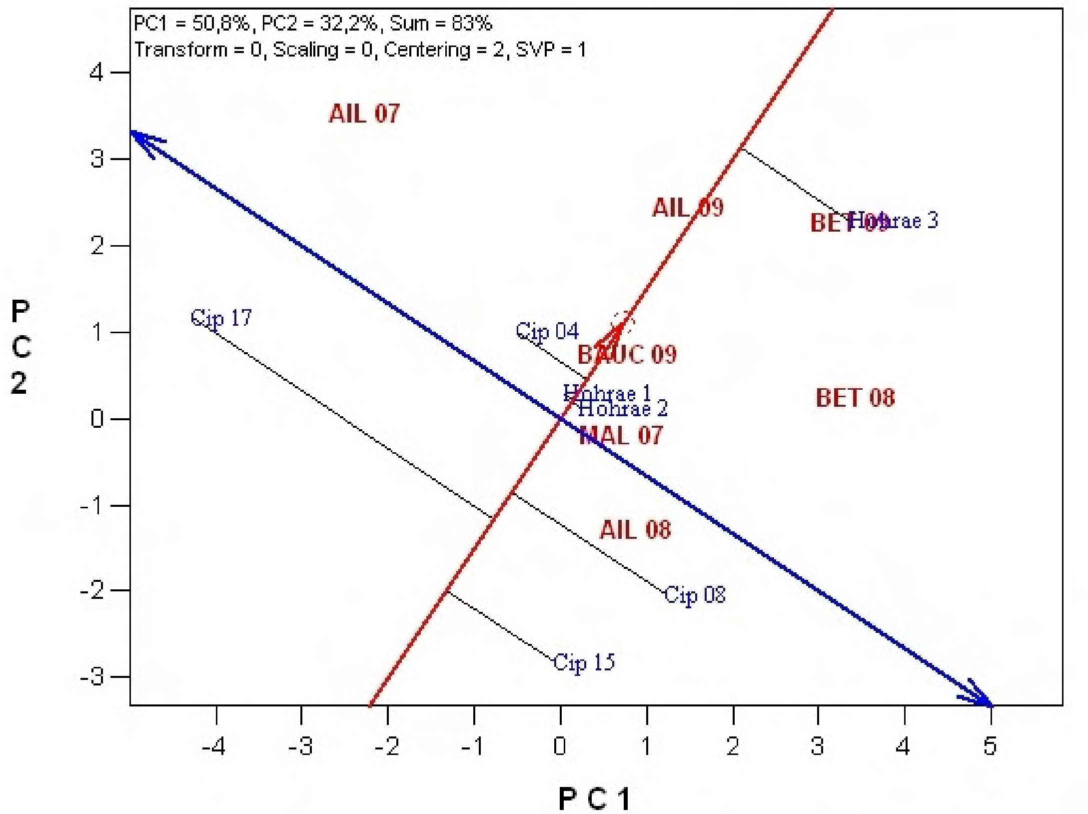

Figure 21. Biplot analysis of 7 sweet potato varieties in 7 environments (location/year)

In order to investigate more closely the performances of the three Hohrae varieties and of CIP 4, another set of data was analysed. The latter included the 4 varieties performances over 12 of the total 15 environments where they were trialed in (Table 50).

Table 50. BiPlot data set #2: sweet potato yields from replicated trials

Variety	*Year and location of replicated trials - Yield (t/ha)*														*Yield advant. (%) **
	Bet 09	Loe 09	Bau 09	Mal 09	Ail 09	Bet 08	Bau 08	Mal 08	Ail 08	Mal 07	Ail 07	Mal 06	*Mean*	*St. dev*	
Hohrae 1	30.2	35.9	6.6	4.8	20.4	23.3	6.8	12.8	20.5	1.9	26.5	3.6	16.1	11.5	96
Hohrae 2	18.1	30.0	9.7	4.4	10.2	11.4	6.9	10.4	28.4	0.3	34.9	2.0	13.9	11.5	69
Hohrae 3	15.6	24.3	4.8	5.6	18.7	8.1	5.7	9.8	23.7	2.7	23.9	5.6	12.4	8.3	51
CIP 04	12.5	7.3	2.8	5.3	18.1	14.2	5.8	8.3	30.1	0.1	29.6	0.3	11.2	10.3	37

* overall average local varieties yields = 8.2 t/ha for those environments

The biplot analysis of this data is presented in Figure 22. This graph confirms the results of the first set of data. Among the 4 varieties analysed, Hohrae 1 and 3 performed most consistently followed by Hohrae 2 and CIP 4.

The BiPlots both accounted for about 85 % of the variation in the data related to genotype and environment. Further trials will assist in providing even larger sets of data.

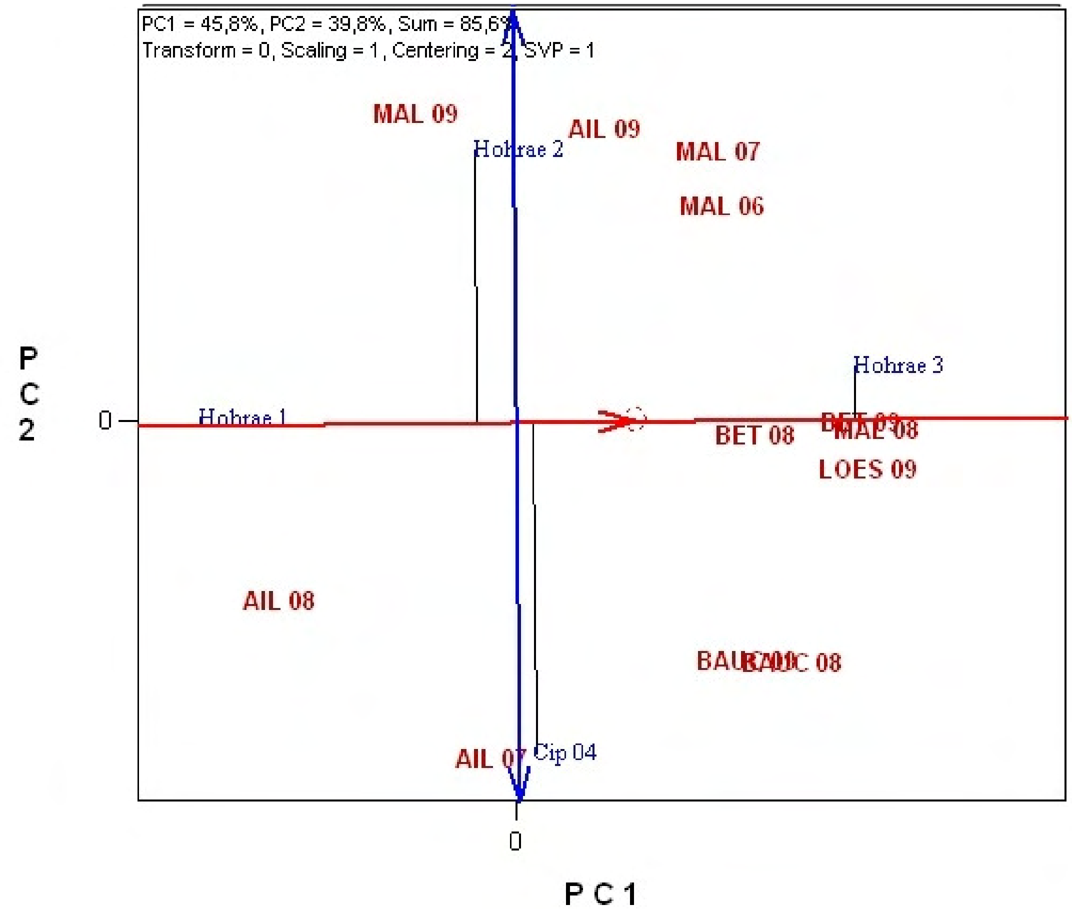

Figure 22. **BiPlot analysis of the 4 top yielding sweet potato varieties (location/year)**

Conclusions

Over 4 years, SoL conducted 15 varietal sweet potato trials on 12 varieties, representing a total of more than 130 individual replicated trial plots. Results varied significantly both by genotype (varieties) and environment (locations and years). Nevertheless, the collected data was robust enough to allow selecting, releasing and confirming 3 varieties of sweet potato as the most suitable according to production (measured as at least +25% to +63% over locals), palatability and suitability (from OFDTs).

2.2.3 Sweet potato observation trials

Materials and methods

Additional sweet potato clones were imported from CIP in Indonesia with the dual objectives of extending the exiting germplasm collection and to identify promising varieties for evaluation in the 2009-2010 replicated trials. 23 new varieties were planted, most of which are briefly described in Table 51.

Table 51. Population details of new sweet potato varieties 2008-2009

Code	*Name*	*Leaf outline*	*Leaf lobe type*	*No. of lobes*	*Central lobe shape*
CIP 55	Wolf 315.2				
CIP 64	420027	Almost divided	Very deep	3	Linear (narrow)
CIP 65	440166	Lobed	Deep	7	Elliptic
CIP 66	441768	Almost divided	Very deep	5	Linear (narrow)
CIP 67	107003.1				
CIP 68	440031	Triangular	Slight	3	Triangular
CIP 69	440024	Triangular	None lateral	1	Toothed
CIP 70	440170	Triangular	Very slight/Slight	3-5	Triangular
CIP 71	400011				
CIP 72	440429	Triangular	Very slight	3	Toothed
CIP 73	440093	Reniform	None lateral	1	Toothed
CIP 74	420014	Lobed	Deep	5-7	Elliptic
CIP 75	440132	Triangular	Very slight/None	1-5	Toothed
CIP 76	400004	Cordate	Slight	3	Triangular
CIP 77	440027	Reniform	None lateral	1	Toothed
CIP 78	442107	Reniform	Very slight	1-3	Toothed
CIP 79	440034	Cordate	Very slight	1-3	Toothed
CIP 80	440167	Triangular	Very slight/Slight	3	Triangular/Toothed
CIP 81	440025	Triangular	None lateral	1	Toothed
CIP 82	440131	Lobed	Moderate	5-7	Semi-elliptic
CIP 83	440001	Cordate	Very slight	1-5	Toothed
CIP J	Jered M21	Lobed	Deep	5	Lanceolate

Observational plots were 5m by 1m in size with one replicate, except at Betano where four were implemented. As for replicated trials, cuttings were spaced at 1m x 0.5m which corresponds to a density of 2 plants/m^2.

Results

The trial at Baucau suffered from extreme drought and no results were obtained. Yields at Maliana were also half those of other sites because of a similar problem. Yields ranged from a few tons per hectare to more than 40 t/ha in two locations (Table 52). The latter was for CIP 72 on two sites indicating that high yields are achievable. Across all sites, 8 varieties yielded above 14 t/ha on average.

Table 52. Yields and yield advantages of the new sweet potato clones, 2008-2009

Variety	*Yield (t/ha)* Betano	*Loes*	*Maliana*	*Aileu*	*Overall*	*st..d.*	*Yield advantage (%) over mean sites* Betano	*Loes*	*Maliana*	*Aileu*	*Overall*
CIP 72	42.3*	40.0	6.8	15.8	26.2	17.6	180	179	13	21	98
CIP 73		24.9	7.0	26.4	19.4	10.8		74	16	103	64
CIP 77	11.5*	24.0	11.3	17.2	16.0	6.0	-24	68	87	32	41
CIP 76		31.4	8.4	5.9	15.2	14.1		119	38	-55	34
CIP 70	13.3*	11.7	12.7	20.7	14.6	4.1	-12	-18	110	59	35
CIP 78		21.6	9.9	11.7	14.4	6.3		51	63	-10	35
CIP 71		17.4	10.4	14.7	14.2	3.5		22	72	13	35
CIP 83	18.4*	6.0	8.1	24.2	14.1	8.6	21	-58	34	86	21
CIP 79		10.3	4.8	20.4	11.8	7.9		-28	-21	57	3
CIP 68		12.7	8.7		10.7	2.9		-11	43		16
Jer M21	3.2*	12.9		15.5	10.5	6.5	-79	-10		19	-23
CIP 74	14.3*	8.2	2.1	11.3	9.0	5.2	-5	-43	-65	-13	-32
CIP 67		16.7	3.3	6.0	8.7	7.1		16	-46	-54	-28
CIP 66		0	1.1	22.9	8.0	12.9		-	-81	76	-35
CIP 69		11.5	4.1		7.8	5.3		-20	-33		-26
CIP 65		1.6	6.4	13.5	7.2	6.0		-89	5	4	-27
CIP 75			6.7	7.6	7.1	0.6			10	-42	-16
CIP 64		11.5	3.6	5.0	6.7	4.2		-20	-41	-62	-41
CIP 82		6.2	2.8	7.5	5.5	2.4		-57	-53	-43	-51
CIP 84			6.0	5.0	5.5	0.7			-2	-62	-32
CIP 81		3.6	2.9	5.0	3.8	1.0		-75	-52	-62	-63
CIP 55	3.0*				3.0	-	-80				-80
CIP 80			0.3	4.3	2.3	2.8			-95	-67	-81
Mean site	15.1	14.3	6.1	13.0	12.1	4.1	-	-	-	-	-

* Results obtained from replicated trials"

In Betano, some of the new varieties were harvested twice to see if an extra 17 days of growing time would attain higher yields. The results (Table 53) indicate that an extra seventeen days did not make difference to yields. The test run on marketable yields gave similar results.

Table 53. Two-way ANOVA on sweet potato yields for 2 harvests, Betano, 2008-2009

Variety	*Harvest* 1	2	*Means*
CIP 74	14.3	11.2	12.8
CIP 83	18.4	14.2	16.3
CIP 77	11.5	12.0	11.8
CIP 70	13.3	12.5	12.9
CIP 72	42.3	28.6	35.4
Jered	3.2	5.4	4.3
CIP 55	3.0	4.0	3.5
Means	*15.1*	*12.6*	*13.8*

Variety	
F prob	<0.001
l.s.d.	5.2
Harvest	
F prob	0.068
l.s.d.	n.s.
Variety. Harvest	
F prob	0.063
l.s.d.	n.s.
%CV	31.5

Conclusions

The results of the observation trials were highly variable and do not replace replicated trials. Nevertheless, the trial data did assist select promising varieties among the new clones. For next cropping season, the replicated trial will integrate CIP 72, 73, 77, 76, 70, 83, while the other varieties will be kept for further observation and for the germplasm collection.

Seventeen days of extra maturity did not increase yields but this factor will be examined in more datail in 2010.

2.2.4 Sweet Potato On-farm Demonstration Trials (OFDTs) 2008-2009

A range of promising sweet potato varieties was evaluated on farm in 17 Sub-Districts of Timor Leste in the 2008/09 wet season. The trial objective was to determine if the promising sweet potato varieties identified on the research stations have a good performance in farmer's fields.

A range (4) of promising sweet potato varieties was tested alongside the local clone. As such the local check at each site could be a different variety. Each on-farm demonstration and trial (OFDT) consisted of a locally sourced variety, defined as the local at that location. In addition, a released variety (Hohrae 3) plus 3 promising sweet potato clones were tested. These have been tested under the code names CIP4, CIP 17 and CIP8 on research stations and appeared to have consistent high yields and acceptable taste.

Materials and methods

The method of conducting the sweet potato OFDT's was very similar to that for the cassava OFDTs. Sweet potato OFDTs were conducted in the districts of Aileu, Ainaro, Baucau, Bobonaro, Liquica Manufahi and Viqueque. This sampled the range of the agro-ecological zones found in Timor from sea level to 1300m altitude.

As for cassava, a sample of 5 plants was dug by the researchers with the farmers to obtain harvest data. The remaining area was harvested as the farmer determined. In previous years, it was found the farmers would harvest the trial plots throughout the season, not allowing a harvest estimate. By identifying 5 plants that the researcher and farmer would harvest together, on the one day, an estimate of the yield was made. For each plant, the researcher recorded the number of tubers per plant , the weight of tubers from the 5 plants and perceptions of the farmers regarding each test entry.

Site characterization

Site characterization was as for the maize OFDT trials. This included soil pH, colour and texture, latitude, longitude and elevation.

Analysis

Data entry and analysis was as done for the maize OFDTs. Raw data was entered into an EXCEL spread sheet, and then summarised and analysed using Genstat Discovery 3. Yield data were analysed by ANOVA (Unbalanced Model) in a range of methods. First, main effects and the interactions between variety and District, Sub-District, AEZ were tested.

Further to this main analysis, the influence of a wide range of factors on sweet potato yield was tested using an unbalanced ANOVA design. The model of the analysis always included variety and AEZ as factors in the model. As elevation was shown to have an impact on crop yield between sites, elevation was included as a co-variate in all the analyses. In turn, a range of factors were 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

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 1,300m. (Table 54).

Table 54. Distribution of sweet potato OFDT sites by elevation, 2008/09.

Elevation (masl)	Locations 2008/09 (%)
0-100	16
100-200	10
200-300	10
300-400	8
400-500	5
500-600	12
600-700	5
700-800	6
800-900	10
900-1000	9
1000-1100	4
1100-1200	3
1200-1300	3
1300-1400	1

Soil pH, elevation and texture

The average soil pH across the OFDT test sites was 6.7, ranging from 4.0 to 9.0. (Table 55).

Table 55. Distribution of soil pH across sweet potato OFDT sites, 2008/09

Soil pH	*Locations 2008/09 (%)*
4	1
4.5	1
5	4
5.5	9
6	14
6.5	31
7	8
7.5	21
8	6
9	3
9.5	2

Soil pH differed statistically (LSD 0.26) between District and Sub-District, as in OFDT's for other upland crops in other years. (Table 56).

Table 56. Mean soil pH and elevation, sweet potato OFDTs by subdistrict, 2008/2009

Sub-District	*Soil pH*	*Elevation (m)*
Aileu Villa	5.6	915
Alas	7.3	12
Baucau Villa	6.8	514
Cailaco	6.9	85
Hatudo	7.1	323
Laga	7.9	399
Laulara	6.0	1171
Lequido	5.3	1261
Liquica	7.0	430
Maliana	7.4	254
Ossu	6.0	662
Remexio	5.3	1097
Same Villa	6.9	345
Turiscai	6.0	1171
Uatolari	6.2	101
Vemasse	6.4	599
Venilale	7.1	827
LSD (p<0.05)	*0.3*	

Trial losses

It is very difficult to determine the yield of all root crops including sweet potato and cassava on farmer's fields in Timor Leste. In this set of OFDTs, of the 151 trials established, yields were only recorded at 76 locations. Trial losses were due mainly to animal predation especially cows, buffalos and wild and domestic pigs. Predation by people was also a possibility.

Variety

All introduced sweet potatoes produced a higher yield than the local check varieties (Table 57). The released variety Hohrae 3 produced the highest yield of all tested varieties, 40% more than the other test varieties.

Table 57. Yield components for OFDT sweet potato varieties, 2008/09

Variety	*Yield (t/ha)*	*Tubers per plant*	*Weight per tuber (g)*
Hohrae 3	15.6	5.0	143
CIP 4	6.4	3.9	110
CIP 8	12.5	4.9	143
CIP 17	8.2	4.9	118
Local	3.8	4.1	69
LSD (p<0.05)	*3.1*	*1.1*	*36*

Districts

The highest yielding Sub-Districts (Alas and Same Villa) were in Manufahi district. (Table 58). There was a large and significant interaction between variety and Sub-District for sweet potato yield. The interaction suggests at that there may be scope for some varieties to be specifically recommended in some locations and not others.

Table 58. Sweet potato OFDT tuber yield (t/ha) by Sub-District 2008/09

District	SubDistrict	Hohrae 3	CIP4	CIP8	CIP17	Local
Aileu	Aileu Villa	6.3	3.8	6.2	3.4	2.3
Aileu	Lequido	7.3		6.7	3.2	1.6
Aileu	Remexio	5.9		4.5	2.5	1.9
Ainaro	Hatudo	25.1	9.3	19.5	10.7	4.3
Baucau	Baucau Villa			6.6	8.1	
Baucau	Laga	4.2	5.7		4.5	0.6
Baucau	Vemasse	9.2	7.1	9.2	8.4	3.4
Baucau	Venilale				7.6	5.3
Bobonaro	Cailaco	16.0	14.2	13.1	14.6	9.2
Bobonaro	Maliana	9.8	5.6		5.2	2.2
Liquica	Liquica	2.5	2.7		3.7	0.9
Manufahi	Alas	40.9		24.8	25.1	10.4
Manufahi	Same Villa	35.7		25.0	28.6	13.2
Manufahi	Turiscai	4.0		4.6	2.2	2.8
Viqueque	Ossu			22.2	25.1	
Viqueque	Uato- Lari	15.2		8.1	7.8	0.0

Significant interaction LSD($p<0.05$) = 9.8

The released variety Hohrae 3, was the highest yielding variety in all but 2 of the 17 subdistricts. In those 2 Sub-Districts (Laga and Liquica), Hohrae 3 yielded well above the local check varieties.

Agro Ecological Zones (AEZ) and yield

Yield results for each variety in each AEZ are shown in Table 59. Yields for all varieties were greatest at on the south coast, at all latitudes. As for the interaction between variety and district, with there was a statistically significant interaction between variety and AEZ. This suggests that there may be some varieties more suited to some AEZ's than others.

Table 59. Sweet potato OFDT mean yield by AEZ, 2008/09

AEZ	*Local (t/ha)*	*Hohrae 3 (t/ha)*	*CIP 4 (t/ha)*	*CIP 8 (t/ha)*	*CIP 17 (t/ha)*
1 Northern coast (0-100m altitude)	5.9	12.3	7.2	13.5	10.8
2 Northern slopes (100-500m altitude)	1.6	8.2	4.9	7.2	6.1
3 Northern uplands (>500m altitude)	3.5	7.3	7.1	6.7	5.4
4 Southern Uplands (>500m)	1.9	21.4		18.9	6.4
5 Southern slopes 100-500m)	6.4	28.0	9.3	19.2	15.1
6 Southern coast (<100m altitude)	4.5	26.7		16.6	15.8
Total					
LSD (P<0.05)		*Interaction 8.1*			

As with the analysis of across Sub-Districts, the released variety Hohrae 3 has the highest yield in all 6 AEZs (Table 59). To investigate the complex and significant interaction of variety and AEZ, a linear regression of yield versus elevation was conducted. In the regression, variety was also considered as a factor.

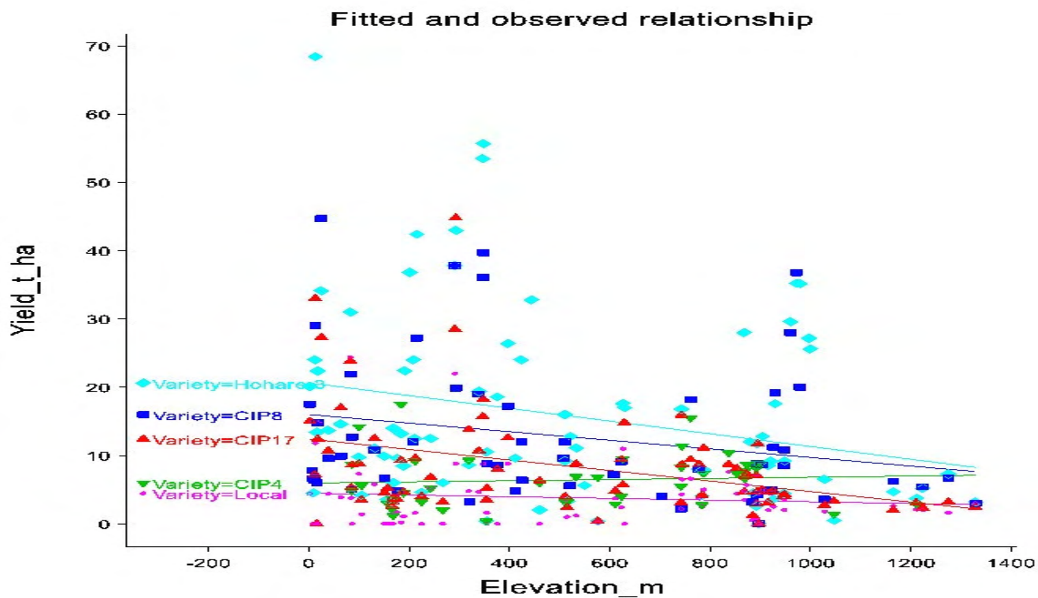

Figure 23. Effect of elevation on sweet potato yield, 5 varieties in OFDTs 2008/09.

Increasing elevation reduced tuber yields in all varieties except CIP 4 (Figure 23). Yields of Equations of predicted sweet potato yield with altitude for each of the test varieties are shown below.

Local	Yield (t/ha) = 4.4 t/ha – 1.2 t/ha/1000m* Elevation (1000m)
Hohrae 3	Yield (t/ha) = 20.6 t/ha – 9.3 t/ha/ 1000m * Elevation (1000m)
CIP 4	Yield (t/ha) = 5.9 t/ha + 0.8 t/ha/ 1000m * Elevation (1000m)
CIP 8	Yield (t/ha) = 16.0 t/ha – 6.2 t/ha/ 1000m * Elevation (1000m)
CIP17	Yield (t/ha) = 15.5 t/ha – 7.7 t/ha/ 1000m * Elevation (1000m)

Based on the regressions above Hohrae 3 has the highest yield at all elevations from 0 to 1000m above sea level. Above 1000m elevation, all sweet potato yields were relatively low.

Agronomic factors affecting yield

Although the overarching purpose of the OFDT system is to test possible candidates for variety release for use on farmers' fields, the process of measuring and comparing yields also provides an opportunity to collect data on agronomic factors and analyse the effect of these factors on yield. This analysis is described in the Materials and methods section above.

The influence of a wide range of characters was tested for affecting the yield of sweet potato in the complete data set. A large number of characters were found to have an influence on root yield, and these include Variety, AEZ, Sub-District, soil colour, soil texture, soil pH and the style of planting (lines or random). The slope of the land, the gender of the head of the household and whether the crop was mono cropped or not had no effect on sweet potato yield (Table 60).

Table 60. Significance of management factors affecting sweet potato yield

Factor	*Significance P<0.05 2008/09*
Variety	✓
Sub-District	✓
AEZ	✓
Soil pH	✓
Soil colour	ns
Number of staff visits	ns
Elevation	✓
Soil texture	✓
Slope of land	ns
Mixed planting or monoculture	ns

Soil pH

Although soil pH affected sweet potato yields, the effect was small. Roots from plants in soil with a pH below 6 appeared to have a lower yield, and high pH soil (8 and 8.5) did not seem to reduce yields. (Table 61).

Table 61. OFDT yield by soil pH for all sweet potato varieties, 2008/09

Soil pH	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5
Mean yield (t/ha)	5.9	5.9	7.4	7.7	8.9	12.5	8.9	15.6
LSD (p<0.05)	6.9							

There was no interaction between soil pH and variety for yield. This suggests that the impact of low pH on sweet potato yields is similar for local and introduced varieties.

Soil texture

In general, sweet potato yield increased with heavier soil texture (Table 62). Crops grown on sandy loam and silty loam soils had significantly lower yields than crops grown on soils with heavier texture (i.e., loams and clays)

Table 62. Impact of soil texture on sweet potato yield 2008/09

Soil texture	*Yield (t/ha)*
Sandy Loam	5.5
Silty Loam	8.4
Loam	11.5
Clay loam	10.1
Fine clay	11.8
Heavy Clay	9.9
LSD (P<0.051)	*4.0*

Farmer's preference for sweet potato clones

All tested sweet potato clones were judged by farmers as having good taste (Table 40) Taste and numerous tubers were the only positive characteristic attributed to local sweet potato varieties. (Table 63). The released variety Hohrae 3 was described as having the added positive attributes of large tubers, easy to sell, had a short season as well as good taste.

Table 63. Reasons farmers (%) for replanting sweet potato varieties in 2009/10.

Characteristic	Hohrae 3	CIP 4	CIP 8	CIP 17	Local
Tastes good	26	67	67	55	82
Big tubers	32	21	19	14	
Good price	11	4	5	0	
Short season	23	8	5	9	
Good colour	1	0	0	5	
Big yield	7	0	5	5	
Many tubers	0	0	0	14	18

The yellow fleshed sweet potato CIP 17 was appreciated for good flesh colour and excellent taste. From anecdotal evidence, CIP 17 seems to have better colour and taste than all other varieties. When asked which variety the farmers themselves would like to plant, they chose Hohrae 3 and CIP17. These are both attractive yellow flesh tubers with sweet taste. One comment about CIP 17 was that it was so sweet, when eaten as breakfast, farmers did not need to add sugar to the coffee.

When further questioned, farmers appeared to prefer Hohrae 3 as a sweet potato for sale, and CIP 17 for their own production.

Conclusions

This year's research confirmed the suitability of Hohrae 3 for increasing food production on Timorese farms. Although CIP 17 was highly desired by farmers in terms of taste and colour, the lower yields of CIP17, compared to Hohrae 3 do not warrant CIP 17 to be released as a named variety. Although CIP 8 was the highest yield of the new test varieties, it was less preferred than Hohrae 3 in terms of positive characteristics, and seemed not to be superior to Hohrae 3 in any character.

2.3 Cassava

Cassava (*Manihot esculenta Crantz*) is grown by approximately 65% of farmers in Timor Leste as a source of food for the household and also for animals (SoL 2008). Roots from the plants are eaten fresh after boiling or steaming and sometimes after being processed into dry chips. Cassava leaves are also boiled and eaten as a vegetable. A small number of plants are grown around the house for home consumption. Some farmers grow larger areas of the crop for sale and as animal feed but there is little or no processing of roots into starch or other products. Varietal selection is therefore based on eating quality in addition to yield improvement.

2.3.1 Replicated cassava trials

All cassava clones included in the trials were sourced from environments to Timor Leste in Indonesia and Thailand. Trials were implemented in Maliana, Baucau, Aileu and Betano as they were in earlier years.

Materials and methods

Each trial was a randomized block design with two replicates each at Aileu and Baucau while at Maliana and Betano, three replicates were possible. The trials were planted in December, 2007 or January, 2008 (Table 64) and harvested 8-12 months later.

Table 64. Cassava planting and harvest details, 2007/08/09

Location	*Number of entries*	*Planting date*	*Harvest date*	*Mean yield (t/ha)*
Maliana	24	15/01/2008	13/01/2009	13.4
Baucau	24	30/12/2007	27/08/2008	4.9
Aileu	23	27/12/2007	29/10/2008	15.8
Betano	25	10/01/2008	16/12/2008	36.8

The same set of accessions reported in SoL, 2008 were included in the trial. A maximum of 25 clones were tested at Betano but only 23 at Aileu. All trials included the same local varieties, Mantega, Merah and Etu Hare. The Indonesian variety, Gading (Ca 026) and Ca 015 (OMM 90-03-100) have recently been released by MAF as new cassava varieties in Timor Leste under the names of Ai-luka 4 and Ai-luka 2 respectively and are referred to using these names in this report.

Plot dimensions were 5m by 5m with a 30cm walkway between each plot. Plant spacing was 1m by 1m square, resulting in 25 plants per plot. At harvest, roots of 20 plants were dug for yield determination. The remaining 5 plants were left for field day observations and for fresh stem production. At harvest, fresh weight of tubers and their starch content were measured immediately. Sample tubers were then taken for determination of HCN content. At the same time as the HCN was measured, the uncooked taste of the sample tubers was recorded (by the researcher responsible) on a scale of 1 to 5 (1 = very sweet; 2 = sweet; 3 = mixed; 4 = bitter; 5 = very bitter). Also, at the time of harvest at Aileu, a farmer field day was conducted. Thirty two farmers were involved in measuring yields and visually inspecting tubers and cassava plants *in situ.* After the harvest, a similar taste test of uncooked tubers (rated 1 to 5) was conducted among the farmers and they were then asked which varieties they would like to plant in their own farms.

Results

Aileu

The results of the Aileu trial are presented in Table 65. Root yields were much better than the low yields recorded at Aileu in 2007. The average yields of the three local varieties were 10.7

t/ha compared to 14.7 t/ha for the newer Thai introductions and 17.9 t/ha for all the other SOL accessions which have now been tested for many years.

The highest yielding varieties in Aileu in 2008 were Ai-luka 2 (Ca 015), Ca 034, Ca 036 and Ca 042, all of which had significantly higher yields than even the best (Etuhare with 14.9t/ha) of the local varieties. The lowest yields were produced by Rayong 60 and the two locals Mantega and Merah. With the exception of Rayong 60, all introduced clones had a yield advantage over the average of the 3 locals. The highest starch contents were obtained from Rayong 5, 72 and 90, Ca 007, as well as Ai-luka 2 and these again were all significantly higher than the starch contents of any of the local varieties tested. However when *total* starch yield was extrapolated from these starch contents and root yields, only Ai-luka 2 (with 8.6t/ha) was significantly higher than the best of the locals (Etuhare with 3.7t/ha)

Table 65. Cassava variety evaluation trial results, Aileu, 2007/08.

Code	*Variety name*	*Root yield (t/ha)*	*Yield advantage over average of locals (%)*	*Starch content (%)*	*Starch yield (t/ha)*
Ca 007	CMM 96-36-224	20.0	87	31.8	6.3
*Ca 009	CMM 96-36-269	*	*	*	*
*Ca 010	OMM 96-01-69	*	*	*	*
Ca 013	CMM 96-25-25	15.1	41	22.2	3.3
Ca 014	OMM 96-01-93	12.0	12	24.3	2.9
Ca 015	Ai-luka 2	25.7	141	33.1	8.6
Ca 016	*Mantega-Aileu*	9.4	-12	23.6	2.2
Ca 017	*Merah-Aileu*	7.8	-27	24.2	1.9
Ca 021	Bogor 1	11.9	11	25.2	3.2
Ca 025	Gempol	12.8	20	23.9	3.1
Ca 026	Ai-luka 4	16.5	54	25.0	4.1
Ca 032	CMM 97-01-158	15.1	41	25.5	3.9
Ca 034	CMM 97-11-155	23.5	120	27.4	6.5
Ca 036	CMM 97-02-36	24.5	129	25.8	6.3
Ca 040	CMM 97-07-145	12.8	20	26.6	3.4
Ca 042	CMM 97-02-181	24.6	130	22.1	5.3
Ca 060	*Local Etuhare*	14.9	39	24.9	3.7
Ca 101	Hanatee	13.3	25	24.6	3.3
Ca 102	Rayong 1	12.1	13	25.1	3.1
Ca 103	Rayong 2	18.1	69	24.7	4.4
Ca 104	Rayong 3	12.1	13	26.6	3.2
Ca 105	Rayong 5	20.1	88	33.1	6.6
Ca 106	Rayong 60	6.6	-39	26.3	1.8
Ca 107	Rayong 72	18.0	68	29.7	5.4
Ca 108	Rayong 90	18.4	72	30.5	5.7
Ca 109	KU 50	13.5	26	27.8	3.7
Site average		*15.8*		*26.4*	*4.2*
Fprob		0.003		0.003	0.001
LSD(P<0.05)		8.5		4.9	2.1
CV%		26.1		9	24.1

* Not included at this site

Maliana

Only 23 of the 26 accessions were planted at Maliana in the 2008 season. Cassava root yields were much lower than those recorded at this site in 2007 (site average of 13.4 vs 35 t/ha) but starch contents remained high. (Table 66).

The clones introduced more recently from Thailand yielded on average (16.0 t/ha) higher than the other SoL accessions (12.1 t/ha). In comparison the average yield of the three locals was only 7.1 t/ha. Five of the Thai varieties, Rayong 3, 5, 72 and 90 as well as Ca 40, all had significantly higher yields than Mantega which was the best performing of these locals at 8.9 t/ha.

Gempol (Ca 025) which has generally performed well over a number of years of SoL trials and the local Merah were the two lowest yielding varieties at Maliana in 2008, while Ai-luka 2 (Ca 015) and Ai-luka 4 (Ca026) only produced yields close to the site average.

Rayong 3, 5 and KU 50 had the highest percentage starch and all were significantly higher than the local varieties. However in terms of actual estimated starch yield, Ca 040, Rayong 3, Rayong 72 and Rayong 90 were all significantly higher than most other tested varieties.

Table 66. Cassava variety evaluation trial results, Maliana, 2007/08.

Code	*Variety name*	*Root yield (t/ha)*	*Yield advantage over average of locals (%)*	*Starch content (%)*	*Starch yield (t/ha)*
Ca 007	CMM 96-36-224	13.2	85	23.4	3.1
*Ca 009	CMM 96-36-269	*	*	*	*
*Ca 010	OMM 96-01-69	*	*	*	*
Ca 013	CMM 96-25-25	12.5	75	27.5	3.4
Ca 014	OMM 96-01-93	14.8	107	26.3	3.9
Ca 015	Ai-luka 2	12.9	81	31.3	4.1
Ca 016	*Mantega-Aileu*	8.9	25	32.1	2.9
Ca 017	*Merah-Aileu*	5.3	-25	24.4	1.3
Ca 021	Bogor 1	7.6	6	28.6	2.2
Ca 025	Gempol	6.0	-16	25.2	1.5
Ca 026	Ai-luka 4	11.6	62	22.3	2.5
Ca 032	CMM 97-01-158	14.5	103	29.0	4.2
*Ca 034	CMM 97-11-155	*	*	*	*
Ca 036	CMM 97-02-36	14.5	103	27.1	3.9
Ca 040	CMM 97-07-145	23.3	226	34.1	8.1
Ca 042	CMM 97-02-181	12.3	72	30.5	3.8
Ca 060	*Local Etuhare*	7.2	1	32.1	2.3
Ca 101	Hanatee	13.3	86	28.6	3.8
Ca 102	Rayong 1	12.8	79	32.9	4.2
Ca 103	Rayong 2	8.4	17	25.7	2.1
Ca 104	Rayong 3	22.8	219	42.3	9.6
Ca 105	Rayong 5	17.3	142	38.6	6.5
Ca 106	Rayong 60	10.8	51	34.9	3.8
Ca 107	Rayong 72	24.0	236	30.6	7.2
Ca 108	Rayong 90	20.4	186	36.7	7.5
Ca 109	KU 50	14.4	101	38.5	5.6
Site average		*13.4*		*30.6*	*4.2*
Fprob		0.001		0.001	0.001
LSD(P<0.05)		7		6.7	2.2
CV%		31.7		13.3	31.1

* Not included at this site

Baucau

Average yields at Baucau in 2007/08 (Table 67) were much lower than those observed in 2006/07. Results from Baucau have generally been very poor over a number of years and indicate that cassava is just not suited to soils at this site. Termite damage and poor establishment of plants is also a recurring problem at Baucau. Although there were no significant differences in yield between varieties, Gempol (Ca 025), Rayong 60 and the local Merah (Ca 017) had the highest yields and the other local, Mantega, produced the lowest yield.

Starch content (%) was quite variable ranging from a low 12 % for Ca 007 and Rayong 90 to over 30% for Rayong 72, Rayong 60, Rayong 2 and Ca 013, but in terms of actual starch yield (t/ha) there was no difference between varieties.

Table 67. Cassava variety evaluation trial results, Baucau, 2007/08

Code	*Variety name*	*Root yield (t/ha)*	*Yield advantage over average of locals (%)*	*Starch content (%)*	*Starch yield (t/ha)*
Ca 007	CMM 96-36-224	2.8	-42.9	12.0	0.4
Ca 009	CMM 96-36-269	*	*	*	*
Ca 010	OMM 96-01-69	*	*	*	*
Ca 013	CMM 96-25-25	4.6	-6.1	18.0	0.9
Ca 014	OMM 96-01-93	5.8	18.4	14.1	0.8
Ca 015	Ai-luka 2	5.0	1.0	33.4	1.8
Ca 016	Mantega-Aileu	3.8	-22.4	23.3	2.0
Ca 017	Merah-Aileu	5.4	9.2	18.5	2.5
Ca 021	Bogor 1	1.9	-61.2	18.9	0.4
Ca 025	Gempol	7.8	59.2	20.5	1.7
Ca 026	Ai-luka 4	4.4	-11.2	20.4	0.9
Ca 032	CMM 97-01-158	6.8	38.8	23.1	2.3
*Ca 034	CMM 97-11-155	2.9	-41.8	21.2	0.6
Ca 036	CMM 97-02-36	4.1	-16.3	27.4	1.2
Ca 040	CMM 97-07-145	7.2	46.9	23.0	1.6
Ca 042	CMM 97-02-181	4.3	-13.3	17.7	0.8
Ca 060	Local Etuhare	6.0	21.4	29.1	1.7
Ca 101	Hanatee	2.6	-48.0	18.2	0.5
Ca 102	Rayong 1	4.4	-11.2	28.6	1.3
Ca 103	Rayong 2	6.3	27.6	24.8	1.7
Ca 104	Rayong 3	4.3	-12.2	20.7	1.0
Ca 105	Rayong 5	6.0	21.4	30.2	1.8
Ca 106	Rayong 60	4.3	-13.3	23.8	1.1
Ca 107	Rayong 72	4.8	-3.1	25.7	1.3
Ca 108	Rayong 90	6.7	36.7	32.2	2.2
Ca 109	KU 50	4.8	-2.0	34.0	1.7
Site average		4.9		23.3	1.3
Fprob		ns		<0.001	ns
LSD(P<0.05)		*		8.6	*

* Not included at this site

Betano

With the exception of Ca034, a complete list of clones was planted again at Betano in 2008. Although there was better germination than in 2007, the varieties Ca 21, 40 and the local Etuhare again (as well as Ca 010 and Rayong 2) had less than optimal plant establishment (ranging from 30-60%). However, all other varieties had good plant establishment and the site average yields at Betano in 2008 was higher (36.8 t/ha) (Table 68) than in 2007 (27.3t/ha).

In general, the more recently introduced varieties from Thailand (average of 41.1 t/ha) performed better than the older SoL varieties (36 t/ha). The exceptions being Rayong 2 and Rayong 90 both of which also yielded relatively poorly at Betano in 2007. The highest yields were observed in Ca 013, Ca 007, Ca 009, Rayong 1, Rayong 3 and Ai-luka 2. These all had yields which were significantly higher than even the best yielding of the local variety (Mantega at 34.1 t/ha) The varieties Ca 036, Ca 042, Rayong 5, Rayong 60, Rayong 72, Hanatee and KU 50 also produced relatively good yields that were significantly higher than the average (25.5 t/ha) of the 3 locals tested. In relative terms, the newly released variety Ai-luka 4 (Gading) did not perform as well in 2008 (14th highest yield) as in 2007 (3rd highest) but still yielded better than the best local (Mantega) and had almost a 50% yield advantage over the local average.

In terms of starch %, only the Thailand varieties, Rayong 3, Rayong 5 and Rayong 72, had significantly higher starch content than the local average (both Mantega and Merah had relatively high starch %). However when this is converted to starch yield, these 3 varieties plus

Ca 013, Ca 009, Ca 042, as well as Rayong 1, Rayong 60, Hanatee and KU50 all produced significantly higher starch yield than the local average.

Table 68. Cassava variety evaluation trial results, Betano, 2007/08.

Code	*Variety name*	*Root yield (t/ha)*	*Yield advantage over average of locals (%)*	*Starch content (%)*	*Starch yield (t/ha)*
Ca 007	CMM 96-36-224	53.0	108	16.7	8.8
Ca 009	CMM 96-36-269	51.5	102	20.2	10.7
Ca 010	OMM 96-01-69	23.1	-9	22.6	5.3
Ca 013	CMM 96-25-25	59.5	133	21.9	13.1
Ca 014	OMM 96-01-93	23.9	-6	19.2	4.5
Ca 015	Ai-luka 2	47.5	86	21.7	10.3
Ca 016	*Mantega-Aileu*	*34.1*	*34*	*26.3*	*8.9*
Ca 017	*Merah-Aileu*	*31.2*	*22*	*23.7*	*7.8*
Ca 021	Bogor 1	24.7	-3	25.3	6.3
Ca 025	Gempol	37.0	45	22.8	8.5
Ca 026	Ai-luka 4	37.6	47	23.4	8.8
Ca 032	CMM 97-01-158	16.0	-37	21.6	3.4
*Ca 034	CMM 97-11-155	*	*	*	*
Ca 036	CMM 97-02-36	40.5	59	25.2	10.2
Ca 040	CMM 97-07-145	13.4	-47	21.0	2.8
Ca 042	CMM 97-02-181	47.0	84	25.3	12.0
Ca 060	*Local Etuhare*	*11.2*	*-56*	*21.8*	*2.4*
Ca 101	Hanatee	46.5	82	25.4	11.8
Ca 102	Rayong 1	53.1	108	24.6	13.1
Ca 103	Rayong 2	14.0	-45	23.5	3.3
Ca 104	Rayong 3	50.5	98	27.5	13.9
Ca 105	Rayong 5	45.2	77	28.2	12.7
Ca 106	Rayong 60	46.9	84	23.5	11.0
Ca 107	Rayong 72	45.2	77	28.2	12.8
Ca 108	Rayong 90	26.2	3	24.8	6.6
Ca 109	KU 50	42.0	65	26.1	11.2
Site average		36.8		23.6	8.8
Fprob		0.001		0.001	0.001
LSD(P<0.05)		13.5		3.9	3.9
CV%		22.3		8.7	26.7

* Not included at this site

Cassava performance across sites and years

In general, the cassava clones which had performed well across sites in previous years produced relatively high yields again in 2008. Both of the recently released varieties, Ai-luka 2 and 4, yielded consistently well in 2008 (the exception being in Baucau where all yields were low). The Thai variety, Rayong 72, again produced high yields and relatively high starch contents. Another Thai variety, Rayong 5 which had only average yields in 2007, also produced good yields at all sites in 2008. Of the older SoL varieties, Ca 36, Ca 42, (both of which have been recently tested in OFDT's) and Ca 13 also performed consistently well in 2008. Although not included in Table 69 because it was only tested at Betano, Ca 9 yielded very well again at this site and maintains a significant long-term yield advantage over local varieties. Rayong 2 again produced very poor yields (similar to 2007) at Betano and also in Maliana, but yielded relatively well at Baucau and Aileu. In contrast, Rayong 60 yielded poorly in Aileu (as it also did in 2007) but was among the higher yielding varieties at Betano in 2008. This suggests that Rayong 2 may be adapted to a cooler higher altitude environment whereas Rayong 60 is not.

The response of farmers at the field day conducted at harvest time in Aileu in 2008, confirms the importance of perceptions of taste in determining farmer planting preferences. In general, farmers selected for planting only those varieties which were considered sweet when tasted uncooked in the field. This is despite the fact that some selected varieties such as Ca 21 and Ca 102 had below average yields at Aileu in 2008 (Table 69). Yield however obviously plays some part in decision-making given that no farmers selected the two very low yielding locals (Mantega and Merah), even though they were considered sweet. Also, two of the higher yielding varieties at Aileu in 2008 (Ai-luka 2, Ca 7 and Rayong 5) were selected by some farmers even though they were not particularly sweet. Most farmers preferred Ca 13 which combined a sweet taste with an average yield performance. Rayong 72 was one of only two varieties recorded as bitter in this particular taste test and was not selected by any farmer despite having a reasonable yield of 18.1t/ha. (Although Rayong 72 was judged on average to be bitter, the subjectivity of taste-tests is revealed in the raw data in which 3 farmers actually scored Rayong 72 as very sweet).

Table 69. 2008 predicted mean cassava yields and long term yield advantage

Code	*Variety*	*All trial (2001-2008) yield advantage (%)*	*2008 mean yield (t/ha)*	*2008 Aileu Taste test**	*Percentage of Farmers who selected this variety (Aileu yield t/ha in brackets)*
Ca 107	Rayong 72	107	25.3	Bitter	0 (18.1)
Ca 015	Ai-luka 2	82	24.3	Mixed	10 (25.7)
Ca 104	Rayong 3	77	25.7	Mixed	0 (12.1)
Ca 013	CMM 96-25-25	69	25.6	Sweet	23 (15.1)
Ca 109	KU 50	68	20.6	Mixed	0 (13.5)
Ca 105	Rayong 5	67	24.0	Mixed	3 (20.1)
Ca 040	CMM 97-07-145	63	15.0	Mixed	16 (12.8)
Ca 007	CMM 96-36-224	63	24.5	Mixed	3 (20.0)
Ca 042	CMM 97-02-181	63	22.0	Sweet	10 (24.6)
Ca 102	Rayong 1	60	23.1	Sweet	3 (12.1)
Ca 036	CMM 97-02-36	55	22.3	Sweet	10 (24.9)
Ca 026	Ai-luka 4	42	19.0	Sweet	16 (16.5)
Ca 108	Rayong 90	36	19.1	Sweet	7 (18.4)
Ca 025	Gempol	33	17.1	Sweet	10 (12.8)
Ca 014	OMM 96-01-93	33	15.2	Mixed	0 (12.0)
Ca 106	Rayong 60	24	19.6	Bitter	0 (6.6)
Ca 101	Hanatee	19	21.2	Sweet	0 (13.3)
Ca 032	CMM 97-01-158	16	13.5	Sweet	0 (15.1)
Ca 021	Bogor 1	10	12.5	Sweet	13 (11.9)
Ca 103	Rayong 2	3	11.6	Sweet	3 (18.1)
Ca 016	Local Mantega	*	15.6	Sweet	0 (9.4)
Ca 017	Local Merah	*	13.7	Sweet	0 (7.8)
Ca 060	Local Etu Hare	*	9.7	Mixed	0 (14.9)
F prob			0.001		
LSD			5.1		

*Conducted on freshly harvested uncooked tubers

HCN content of tested cassava varieties

No HCN contents were measured in Baucau and only HCN recorded in Maliana without a corresponding taste test, but as Table 70 indicates, there was considerable variation again (as in 2007) in HCN contents and taste of varieties between sites in 2008. The average HCN content of varieties was higher at Aileu than at both Maliana and Betano. The Maliana trial in particular apparently produced very low HCN contents with KU 50 the highest with just 67 ppm HCN. In contrast the measured HCN content of KU 50 at Aileu was 300ppm. Generally, the results from Aileu in 2008 were similar to those in recorded 2007. The locals Merah and Mantega as well as Ai-luka 4, Ca 13 and Gempol again had low HCN contents while Ca 34 and 36 again had relatively high HCN content. However Ai-luka 2 and Rayong 72 both recorded much higher HCN at Aileu in 2008 than they did in 2007. There were also some differences in the perceived taste of varieties between the two trials at Aileu. In 2007, both Rayong 3 and 60 were considered bitter but in 2008 were recorded as sweet. On the other hand Rayong 1, 2 and 5 were all sweet in

2007 but apparently considered bitter in the 2008 Aileu trial. Table 70 provides examples of similar differences in taste between sites in the 2008 trials. (eg.Ca 32, Ca 36 and local Merah sweet at Aileu but bitter at Betano). Unlike 2007, there was no correlation between HCN content and perceived taste in the 2008 trials. This is demonstrated by the examples from the Aileu trial (Table 70) where Rayong 3 with a HCN content of just 25 tasted bitter and Rayong 60 which had a relatively much higher HCN content of 125 but apparently was judged as being sweet.

The average HCN contents of the cassava varieties as tested across both years and all trials so far in which HCN has been measured are also presented in Table 70 The large standard deviations observed for most varieties suggest considerable variability in this 'trait' which may be due to either environmental factors and/or experimental error in measuring HCN content. Only varieties such as local Mantega, Ai-luka 4, Gempol, Ca 21, Hanatee and Rayong 2 appear to have consistent HCN contents (and low) over time and location

Table 70. Cassava HCN contents across sites in 2008 and 2 year average of trials

Variety	*Aileu HCN*	*Aileu Taste score*	*Betano HCN*	*Betano Taste score*	*Maliana HCN*	*Average HCN all 2007and 2008 trials (SD in brackets)*
Ca007	225	Mixed	44	Mixed	27	121 (88)
Ca009			101	Mixed		107 (9)
Ca010			47	Mixed		40 (10)
Ca013	55	Sweet	22	Mixed	17	28 (14)
Ca014	75	Bitter	31	Mixed	17	40 (23)
Ai-luka 4	100	Sweet	30	Sweet	12	44 (30)
Mantega	35	Sweet	15	Sweet	37	29 (9)
Merah	75	Sweet	19	Bitter	53	59 (44)
Ca021	35	Sweet	19	Sweet	20	26 (11)
Ca025	30	Sweet	33	Sweet	22	24 (9)
Ca026	35	Sweet	14	Sweet	33	28 (10)
Ca032	40	Sweet	60	Bitter	40	40 (13)
Ca034	110	Sweet				122 (16)
Ca036	100	Sweet	32	Bitter	40	82 (57)
Ca040	40	Sweet	35	Mixed	47	55 (23)
Ca042	115	Mixed	33	Mixed	40	58 (35)
Etuhare	60	Mixed	13	Mixed	35	31 (19)
Hanatee	20	Mixed	40	Mixed	30	31 (9)
Rayong 1	150	Bitter	26	Mixed	40	61 (45)
Rayong 2	25	Bitter	24	Sweet	25	31 (9)
Rayong 3	40	Sweet	22	Mixed	50	45 (34)
Rayong 5	125	Bitter	21	Sweet	50	67 (44)
Rayong 60	125	Sweet	59	Mixed	5	67 (52)
Rayong 72	200	Mixed	37	Sweet	57	85 (65)
Rayong 90	65	Sweet	38	Mixed	15	45 (26)
KU 50	300	Mixed	69	Mixed	67	157 (105)
Trial Average	89		35		34	
F prob (0.05)	<0.001		0.004		ns	
LSD	110		36			

Conclusions

The results of the replicated cassava variety trials conducted in 2008 confirm the correctness of the decision to release Ai-luka 4 (Gading) and Ai-luka 2 (Ca015) for cultivation in Timor Leste. Both performed relatively well at all locations and both (but Ai-luka 2 in particular) maintained a very good average yield advantage over local varieties. Ai-luka 4 continued to be rated as sweet in all the taste tests conducted in 2008 (Farmer field day and those associated with HCN testing), while Ai-luka 2 produced just one mixed response.

Gempol (Ca025), which also was suggested in the 2007 ARR for possible release, performed only moderately in 2008 with low yields at Aileu and Maliana, but still managing to out-yield the locals at Betano and Baucau. However it still remains a candidate for release because of its consistent rating as a sweet tasting variety. The other varieties which have been tested together with Gempol in OFDT's, namely Ca 036, Ca 042 and Rayong 72 also yielded relatively well in the 2008 replicated trials and should continue to be included in future OFDT's. Although Rayong 72 continues to produce relatively high yields and starch content, it has so far hasn't received very favorable response in taste tests and as such is should not be considered for release in the immediate future. Ca 036 and Ca 042 are generally considered sweet, but have had some mixed responses in terms of taste and therefore also need further evaluation (in both OFDT's and taste tests) before they could be recommended for release.

The 'quiet achiever' of the older introduced SoL varieties is Ca013. It has yielded consistently well over many years now and in fact is second only to Ai-luka 2 in terms of long-term yield advantage (Table 69), ignoring the recently included Thai varieties). It was overlooked for inclusion in OFDT's because it had previously been rated as bitter in a taste test conducted at Betano in 2004. However it has since received only one subsequent bitter response in a taste test of uncooked tubers conducted together with HCN testing in Baucau in 2007. It has been consistently rated as sweet in Aileu and was the most preferred variety at the farmer field day conducted there in 2008.

2.3.2 Cassava On-Farm Demonstration Trials 2008-2009

Cassava OFDTs were established in 17 Sub-Districts of Timor Leste during the wet season of 2008/09. The trial objective was to determine whether the elite cassava varieties identified in the research stations, also perform well in farmers fields. These trials followed OFDTs established in 2007-2008 which tested Ca15 and Ca 26. Despite the fact that none of these trials were successfully harvested, the response from farmers was particularly encouraging and they were released as Ai-luka 2 and Ai-luka 4 respectively. Both of these clones performed extremely well in replicated trials up to and including 2007-2008. In 2008-2009, four (4) other introduced cassava clones were tested alongside the local cassava variety. The new clones had been selected from the replicated trial plots conducted 12 months earlier. One year was then spent multiplying sufficient planting material for the OFDTs. The clones were selected as having high stable yield, were sweet to taste and had been selected by farmers as their preferred option. The clones under test included an Indonesian variety Gempol (coded as Ca25), two test clones from ILETRI (also known as RILET) in Indonesia (OMM 90-03-100 and CMM-97-02-181, coded as Ca15 and Ca42 respectively) and a Thai variety Rayong 72 (coded as Ca107) The clones Ca25, Ca36 and ca42 had been tested extensively since they were introduced to Timor from CIAT (Bangkok) in 2001, and Ca 107 was a more recent introduction from Thailand in 2005.

Materials and methods

Cassava OFDTs were conducted on the north coast districts of Aileu, Baucau, Bobonaro and Liquica. This sampled the range of north coast environments from sea level to 1218m altitude. Almost no cassava is grown above this altitude, so no OFDT's were conducted at the higher altitudes.

The OFDT's were conducted on farmer's fields, with farmer management. Trial characteristics were measured by researchers based in the sub-districts. Each researcher used their own contacts to identify participating farmers. This was often through consultations with the Chefe de Suco, with MAF extension and other staff, or farmers already known to SoL personnel.

At each site, SoL researchers gave 25 stems of each variety to the farmer for planting. The stems were planted on a 5m by 5m grid at a 1m by 1m spacing. Collaborating farmers provided the local variety for testing.

The resulting 5m by 5m plot was marked out with string, and name plates identified the different varieties. Only one replicate was planted at each site in a randomized plot design.

Five plants in each plot were marked for harvest by the researchers. Farmers were requested not to harvest roots from these plants as was the traditional practice. In previous years, it was found that the farmers would harvest roots randomly from the trial plots throughout the season, not allowing for a harvest estimate. By identifying 5 plants that the researcher and farmer would harvest together, on the one day, an estimate of the yield was made. The researcher recorded the number of tubers per plant, the weight of tubers from the 5 plants and the perceptions from the farmers for each variety.

Site characterization

Site characterization was as for the maize OFDT trials. This included soil pH, colour and texture, latitude, longitude and elevation.

Analysis

Data entry and analysis was similar to that applied to the maize OFDT's. Raw data was entered into an Excel spread sheet, and then summarised and analysed using Genstat Discovery 3. Yield data were analysed by ANOVA (Unbalanced Model) with a range of methods. In the first instance, main effects and interactions between variety and District, Sub-District, AEZ were tested.

Further to this main analysis, the influence of a wide range of factors on cassava yield was tested using an unbalanced ANOVA design. The model of the analysis always included variety and AEZ as factors in the model. As elevation was shown to have an impact on crop yield between sites, elevation was included as a co-variate in all the analyses. In turn, a range of factors were 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

Measurements were taken at sixty six cassava OFDT sites in 2008-2009. This was a sub-sample of the total number of trials implemented because cassava is a long duration crop, and at the time of publication, only this number was available for harvest. Unfortunately because of the problems of farmers harvesting the crop beforehand and trial losses due to animals, especially cows, buffaloes, wild and domestic pigs yield data was collected from only 30 of these locations.

Testing environments

Cassava 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 1,100m. (Table 71). Forty four percent of these were less than 200m. Cassava yields were lower at higher altitudes (see below) and this was reflected in the smaller number of trials at these locations.

Table 71. Distribution of cassava OFDT sites by elevation, 2008/09.

Elevation (masl)	*Locations 2008/09 (%)*
0-100	27
100-200	17
200-300	9
300-400	6
400-500	2
500-600	8
600-700	13
700-800	2
800-900	3
900-1000	8
1000-1100	2
1100-1200	3

Soil pH, elevation and texture

The average soil pH across the OFDT test sites was 6.8, ranging from 5.0 to 8.0. (Table 72). Eighty five percent of the trials were installed in neutral or slightly below or above neutral.

Table 72. Soil pH of cassava OFDT sites, 2008/09

Soil pH	*Locations (2008/09) (%)*
5.0	2
5.5	4
6.0	5
6.5	25
7.0	25
7.5	35
8.0	4

Mean soil pH differed statistically (LSD 0.26) between District and Sub-Districts, as in OFDT's for other upland crops in other years. (Table 73).

Table 73. Soil pH and elevation of cassava OFDT by Sub-District, 2008/09

Sub-District	*pH*	*Elevation*
Aileu Villa	6.7	957
Baucau Villa	6.9	551
Cailaco	6.1	98
Liquica	6.2	612
Maliana	7.3	344
Maubara	6.7	248
Uatulari	6.4	26
Vemasse	7.5	177

Many of the soils (55%) on the OFDT sites were clay-loams or fine clays (Table 74) with a smaller percentage of either sandier or heavier textures.

Table 74. Distribution of soil texture of cassava OFDT, 2008/09

Soil texture	*Locations 2008/09 (%)*
Sandy	2
Sandy Loam	12
Silty Loam	16
Loam	12
Clay Loam	25
Fine Clay	30
Heavy Clay	4

Root yields

Cassava root yields of all four tested varieties produced larger tuber yields than the local varieties (Table 75). This was most likely due to a combination of the number of tubers per plant and weight of each tuber as neither was significantly different from the control despite physical evidence this was the case.

Table 75. Yield components for cassava OFDTs 2008/09

Variety	*Yield (t/ha)*	*Tubers per plant*	*Weight per tuber (g)*	*Mean yield from replicated trials (2002-2008)**
Ca107	15.9	6.6	358	28.2
Ca25	13.9	5.5	223	21.2
Ca36	12.2	4.9	259	22.2
Ca42	10.5	4.6	233	24.6
Local	8.7	4.9	212	14.7
LSD	*4.3*	*ns*	*ns*	

* Ca107 from 2005-2008

The high yield of Ca25, Ca36 and Ca42, compared to the local was consistent with the performance of the varieties in on-station replicated trials over the period from 2002 to 2008. Ca107 performed similarly highly from 2005-2008. In both the research station data and the on-farm testing, Ca107 yielded consistently much more than the local checks (85 and 92% respectively). Ca107 was bred in Thailand where it was released in 2000. It has shown consistent high yielding performance across many locations and years in Thailand, possesses high starch content, good germination and drought tolerance. The yield advantage of Ca107 was due to a combination of more tubers per plant, as well as larger average tuber size, though there was no significant difference of either characters between Ca107 or the local in this trial.

Ca25, Ca36 and Ca42 are advanced breeding lines from CIAT and performed better than the local clones but not as well as Ca104, in both replicated research station trials and in the on farm testing.

Districts

Yields of all varieties trialled in OFDTs were highest in Cailaco and Maubara Sub-District and lowest in Aileu villa, Baucau villa and Uatulari (Table 76). There was no significant interaction between variety and Sub-District. This suggests that the higher yield of the introduced varieties, especially Ca107 was consistent across Sub-Districts and there is no reason to recommend different varieties for different Sub-Districts.

Table 76. Cassava OFDT tuber yield (t/ha) by Sub-District 2008/09

District	*Sub-District*	*Ca107*	*Ca25*	*Ca36*	*Ca42*	*Local*
Aileu	Aileu villa	8	8	7	6	3
Baucau	Baucau villa	8	9	7	5	6
	Vemasse	23	18	15	20	16
Bobonaro	Cailaco	37	41	27	28	17
	Maliana	13	9	14	7	10
Liquica	Maubara	36	14	4	8	11
Viqueque	Uatulari	12	3	9	8	5
	Mean	*20*	*14*	*12*	*12*	*10*

Agro Ecological Zones (AEZ) and yield

Yield results for each variety in each AEZ are shown in Table 77. Yields for all varieties are greatest at low altitudes (AEZ 1,2 and 6). There was no statistically significant interaction between variety and AEZ. As such, different varieties cannot be recommended for different AEZs.

Table 77. Cassava OFDT mean yield by AEZ, 2008/09

AEZ	*Number of test locations*	*Local (t/ha)*	*Ca107 (t/ha)*	*Ca25 (t/ha)*	*Ca36 (t/ha)*	*Ca42 (t/ha)*
1 Northern coast (0-100m altitude)		18	44	40	26	27
2 Northern slopes (100-500m altitude)		11	14	12	13	13
3 Northern uplands (>500m altitude)		6	10	8	8	5
6 Southern coast (<100m altitude)		4	11	3	9	7
Total	*30*					
LSD (P<0.05)			*Interaction ns*			

As with the analysis of across sub-districts, Ca107 had a consistent yield advantage above the local across all AEZs (Table 77). However, yields of all varieties generally declined with increasing elevation. Yield decline was more prominent with the high yielding variety Ca107 (Figure 24).

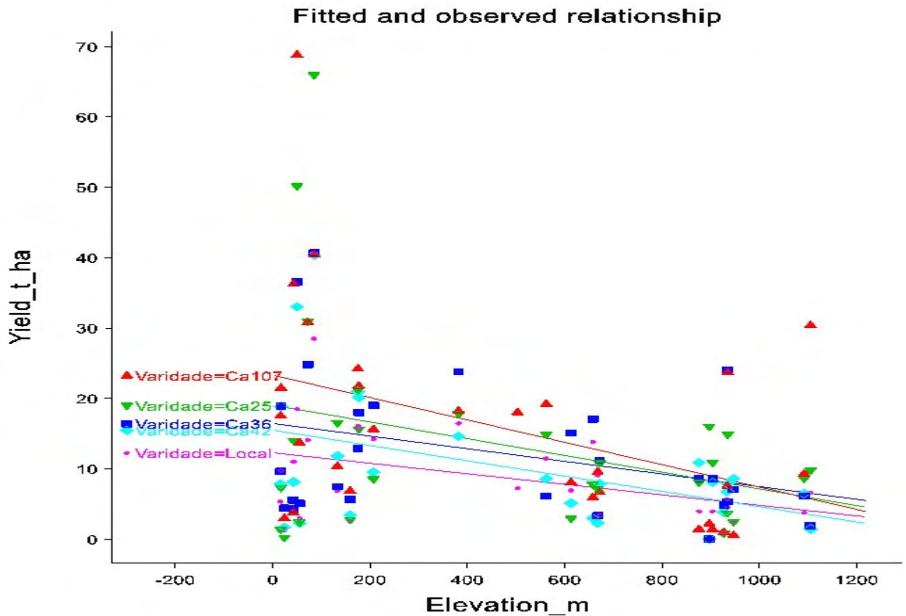

Figure 24. Relationship between cassava yield and elevation, 2008-2009

Equations of predicted cassava yield with altitude for each of the test varieties were as follows.

Local	Yield (t/ha) = 12.2 t/ha–7.5t/ha/1000m x Xm*
Ca 107	Yield (t/ha) = 23.3 t/ha–15.9t/ha/1000m x Xm
Ca 25	Yield (t/ha) = 19.0 t/ha–11.9t/ha/1000m x Xm
Ca 36	Yield (t/ha) = 16.4 t/ha–8.9t/ha/1000m x Xm
Ca 42	Yield (t/ha) = 15.5 t/ha–10.9t/ha/1000m x Xm

*Xm is elevation in metres

The range of regressions predicts a zero yield of cassava at 1500-1800m above sea level.

Agronomic factors affecting yield

Although the overarching purpose of the OFDT system is to test possible candidates for variety release for use on farmers' fields, the process of measuring and comparing yields also provides an opportunity to collect data on agronomic factors and analyse the effect of these factors on yield. This analysis is described in the Materials and methods section above.

The influence of a wide range of characters was tested for affecting the yield of cassava in the complete data set. A large number of characters were found to have an influence on root yield, and these include variety, Sub-District, AEZ, soil pH, elevation and soil texture. The soil colour, number of staff visits, the slope of the land and whether the crop was mono cropped or not had no effect on grain yield (Table 78).

Table 78. Significance of management factors affecting cassava yield

Factor	*Significance P<0.05 2008/09*
Variety	✓
Sub-District	✓
AEZ	✓
Soil pH	✓
Soil colour	ns
Number of staff visits	ns
Elevation	✓
Soil texture	✓
Slope of land	ns
Mixed planting or monoculture	ns

Soil pH

Cassava yields in the OFDTs were related to the pH of the soils on which the plots were sited. The highest root yields were from soils with a pH of 6.0 – 7. Acid soils (pH<5.5) significantly reduced cassava yields (Table 79). Farmers would be well advised not to grow cassava on acid soils.

Table 79. OFDT yield by soil pH for all cassava varieties, 2008/09

Soil pH	5.0	5.5	6.0	6.5	7.0	7.5	8.0
Mean yield (t/ha)	1.5	7.9	40.1	15	12	12	11
LSD (p<0.05)	*1.1*						

Soil Colour

Soil colour had a significant effect on cassava yield across the test sites. Light brown soils produced less yield than other soil colours, and dark brown soils produced the greatest yields. (Table 80). Darker coloured soils are generally recognized by farmers as being higher yielding for other crops (see SoL, 2008) and are preferred cropping areas.

Table 80. Effect of soil colour of cassava yield 2008/09

Soil colour	*Yield (t/ha)*
Red	10.8
Black	15.4
Yellow	15.8
Dark brown	19.1
Light Brown	6.7
LSD (P<0.05)	*7.6*

Soil texture

Cassava yields were highest in soils classified as "loams" (Table 81), although these were a small percentage of the total locations (Table 74). Yields were significantly lower in the sandy soils.

Table 81. Impact of soil texture on cassava yield 2008/09

Soil texture	*Yield (t/ha)*
Sandy	3.1
Clay Loam	10.1
Silty loam	13.6
Loam	29.1
Clay loam	10.1
Fine clay	11.1
LSD (P<0.051)	*1.1*

Farmer's preference for cassava varieties

Local cassava varieties were generally preferred over the introduced clones because of good, taste, where as the introduced cassava varieties were superior in other aspects. Most of the introduced cassava varieties that were tested were preferred due to their high yield and large tubers, and Ca107 was also preferred because of its good tuber colour (Table 82).

Table 82. Reasons (%) for farmers replanting test cassava varieties, 2008/09.

Characteristic	*Local*	*Ca25*	*Ca36*	*Ca42*	*Ca107*
Tastes good	12	0	0	0	5
A local variety	3	0	0	0	0
High yield	2	8	16	7	9
Good tuber colour	0	1	0	0	5
Large tubers	0	6	5	3	4
Adds to our range of varieties	0	5	1	6	2
Produces food quickly	0	1	1	0	0
Wind resistant	0	0	1	0	0

There were very few negative comments about the varieties when people were asked why they did not like the them. Of the eleven farmers with negative comments, the local variety received none. The only negative comments made about the test entries were that the production was low, and the tubers were a little bitter (Table 83)

Table 83. Reasons farmers (number) gave for not planting test cassava varieties.

Characteristic	*Local*	Ca25	Ca36	Ca42	Ca107
Poor yield	0	0	1	3	1
A little bitter	0	3	0	2	1
Total respondents		3	1	5	2

Conclusions

Cassava OFDTs established in earlier years failed to produce measurable yields because of a range of reasons. This was often due to premature harvest and animal damage. Although 66 cassava OFDTs were established in 2009, only 30 were harvested for comparison but these provided valuable insight into the cultivation of cassava in Timor Leste. Root yields of two test clones were significantly higher than the local varieties with Ca107 yielding almost double the roots of the local varieties. Farmers preferred the taste of the local but Ca107 was placed a close second. Farmers also liked the good colour of Ca107 and some commented its large tubers. This clone has been released in Thailand (as Rayong 72) and performed above that of Ai-luka 2 and Ai-luka 4 (see replicated trials above). Although not as preferred as the local for eating by farmers, it has a significant measured yield advantage and will be considered for release.

The results also strongly indicate that cassava should not be cultivated at higher altitudes nor in acid soils. The range of yields was also extreme at lower (sea level) levels. The reasons for this should be investigated and the conditions under which the higher yields were harvested closely examined.

2.4 Rice

2.4.1 Rice Replicated trials, 2008-2009

One replicated rice (*Oryza sativa*) trial was conducted during the 2008-2009 reporting year. This trial was located at Aileu. All lines tested by SoL were sourced from IRRI in the Philippines including the variety Nakroma, released by MAF in 2007. The 2008-2009 year was the third that this set of genotypes was trialled in Timor Leste. The set included 18 new entries (this being the third year of evaluation), Nakroma (top variety evaluated over the period from 2001-2004 and performed extremely well on OFDTs in 2006-2007, 2007-2008) and two local varieties.

Methodology

A total of 21 varieties, including two local varieties, were tested during the 2008-2009 wet season in Aileu.

The trial consisted of 4 replicates with complete randomized plots, each being 5 x 5m in size. Planting hills (one seed per hill) were spaced at 20cm x 20cm. This corresponded to maximum plant densities of about 25 plants/m². No fertilizer was applied. The crop was planted in September and harvested 4-5 months later (Table 84):

Table 84. Planting and harvest details of the Aileu rice varietal trial, 2008/09

Location	*Season*	*Number of entries*	*Number of replicates*	*Planting date*	*Harvest date*	*Days to maturity*	*Rainfall (mm)**	*Mean yield (t/ha)*
Aileu	Wet	21	4	28 Sept, 08	12 Feb 09	137	875	1.3

* Total rainfall from planting to harvest date

Plants were established in a nursery and transplanted into the plots 20-30 days afterwards. At harvest, the whole plot was cut by hand and threshed. The grain was sun-dried to an approximate 12% moisture content before being weighed for yield determination.

The data was analysed using GenStat Discovery 3 in order to determine varietal effects. As a row effect was detected, a REML model (Regular grid) using a Random row term was used (d.f.=20). Yield advantages were calculated from the resulting predicted means over the average of the local varieties.

Results

Table 85 presents the results for all tested varieties, as well as the overall yield advantages over the local checks.

The average yield of 1.3 t/ha was very low compared to those in 2007-2008 (3.0 t/ha). Despite this fact, there were significant differences for grain yield between varieties. Angelica, PSB RC 82, the local Meloban, PSB RC 80 and Matatag 2 performed significantly better than the other varieties. The MAF recommended variety Nakroma yielded approximately 12% above the locals. The newly included local check “Do’ot” was the least yielding variety of all. The range in yields was independent of plant height and seed weight.

Table 85. Rice yields and yield advantages, Aileu 2008/09

Variety	*Plant height (cm)*	*Seed weight (g/1000)*	*Yield (t/ha)*	*Yield advantage over locals (%)*
IR61979-138-1-2-3 (ANGELICA)	56.0	24.4	2.2	111
IR64683-87-2-2-3-3 (PSB RC 82)	62.0	24.7	2.1	103
Local 1 (Meloban)	53.0	23.2	1.9	80
IR62141-114-3-2-2-2 (PSB RC 80)	57.1	25.0	1.7	64
IR69726-29-1-2-2-2 (MATATAG 2)	62.5	22.4	1.7	61
IR39357-71-11-2-2	46.5	24.1	1.6	47
IR54742-31-9-26-15-2	57.8	23.2	1.5	43
IR59552-21-3-2-2 (PSB RC 64)	58.9	25.1	1.5	42
IR77298-5-6 (IR014108)	54.6	22.8	1.5	38
IR68305-18-1-1 (NSIC 118)	56.7	22.5	1.4	37
IR68144-2B-2-2-3 (MS 13)	37.0	20.8	1.4	31
IR69726-116-1-3 (MATATAG 1)	61.1	24.6	1.3	19
IR71606-1-1-4-2-3-1-2 (NSIC 110)	44.3	24.8	1.2	13
Nakroma	62.8	24.0	1.2	12
IR73885-1-4-3-2-1-6 (MATATAG 9)	55.7	23.0	1.2	9
RHS 334-28CX-2CX-5CX-OZA	55.9	25.2	1.1	7
IR72102-4-159-1-3-3-3 (NSIC 112)	50.9	25.1	1.1	6
IR52952-B-B-3-3-2	53.3	23.3	0.9	-10
IR68333-R-R-B-22 (MS 11)	62.2	24.8	0.9	-12
IR58088-16-2-2	55.4	33.8	0.5	-49
Local 2 (Do'ot)	64.8	25.6	0.2	-80
F prob	*<0.001*	*<0.001*	*<0.001*	
Wald/d.f.	*14.8*	*9.5*	*6.9*	
l.s.d.	*5.2*	*2.3*	*0.5*	
Mean site	55.6	24.4	1.3	
Mean locals	58.9	24.4	1.1	

2.4.2 Rice replicated trials, multi-year and multi-location analysis

Materials and methods

Four successful rice trials were implemented over the period from 2007 to 2009 (3 years), testing the performances of a total 24 varieties at 3 different sites (Maliana 2007, Betano 2007/08, Aileu 2007/08 and 2008/09). Some varieties were not included in all trials (in particular the local checks) and some trials were not performed at every site every year. Mean yields and yield advantages are presented in Table 86. Mean site performances varied from 1.3 t/ha to a maximum of 4.2 t/ha (Maliana trial), with an overall average of 2.5 t/ha. In Aileu, both low and high yields were recorded.

The varieties which were tested in all four trials had overall yields ranging from 1.7 t/ha to 3.2 t/ha. This corresponded to overall yield advantages ranging from -80% to +40% under or over the local checks. The performance of the checks was also variable, with some performing extremely well compared with other entries (i.e. local Meloban) or extremely poorly (i.e. Do'ot). Five local checks were included over the period and none were included twice. This made comparisons with checks difficult over time difficult. Nakroma was included in three of the trials and although it performed relatively poorly at one site during one year managed to average 8% yield advantage over the period. This variety was released in 2007 in response to earlier good performances and has performed well in OFDTs (see below). Four or five more recently included entries appear to be performing even better. These are IR69726-29-1-2-2-2(MATATAG 2), IR64683-87-2-2-3-3(PSB RC 82), IR61979-138-1-2-3(ANGELICA), IR62141-114-3-2-2-2(PSB RC 80), and possibly IR54742-31-9-26-15-2. Matatag 2 performed consistently higher at all sites, while PSB RC 60 performed better over three of the four sites. Overall, performance of these two varieties was +34% and + 29% respectively over locals. In previous taste tests, PSB RC 80 had also been considered to be good tasting (defined as soft to eat, oily and fragrant) and had been included in the on-farm testing program in 2009, along with Nakroma.

Table 86. Rice mean yields and yield advantages over 2007, 2008, 2009

Variety	*Yield advantage over locals (%)*				*Overall 2007-2009*		
	Maliana 2007	*Betano 2007/08*	*Aileu 2007/08*	*Aileu 2008/09*	*Mean yield advantage (%)*	*St. dev*	*No of trials*
Local 1 (Meloban)			0	80	40	57	2
IR69726-29-1-2-2-2(MATATAG 2)	20	31	23	61	34	19	4
IR64683-87-2-2-3-3(PSB RC 82)	-6	38	-9	103	32	52	4
IR61979-138-1-2-3(ANGELICA)	-20	38	-3	111	32	58	4
IR62141-114-3-2-2-2(PSB RC 80)	25	31	-3	64	29	27	4
IR54742-31-9-26-15-2	22	31	6	43	25	16	4
Local President		23			23	-	1
IR59552-21-3-2-2(PSB RC 64)	-8	31	0	42	16	24	4
IR 64	11				11	-	1
IR77298-5-6(IR014108)	20	-31	11	38	10	29	4
Nakroma		38	-26	12	8	32	3
IR73885-1-4-3-2-1-6(MATATAG 9)	6	23	-9	9	7	13	4
IR68144-2B-2-2-3 (MS 13)	22	8	-49	31	3	36	4
IR52952-B-B-3-3-2	8	38	-26	-10	3	28	4
IR71606-1-1-4-2-3-1-2(NSIC 110)	4	15	-23	13	2	18	4
IR72102-4-159-1-3-3-3(NSIC 112)	25	-38	-3	6	-3	27	4
IR39357-71-11-2-2	1	-69	-34	47	-14	50	4
IR68305-18-1-1(NSIC 118)	-32	-62	-20	37	-19	41	4
RHS 334-28CX-2CX-5CX-OZA	-48	-31	-11	7	-21	24	4
IR58088-16-2-2	-6	-8	-26	-49	-22	20	4
Local Membramo		-23			-23	-	1
IR69726-116-1-3-(MATATAG 1)	-6	-46	-69	19	-25	39	4
IR68333-R-R-B-22(MS 11)	-39	-77	-20	-12	-37	29	4
Local 2 (Do'ot)				-80	-80	-	1
Average yield locals (t/ha)	-	*1.3*	*3.5*	*1.1*			*Total:*
Average site yield (t/ha)	*4.2*	*1.3*	*3.0*	*1.3*			*81*

Cross-site analyses on yields were conducted using BiPlots (GGE BiPlot program) in order to evaluate the performances and consistency of the tested varieties across years and locations (genotype / environment).

Results

The most extensive selection on which to run a BiPlot analysis included 12 varieties in all 4 environments. One missing data for Maliana had to be accounted for in order to include Nakroma in the dataset. However this did not impact significantly on the results. The set of data included 75 data points (season x variety combinations) out of a total of 81. The corresponding BiPlot analysis is presented in Figure 25. The BiPlot shows the varieties means stability (vector with arrows) versus the environments (vector without arrow), components which accounted for 70% of the variation encountered.

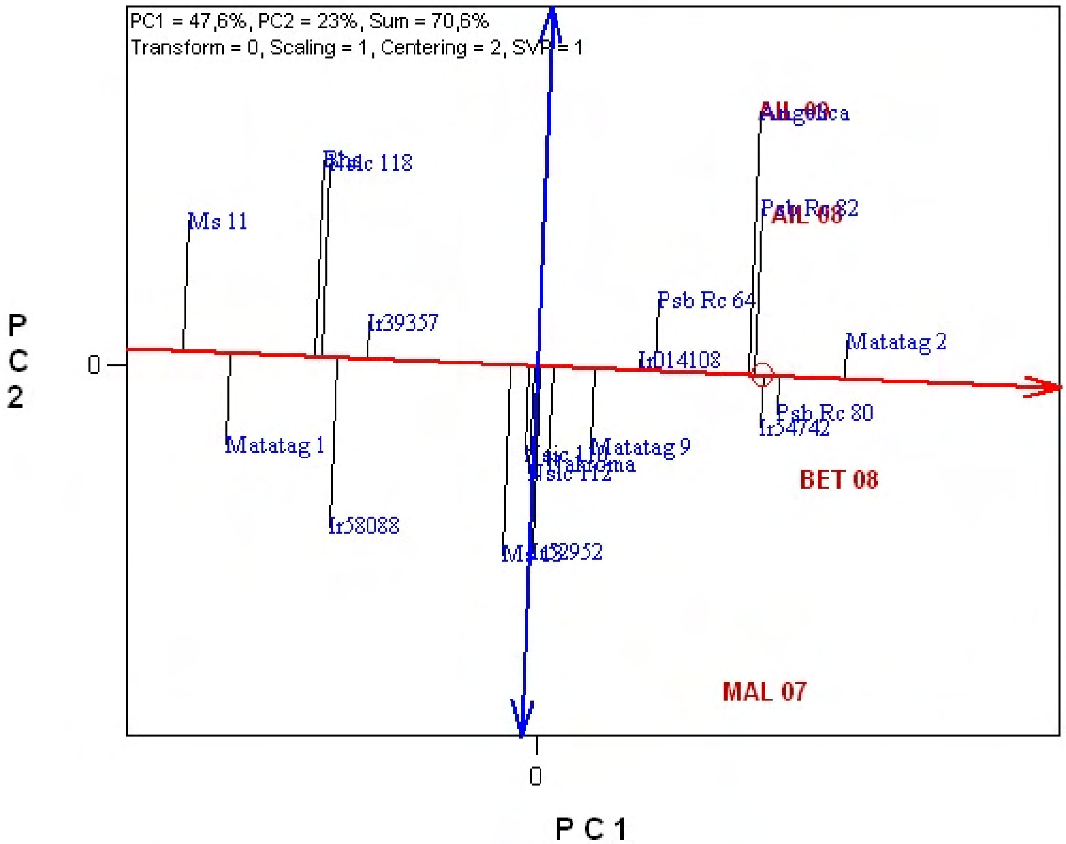

Figure 25. BiPlot analysis of 19 rice varieties in 4 environments, 2007-2009

Results show that even if some similarities could be found in the two Aileu trials, the four environments did not give similar results. Nevertheless, the three top yielding varieties Matatag 2, PSB RC 80 and IR54742-31-9-26-15-2 appeared to be among the most consistent varieties across environments.

Conclusions

Over a three year period, SoL conducted 4 successful varietal rice trials on 24 varieties, representing a total of 81 individual data points (season x variety combinations). Results varied significantly both by genotype (varieties) and environment (locations and years).

The collected data allowed identifying three high yielding varieties which performed with an overall +25-34% yield advantage over the local checks. The suitability of the best tasting of them, PSB RC 80, is currently further investigated in the on-farm testing program.

2.4.3 Rice On-Farm Demonstration Trials (OFDTs)

This section contains data from SoL rice on-farm demonstration trials conducted during 2008 - 2009. Some of these OFDT's included PSBRC 80 for the first time, a variety from the Philippines which has performed consistently in replicated trials over a number of years. However because of a seed shortage PBSRC 80 could not be included in all OFDT's.

Materials and methods

Much of the process for establishing rice OFDTs was similar to that used in other crops and the methods used to obtain the data presented in this report are as described in full in previous SoL Annual Research Reports.

Farmers were chosen using similar processes as for other crops. All farmers received 4kg bags of Nakroma seed and 50% of the farmers also received 100g of PSBRC 80 seed. As in previous years, actual area planted to each variety (plot size) varied according to each farmer's bunded paddy area. But in most cases, Nakroma, PSBRC 80 and whatever local variety the farmer generally used were grown side by side in one paddy. Where possible, a 5m x 5m area was used for yield measurements, however at some sites smaller sample sizes were taken. The plot size of PSBRC 80 was particularly small because of the shortage of seed.

After harvest, the wet threshed grain was weighed. This grain was then dried and weighed again. All of the weights quoted in the Results and Discussion section are for paddy rice (dry, threshed, un-milled weights). Data was entered into MS Excel and then GenStat Discovery Edition 4.2 for ANOVA (Unbalanced Model) analysis. All data included in this analysis was collected, entered and analyzed by SoL staff.

Results and discussion

A total of 86 OFDT trials were installed for evaluation during the 2008/09 season. Of these, analyzable yield data (*i.e.* yield from at least 2 of the 3 varieties tested) was obtained from 71 trials. As in previous years, insufficient water and damage by animals remains the primary reasons for failure. Also, the majority of those recorded as the primary rice farmer were again male (*88% vs 12%).*

Yield

The yield advantage of Nakroma over local varieties when averaged over all trials in 2008-09 was 18% compared with 30% in 2007-08 and 20% in 2006/07 (Table 87). When analysed with Genstat as an unbalanced treatment structure with three variety levels there was no significant difference in yield between varieties. However when the data was analysed in a simple paired comparison between Nakroma and the local variety, the mean yield of Nakroma across all Districts was significantly higher than the local (F prob =0.03).

Table 87. Rice yields of OFDT, all districts, 2006 to 2009

Variety	*Mean yield (t/ha)*			*Yield advantage (%)*		*LSD*
	Local	Nakroma	PSBRC 80	Nakroma	PSBRC 80	*(p=0.05)*
2006/06 (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*
Total (246 sites)	3.2	3.9		22		

*significant for a pair wise comparison between mean yields of Nakroma and local only

As in previous years, the greatest yield advantage of Nakroma, was observed in the Baucau region (Table 88). PSBRC 80 also out-yielded the local in all sub-districts in Baucau and although it was only tested in 5 trials in Cailaco (a Sub-District of Bobonaro) had a massive 54% yield advantage over the local varieties in that sub-district. However when averaged over all the trials in which it was included in 2008/09, PSBRC 80 produced only a marginally higher yield than the locals. There was a statistically significant difference in overall rice yield between Sub-Districts in 2008/09, but this was due to very high yields recorded at a single site in Atabae (Table 88). Otherwise there was no difference in yield between Sub-Districts in 2008/09.

Table 88. Mean yields (t/ha) of rice OFDT in SoL Sub-Districts, 2008/09

District	Sub-District [1]		Sub-district mean yield (t/ha)	Yield of local, (t/ha)	Yield of Nakroma (t/ha)	Yield of PBSRC80 [2] (t/ha)	Yield advantage of Nakroma (%)	Yield advantage of PBSRC80 (%)
Aileu	Aileu Vila	(10)	3.9	4.2	4.2	3.3 (3)	0	-21
Baucau	Baucau	(13)	3.7	2.9	4.3	3.9 (13)	46	34
	Venilale	(10)	2.5	2.2	2.7	3.0 (2)	24	37
	Vemasse	(10)	3.3	3.0	2.6	4.0 (8)	14	33
	District total	*(33)*	*3.3*	*2.7*	*3.7*	*3.4 (23)*	*37*	*24*
Viqueque	Ossu	(14)	3.3	3.6	3.2	3.4 (14)	-10	-5
Bobonaro	Atabae	(1)	6.2	6.0	6.3	*	5	*
	Maliana	(7)	3.3	3.0	3.9	2.2 (1)	30	-25
	Balibo	(1)	3.7	4.0	3.3	*	-18	*
	Cailaco	(5)	3.0	2.4	2.9	3.7 (5)	20	54
	District total	*(14)*	*3.4*	*3.1*	*3.9*	*2.8 (6)*	*28*	*-10*
LSD (p=0.05)			*1.4*	*2.1*	*2.1*	*2.1*		

[1]The total number of trials in this Sub-district is in brackets ( )

2 The number of trials in which PSBRC 80 was included is in brackets ( )

* Not planted

Agronomic factors affecting yield

Those factors, other than variety and sub-district, which affected rice yields between 2006 and 2009 are summarized in Table 89. In 2009, statistical analysis indicated significant differences in rice yield between AEZ's. However as the more detailed Table 90 reveals, this is due only to some surprisingly high yields being produced in the higher altitudes of AEZ 4, compared with relatively low yields at the lower altitudes of the southern coast. These contradictory results apparently have meant that the strongly negative correlation between elevation and yields that was observed in previous years was not found in 2009. Although not a significant difference, the generally higher yields produced on the Northern coast at lower elevations (*i.e.* AEZ 1) in comparison to the higher elevations (*i.e.* AEZ 3) are based on a larger data set and are more believable.

Table 89. Significance (p = 0.05) of factors affecting rice yield, OFDTs 2006 to 2009

Factor	*Significance*		
	2006/07	2007/08	2008/09
AEZ	✓	✗	✓
Elevation	✓	✓	✗
pH	✗	✗	✗
Soil texture	✗	✗	✓
Soil colour	✗	✗	✓

The pH of soil in rice paddies again had no effect on yield. However in 2009, both soil texture and colour produced significant differences. Highest mean yields in 2009 were found in Sandy-loam soils (4.7t/ha) in contrast with fine clay (only 3.0 t/ha). However both of these soil types were the least common (4 and 12%) respectively. The most common soil texture measured in the 2009 OFDT rice trials was loam and occurred at 40% of sites.

It was a similar story with regard to the significant effect of soil colour on rice yield. Red soils (4.5 t/ha) apparently produced significantly higher yields than either brown (3.3 t/ha), or the lighter coloured soils known in Timor Leste as "kopi susu" (3.2 t/ha), but was observed at only 3% of sites. In comparison, brown and kopi susu soils occurred at 37 and 42% of trial sites respectively.

Table 90. Yield of rice OFDT by Agro-Ecological Zone 2008/09

AEZ	*Number of successful OFDTs*	*Average yields (t/ha)*			*Yield advantage over local (%)*	
		Local	*Nakroma*	*PSBRC 80**	*Nakroma*	*PSBRC 80*
1 Northern coast (0-100m altitude)	20	3.2	4.3	3.4 (20)	33	6
2 Northern slopes (100-500m altitude)	9	2.6	3.4	2.8 (2)	31	8
3 Northern uplands (>500m altitude)	28	3.1	3.7	3.1 (11)	19	0
4 Southern upland (>500m altitude)	4	4.4	5.0	5.0 (4)	13	13
5 Southern slopes (100-500m altitude)	3	2.1	2.1	2.0 (3)	10	-5
6 Southern coast (<100m altitude)	7	3.6	2.6	3.1 (7)	-26	-11

* Number of trials which include PSBRC 80 in brackets ( )

Local rice varieties

The names of only 29 local rice varieties used as the local check in the rice OFDT were recorded out of the 71 OFDT's for which there was complete yield data. As in 2007/08, the most common 'local' varieties were Membramo, IR 64 and 'Siaong'. Interestingly, Hybrid rice distributed by MAF was grown as a 'local' in 5 of the 2009 OFDT's (3 in Ossu and 2 in Cailaco). The average yield of the introduced hybrid variety in these 5 trials was 2.3 t/ha compared with 2.5 t/ha for Nakroma and 2.0 t/ha for PSBRC 80. Fertilizer was applied in all these 5 trials.

Effect of farmer management on yield

The increasing use of tractors to cultivate rice paddies continued in 2009 with almost 80% (Table 91) of farmers now using tractors as a result of the ongoing MAF agricultural mechanization program. However as in 2007/08, the use of tractors had no effect on subsequent rice yields.

In 2009, the vast majority of farmers continued the practice of soaking seeds before sowing but interestingly, as in the previous two years, higher (albeit non-significant) rice yields were recorded at the few sites where seeds weren't pre-germinated prior to planting.

The unexpected result from the 2007/08 OFDT's in which, the small minority of farmers who simply broadcast seeds had significantly higher yields than those who went to the trouble of transplanting seedlings, was repeated again in these 2008/09 trials. Even though this result in both years has been derived from only a small number of observations, further investigation of possible reasons why this occurred is warranted.

The number of farmers transplanting later than the recommended time in the nursery (app. 3 weeks) steadily declined from 44% transplanting after 4 weeks in 2006/07 to 35% in 2007/08 and then down again to 25% in 2008/09. However, over the three years, there was no benefit in terms of increased yield by transplanting early. Similarly, there was a steady increase in the number of farmers planting in lines over time, but in 2008/09, yields from trials where farmers continued to plant randomly actually had significantly higher yields than those planted in lines. In 2008/09 there was also a big jump in the number of farmers applying fertilizer (30%) to rice. This was applied either as just urea or in combination with inorganic phosphate and or potassium. The actual rates applied are not clear from the recorded data (some farmer responses suggest 50 kg /ha urea), but given the poor yield response to whatever fertilizer was applied to these trial sites, it is likely to have been sub-optimal. Interestingly, there was no real change in the farmers weeding management between 2006 and 2009. In fact in 2009, a larger percentage of farmers did not weed at all and this apparently had no detrimental effect on yield.

There is much room for improvement in the actual application and integration of the various ICM rice cultivation methods which are currently being promoted in Timor Leste.

As in previous years, farmers were asked about the disadvantages and advantages of the varieties being compared in the trial and the responses were the same. In general, farmers liked their local varieties as they were adapted to their climate and way of farming. The disadvantages of the local rice varieties were that they were tall; prone to lodging and also that they produced more empty seeds then the new SoL varieties. Nakroma was desired by farmers for its high yield; good taste (a little fragrant), white clean rice, short stem that is resistant to wind damage and produces an early harvest. Once again, there were no negative characteristics recorded for Nakroma. PSBRC 80 also received similarly favorable comments from farmers.

Table 91. Significance of management factors affecting OFDTs from 2006 to 2009

	Factor	*2006/07*		*2007/08*		*2008/09*	
		% farmers using	Yield (t/ha)	% farmers using	Yield (t/ha)	% farmers using	Yield (t/ha)
1.	Cultivate with buffalo	58	2.8	54	4.5	19	4.0
	Cultivate with horse	21	4.3	11	3.5	2	3.3
	Cultivate with tractor	21	4.8	34	3.5	79	3.3
	LSD (0.05)		0.9		Ns		Ns
2.	Pre-germinate seeds	96	3.3	97	4.3	98	3.5
	No pre-germination	4	4.3	3	5.0	2	4.9
	LSD (0.05)		Ns		Ns		Ns
3.	Broadcast seeds	6	3.0	4	6.8	4	4.7
	Transplant seedlings	94	3.3	96	4.2	96	3.3
	LSD (0.05)		Ns		1.6		1.0
4.	Transplant less than 2 weeks	17	3.9	6	5.3	24	3.1
	Transplant 2-4 weeks	39	2.1	58	4.3	51	3.2
	Transplant more than 4 weeks	44	3.3	35	4.0	25	3.7
	LSD (0.05)		0.9		Ns		Ns
5.	Plant in lines	19	4.3	47	4,4	65	3.1
	Plant random	81	3.1	53	4,2	35	4.2
	LSD (0.05)		0.8		Ns		0.5
6.	Wide planting distance	0	*	15	3.1	34	3.2
	Close planting spacing	100	*	85	4.5	66	3.6
	LSD (0.05)				0.9		Ns
7.	Applied fertilizer	6	5.0	3	4.4	30	3.1
	No fertilizer used	94	3.2	97	4.3	70	3.6
	LSD (0.05)		1.24		Ns		Ns
8..	No weeding	25	3.6	36	4.2	42	3.4
	Weeded once	72	3.3	43	4.3	38	3.5
	Weeded more than once	3	2.4	22	4.7	21	2.8
	LSD (0.05)		Ns		Ns		Ns

Conclusions

In 2008/09, Nakroma once again demonstrated its yield superiority over existing local varieties. In a small number of sites it even produced yields on par with that of hybrid rice grown side by side under similar conditions.

Although PSBRC 80 produced yields no better than the local controls in the limited number of trials in which it was included, it appeared to be favorably received by farmers and was recommended to be included in future OFDTs.

Data recorded on farmers management over the period from 2006-09 suggest that despite farmers gradually adopting recommended practices (*e.g.* using tractors, transplanting earlier, planting in lines and applying fertilizer etc), this had not been translated into significant yield improvement. This indicates the need for greater emphasis on both agronomic research and extension to assist farmers to successfully apply improved rice growing methods and therefore fully realize the demonstrated yield potential of new varieties such as Nakroma.

2.5 Peanuts

2.5.1 Replicated trials, 2008-2009

All peanut (*Arachis hypogaea* L.) lines tested by SoL were sourced from ICRISAT in India. Peanut variety trials have been conducted for a number of years which allowed the selection of a big-seeded variety for release in 2007, Utamua (PT 05).

During the 2008-2009 cropping season, seven peanut replicated trials were conducted at Betano, Baucau, Maliana, Aileu and Loes. Characteristics of the varieties used in the trials are as presented in Table 92. The Darasula local check was still included, while the two locals from Betano were expanded to all trial sites with the addition of another one from Loes. In Maliana, a fifth local check was also tested.

Table 92. Population details, replicated peanut trials, 2008/09

Code	*Name*	*Origin*	*Botanical type*	*Seed skin colour*
Utamua (PT 05)	ICGV 88438	ICRISAT	Spanish bunch	Brown
PT 10	Local Darasula	TL - Baucau	Timorese local	Brown
PT 11 *	ICGV 95058	ICRISAT	Spanish bunch	Brown
PT 12 *	ICGV 96172	ICRISAT	Spanish bunch	Brown
PT 13 *	ICGV 95069	ICRISAT	Spanish bunch	Brown
PT 14 *	ICGV 96165	ICRISAT	Virginia	Red
PT 15 *	ICGV 97128	ICRISAT	Virginia	Brown
PT 16 **	ICGV 98378	ICRISAT	Spanish bunch	Brown
PT 17 **	ICGV 98379	ICRISAT	Spanish bunch	Brown
PT 18 **	ICGV 98381	ICRISAT	Spanish bunch	Brown
PT 19 **	ICGV 98375	ICRISAT	Spanish bunch	Brown
PT 20 **	ICGV 99017	ICRISAT	Spanish bunch	Brown
PT 21	Local Mean Betano	TL - Same	Timorese local	Red
PT 22	Local Bo'ot Betano	TL - Same	Timorese local	Brown
PT 23	Local Bo'ot Loes	TL - Maubara	Timorese local	Brown
PT 24	Local Maliana	TL - Bobonaro	Timorese local	Brown

* Medium-duration cycle ** Foliar disease resistant

Methodology

Yields, yield advantages and yield components

One trial was held in each of Betano, Baucau, Maliana, Aileu and Loes during the wet season of 2008-2009, with two extra dry season trials conducted in Betano and Loes. A total of 15 varieties were tested in each trial, with the addition of an extra local variety in Maliana.

Trials consisted of 3 or 4 replicates with complete randomized plots, each being 5 x 5m in size. Planting hills (two seeds per hill) were spaced at 40 x 20cm (except in Betano where spacing was 50 x 20cm) in 4 x 5m plots for both wet and dry season trials. This corresponds to maximum plant densities of 8 plants/m² at Betano and 12 plants/m² at the other sites. Neither fertilization nor irrigation was applied. Wet season trials were planted between October and December 2008 and harvested around April 2009 (Table 93). At harvest, all plants were dug, dried and weighed. Three sample plants were kept aside for measurement of yield components. Variables observed were: sun dried pod yield, number of pods/plant, number of empty pods/plant, weight of seeds/plant and sun dried weight of pods/plant. GenStat was used to analyse the data.

Dry season trials were planted in either February (Betano) or June (Loes).

Table 93. Planting and harvest details of peanut varietal trials, 2008/09

Location	*Season*	*Number of entries*	*Number of replicates*	*Planting date*	*Harvest date*	*Days to maturity*	*Rainfall (mm)[a]*	*Mean yield (t/ha)*
Betano (Manufahi)	Wet	15	4	15.12.08	20.04.09	126[b]	705	1.2
Loes (Maubara)	Wet	15	3	16.12.08	24.04.09	129	970	2.6
Fatumaka (Baucau)	Wet	15	3[c]	27.11.08	30.03-09	123	1685	1.2
Corluli (Maliana)	Wet	16	3	12.10.08	*	*	1200[e]	1.2
K. Portugal (Aileu)	Wet	15	3	25.11.08	23.04.09	149	805	0.4
Betano	Dry	15	4	12.02.09	01.07.09	142	65	-
Loes	Dry	15	3	03.06.09	13.10.09-16.11. 09	129+	0 [d]	1.3

a Total rainfall from planting to harvest dates for each research station.
b Except the local checks which were harvested the 27th of March, i.e. 24 days earlier.
c 3 replicates of 4 total
d Crop relied on residual soil moisture only (rainfall in April and May: 125 mm)
e Estimate

A number of parameters were recorded during plant growth, starting with emergence rates (plant stand) at 2-5 weeks. The impact of several foliar diseases (yellowing, rust and spotted leaves diseases) was monitored at 2-3 months. In some locations, the percentage of plants presenting rotten roots, the number of flowering plants and the number of pegs above ground per plant were also recorded. At harvest, plant mortality and the weight of fresh and then dry pods were measured as well as some of the yield components. Yield and plant densities were measured from the whole plot. Yield components (pods and seed dry weight, number of seeds per pod, percentage of good pods) and most of the disease percentages were obtained from samples (100 pods and/or 5 plants per plot). 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 Discovery 3 in order to determine varietal effects. Depending on planting designs (regular or irregular grid) and on the presence of row and/or column effect in the yields, different tests were performed (Table 94)

Table 94. Statistical tests used in the analysis of the 2008/09 peanut varietal trials

Station	*Row/Col effects*	*Grid*	*Test*	*Type*
Betano	No	Regular	ANOVA	One-way in Randomized blocks
Loes	Yes, Col	Regular	REML	AR1 Random &Linear on Column
Baucau	Yes, both	Regular	REML	AR1 Linear on Row & Column
Maliana	No	Regular	ANOVA	One-way in Randomized blocks
Aileu	No	Irregular	ANOVA	Unbalanced
Betano dry	No	Regular	ANOVA	One-way in Randomized blocks
Loes dry	No	Regular	ANOVA	One-way in Randomized blocks

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 identified using a Simple Linear Regression. The percentage of variability accounted for is equivalent to an adjusted R^2.

Taste tests

Taste tests were organised during farmer field days at the time of harvest at Betano and Loes research stations (wet season)(Table 95). At each site, farmers were presented with yield results and tasted uncooked, boiled and fried peanut samples. In Loes, 15 to 20 people participated to the tests which evaluated all 15 varieties. In Betano, 50 to 60 farmers evaluated all 15 raw (uncooked) samples. Six varieties (two locals plus best yielding varieties) were evaluated cooked. The participants were asked if they liked the variety and if they were willing to plant it. The questionnaire otherwise included questions about oiliness and if the seeds were not dry. These two criteria are highly regarded in peanut quality. For uncooked samples the respondents were also asked if the shells were easy to open. All questions were to answer with a yes or no.

Table 95. Peanut taste tests during farmers' field days, 2009

Station	*Number of varieties tested per preparation*			*Number of participants*	*Proportion of women*
	Uncooked	*Boiled*	*Fried*		
Betano	15	6	6	50 to 60 pers.	10 %
Loes	15	15	15	15 to 20 pers.	16 %

To analyse farmers' preferences, an Unbalanced ANOVA was run over all the results with Variety*Station*Preparation as the treatment factors and with the participants as the blocking factor. Correlations with Simple Linear Regressions were then calculated over the varieties predicted means.

Results

In Baucau, 4 replicates were planted. However, one was severely affected by leaf yellowing and half the plots died. This replicate was therefore excluded from the analysis. The Betano dry season trial was completed until harvest but yields were drastically reduced by dog predation. As a result, yield differences could not be interpreted. Nevertheless, other yield components were measured.

Yields and yield advantages

Table 96 presents the dry pod yields at each site for all tested varieties, as well as the overall yield advantages over the local checks.

The season mean yield across all sites was of 1.3 t/ha, which was also the mean yield for Baucau, Maliana, Loes dry season and Betano, even though the latter was planted with a lower plant density. Loes wet season trials yielded twice as much as the average site yield (2.6t/ha) and the yields at Aileu were extremely low (0.4t/ha). The statistical tests revealed that the varieties yielded significantly differently at each site except in the Loes dry season trial and in Aileu where the coefficients of variation were also found to be high. Aileu received less rainfall and performed lower than the previous year (800mm for an average site yield of 0.4 t/ha this year, against 1200mm and 1.1t/ha in 2007/08). Conversely, Betano and Maliana benefited from much greater rainfall (700mm and 1200mm respectively against 155mm and 980mm during the 2007/08 wet season). Germination rates were variable but general establishment was good with only 12% of the varieties tested being below 5 plants/m² at harvest time.

The top yielding varieties were PT 16, PT 12, Utamua and PT 15 with 1.8-1.5 t/ha, which corresponds to yield advantages of +30 to +55% above locals. However, all performed differently across stations. For instance, Utamua performed well everywhere but below average in Betano. PT 15 showed an opposite pattern by performing moderately everywhere but extremely well in Loes wet season trial (3.7 t/ha). Among the local checks, Bo'ot Loes ("Loes Big") and Mean Betano ("Betano Red") performed the best with 1.2-1.3 t/ha whilst the three other local varieties yielded 1.0 t/ha or below.

Table 96. Peanuts yields and yield advantages, 2008/09

Variety	*Yields (t/ha)*								*Overall yield advantages (%) over locals*
	Betano	*Loes*	*Baucau*	*Maliana*	*Aileu*	*Loes dry*	*Arithmetic means*	*St. dev.*	
PT16	1.7	3.6	1.3	1.8	0.5	1.7	1.8	1.0	56
PT12	1.6	3.0	1.5	1.8	0.3	1.6	1.7	0.9	47
Utamua	0.7	3.1	1.6	1.5	0.6	1.5	1.5	0.9	32
PT15	1.3	3.7	1.1	0.9	0.4	1.3	1.5	1.2	31
PT11	1.4	2.2	1.6	1.4	0.3	1.6	1.4	0.6	27
PT13	1.5	3.2	1.3	0.9	0.6	1.1	1.4	0.9	27
Loc. Bo'ot Loes	0.7	2.9	1.2	1.3	0.5	1.4	1.3	0.9	19
PT19	1.7	2.2	1.4	1.3	0.4	1.0	1.3	0.6	18
PT18	1.4	2.1	1.4	1.6	0.4	1.1	1.3	0.6	17
PT20	1.6	2.2	1.5	0.6	0.5	1.2	1.3	0.7	11
Loc. Mean Betano	1.6	2.6	0.8	0.9	0.4	1.0	1.2	0.8	9
PT14	0.9	2.0	1.0	1.4	0.6	1.1	1.2	0.5	4
PT17	0.6	1.7	1.4	1.5	0.3	1.5	1.2	0.6	4
Loc. Darasula	0.9	1.8	1.1	0.7	0.4	1.2	1.0	0.5	-10
Loc. Maliana				1.0			1.0	-	-12
Loc. Bo'ot Betano	0.7	2.5	0.3	0.8	0.4	0.8	0.9	0.8	-18
F prob	*<.001*	*<0.001*	*<0.001*	*<.001*	*0.677*	*0.590*			
%CV	*28*	*3*	*9*	*26*	*46*	*39*			
l.s.d.	*0.5*	*1.0*	*0.4*	*0.5*	*ns*	*ns*			
Mean site	1.2	2.6	1.2	1.2	0.4	1.3	1.3	0.7	-
Mean locals	1.0	2.5	0.8	1.0	0.4	1.1	1.1	0.7	-

The results were re-examined on dry seed yields (without shell) which were available for Betano, Aileu and Loes wet season trials. A linear regression (Figure 26) revealed a 98% coefficient of correlation between the seed yields and the pod yields indicating that there was a very close correlation between seed and pod yield. The average seed yield across the three stations was found to be of 1.1 t/ha, which corresponded to shelling percentages averaging 70%.

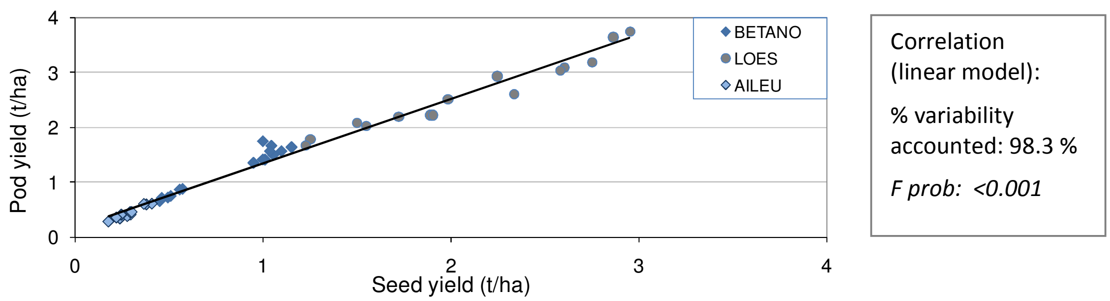

Figure 26. Correlation between pod yields and seed yields, peanut 2008/09

Yield components and other parameters

Grand means within and across stations for yield components are summarized in Table 97, as are correlations with the yields. The predicted means for the yield components and the other measured parameters are detailed in Table 97 and Table 98 and plotted in the graphs of Figure 27.

Table 97. Yield components grand means within and across stations, peanut 2008/09

Stations	*Plant /m²*	*Pods /plant*	*Weight of pods (g/100)*	*Number of seeds /pod*	*Weight of seeds (g/100)*	*% of good pods*	*Shelling (% dry weight)*	*Seed yield (t/ha)*
Betano	5.7 **	14.0 **	126 **	2.0 **	43 **	48 **	67	0.8 **
Loes	6.3 **	25.6 *	166 **	2.1 *	66 **	76 **	80	2.1 **
Baucau	9.2 **	10.4 **	142 **		55 **	45 **		
Maliana	6.0 **	22.2 **	153 **		52 **			
Aileu	7.4 *	3.8	161 **	1.7	60 **	43	63	0.3
Betano dry	6.3 **	16.7	154 **	1.9 **	58 **	50	70 **	
Loes dry	5.3	19.7 *	113 *	1.2		48		
Grand Mean across stations	6.6	16.1	145	1.8	56	52	70	1.1
Correlation with pods yield (%)	-	*51.1 ***	-	*8.7 **	-	*38.9 ***	*63.3 ***	*98.8 ***

ANOVA/REML on varieties (within station only) and Linear regressions: ** significant at F prob ≤0.001
* significant at F prob <0.050

Table 98. Peanut yields and yield components, replicated trials 2008/09

Site	Variety	Dry pod yield (t/ha)	Plants /m²	Pods/ plant	Weight of 100 pods (g)	No of seeds /pod	Weight of 100 seeds (g)	% of good pods	Shell (% dry weight)	Site	Dry pod yield (t/ha)	Plants /m²	Pods/ plant	Weight of 100 pods (g)	No of seeds /pod	Weight of 100 seeds (g)	% of good pods	Shell (% dry weight)
BETANO	PT16	1.7	6.0	18.0	128	2.1	33.8	46.9	57.6	BETANO DRY		6.7	17.4	128	1.8	49.6	52.1	70.1
	PT12	1.6	5.6	17.2	133	1.8	51.4	41.6	70.6			6.1	17.7	149	1.8	59.3	55.2	71.9
	Utamua	0.7	6.8	5.1	156	1.9	58.0	1.3	68.8			4.0	15.8	192	1.7	74.2	44.3	66.7
	PT15	1.3	6.1	16.0	108	2.0	38.1	37.0	70.2			7.0	14.9	140	1.9	51.4	54.8	69.3
	PT11	1.4	5.2	21.0	98	1.8	38.6	37.5	71.5			6.2	21.3	146	1.9	53.7	41.8	71.9
	PT13	1.5	6.1	18.9	101	1.9	37.7	41.0	70.3			7.1	19.7	132	1.9	50.1	41.3	74.0
	L. Bo'ot Loes	0.7	5.5	6.2	154	2.5	40.7	67.7	64.6			6.9	8.6	184	2.3	52.5	62.1	66.1
	PT19	1.7	5.7	19.2	127	1.9	40.1	54.4	62.0			5.7	22.5	148	1.8	59.4	45.5	70.7
	PT18	1.4	5.6	15.4	125	1.8	48.6	33.7	70.5			6.0	23.2	141	1.7	56.1	48.6	66.6
	PT20	1.6	6.0	20.1	100	1.9	36.0	62.5	66.4			6.8	17.7	145	2.0	55.0	52.2	74.0
	L. Mean Bet.	1.6	5.3	14.1	154	2.2	52.0	69.9	70.0			6.8	12.9	167	2.2	56.9	48.0	73.8
	PT14	0.9	6.3	9.4	112	1.9	37.5	41.7	64.2			6.1	16.0	143	1.9	54.2	58.2	70.2
	PT17	0.6	3.1	14.5	131	1.8	51.1	36.7	69.0			6.1	13.8	160	1.8	61.4	37.3	70.0
	L. Darasula	0.9	6.2	7.8	137	2.1	43.8	77.6	65.4			6.4	20.2	167	1.6	83.2	47.8	71.5
	L. Bo'ot Bet.	0.7	6.2	7.6	119	2.1	39.7	76.2	68.4			7.0	9.2	163	2.0	56.2	56.8	69.9
	MEAN	1.2	5.7	14.0	126	2.0	43.1	48.4	67.3			6.3	16.7	154	1.9	58.2	49.7	70.5
	F prob	*<.001*	*<.001*	*<.001*	*<.001*	*<.001*	*<.001*	*<.001*	*0.194*	*F prob*		*<.001*	*0.298*	*<.001*	*<.001*	*<.001*	*0.114*	*<.001*
	%CV	*28*	*16*	*35*	*16*	*8*	*11*	*30*	*20*	*%CV*		*12*	*48*	*10*	*10*	*15*	*22*	*8*
	lsd	*0.5*	*1.3*	*7.0*	*28*	*0.2*	*6.9*	*20.8*	*ns*	*lsd*		*1.1*	*ns*	*22*	*0.3*	*12.3*	*ns*	*3.4*

Site	Variety	Dry pod yield (t/ha)	Plants /m²	Pods/ plant	Weight of 100 pods (g)	No of seeds /pod	Weight of 100 seeds (g)	% of good pods	Shell (% dry weight)	Site	Dry pod yield (t/ha)	Plants /m²	Pods/ plant	Weight of 100 pods (g)	No of seeds /pod	Weight of 100 seeds (g)	% of good pods	Shell (% dry weight)
LOES	PT16	3.6	7.0	34.2	150	2.3	52.0	87.3	79.4	LOES DRY	1.7	5.7	24.3	106	1.4		50.4	
	PT12	3.0	7.3	24.6	154	1.9	66.0	73.1	81.1		1.6	5.5	21.7	111	1.2		63.3	
	Utamua	3.1	5.7	24.3	226	1.8	99.4	77.9	79.3		1.5	5.5	10.9	192	1.7		31.7	
	PT15	3.7	5.6	36.9	182	1.8	81.0	84.2	79.8		1.3	4.4	31.5	98	1.2		43.8	
	PT11	2.2	7.1	24.8	142	1.8	63.7	66.3	82.0		1.6	4.0	19.3	113	1.2		54.3	
	PT13	3.2	8.0	25.8	136	2.1	56.3	79.8	84.2		1.1	5.9	14.7	108	1.2		39.1	
	L. Bo'ot Loes	2.9	6.9	20.6	184	2.6	55.3	76.6	78.6		1.4	6.5	15.5	125	1.3		57.5	
	PT19	2.2	6.8	19.2	167	2.1	65.7	75.9	82.9		1.0	6.3	29.3	82	1.1		45.2	
	PT18	2.1	5.8	23.5	157	1.8	68.3	79.2	78.2		1.1	4.7	19.7	120	1.2		46.3	
	PT20	2.2	5.2	28.5	149	1.9	65.0	57.1	82.2		1.2	3.9	14.8	93	0.8		43.5	
	L. Mean Bet.	2.6	5.4	36.9	147	2.5	60.7	78.6	83.8		1.0	5.1	15.9	141	1.3		46.0	
	PT14	2.0	6.9	28.9	131	1.6	63.0	71.1	77.0		1.1	5.9	16.4	82	0.9		34.9	
	PT17	1.7	5.5	18.4	195	2.1	72.0	81.1	76.0		1.5	4.9	29.3	101	1.1		55.8	
	L. Darasula	1.8	4.8	16.4	178	2.2	65.0	81.1	79.2		1.2	5.9	13.7	134	1.2		60.0	
	L. Bo'ot Bet.	2.5	6.2	20.7	194	2.5	60.0	76.7	78.3		0.8	6.0	17.9	86	0.8		53.1	
	MEAN	2.6	6.3	25.6	166	2.1	66.2	76.4	80.1		1.3	5.3	19.7	113	1.2		48.3	
	χ^2 prob	*<.001*	*<.001*	*0.006*	*<.001*	*0.005*	*<.001*	*<0.001*	*0.844*	*F pr*	*0.59*	*0.173*	*0.005*	*0.015*	*0.493*		*0.1*	
	Wald/df(14)	*2.71*	*2.77*	*2.19*	*3.07*	*2.23*	*6.45*	*3.28*	*0.63*	*%CV*	*39*	*22*	*32*	*27*	*35*		*25*	
	lsd	*1.0*	*0.0*	*12.4*	*43*	*0.6*	*12.9*	*11.7*	*ns*	*lsd*	*ns*	*ns*	*10.4*	*25*	*ns*		*ns*	

Site	Variety	Dry pod yield (t/ha)	Plants /m²	Pods/ plant	Weight of 100 pods (g)	No of seeds /pod	Weight of 100 seeds (g)	% of good pods	Shell (% dry weight)	Site	Dry pod yield (t/ha)	Plants /m²	Pods/ plant	Weight of 100 pods (g)	No of seeds /pod	Weight of 100 seeds (g)	% of good pods	Shell (% dry weight)
BAUCAU	PT16	1.3	10.0	9.8	140		47.6	29.6		MALIANA	1.8	7.7	25.1	140		42.4		
	PT12	1.5	9.8	14.1	129		45.1	56.3			1.8	7.3	27.6	160		59.2		
	Utamua	1.6	10.1	7.6	203		110.8	56.3			1.5	4.3	32.5	220		72.0		
	PT15	1.1	10.5	9.2	117		57.0	56.3			0.9	4.6	19.8	142		55.2		
	PT11	1.6	9.2	13.9	121		47.9	56.3			1.4	7.0	20.1	127		49.8		
	PT13	1.3	9.0	14.2	134		45.8	37.0			0.9	6.8	13.5	120		39.6		
	L. Bo'ot Loes	1.2	9.6	8.3	144		50.3	44.5			1.3	7.9	14.8	180		47.2		
	PT19	1.4	9.4	11.0	138		62.2	60.3			1.3	6.3	16.4	140		49.7		
	PT18	1.4	8.5	14.0	139		58.9	60.5			1.6	6.1	28.0	160		60.9		
	PT20	1.5	9.5	12.0	132		51.2	16.7			0.6	3.0	31.2	133		53.3		
	L. Mean Bet.	0.8	8.6	5.9	131		45.5	50.8			0.9	6.7	22.1	167		48.7		
	PT14	1.0	8.3	10.5	108		52.3	26.5			1.4	6.2	33.0	133		45.9		
	PT17	1.4	9.0	11.6	156		53.5	28.7			1.5	4.9	18.9	167		59.4		
	L. Darasula	1.1	9.8	9.3	185		47.8	53.2			0.7	4.7	17.5	140		45.7		
	L. Maliana										1.0	5.6	15.3	173		46.8		
	L. Bo'ot Bet.	0.3	6.7	5.3	149		51.6	40.9			0.8	6.4	19.9	142		52.3		
	MEAN	1.2	9.2	10.4	142		55.2	44.9			1.2	6.0	22.2	153		51.8		
	χ^2 prob	*<.001*	*0.001*	*<.001*	*<.001*		*<.001*	*<.001*		*F pr*	*<.001*	*<.001*	*0.001*	*<.001*		*<.001*		
	Wald/df	*9.1*	*2.6*	*4.5*	*2.8*		*16.7*	*4.1*		*%CV*	*26*	*20*	*27*	*9*		*8*		
	lsd	*0.4*	*1.7*	*4.8*	*44*		*11.2*	*21.8*		*lsd*	*0.5*	*1.9*	*9.8*	*24*		*7.1*		

Site	Variety	Dry pod yield (t/ha)	Plants /m²	Pods/ plant	Weight of 100 pods (g)	No of seeds /pod	Weight of 100 seeds (g)	% of good pods	Shell (% dry weight)
AILEU	PT16	0.5	6.8	4.6	157	1.8	58.1	47.5	65.6
	PT12	0.3	6.1	3.8	158	1.7	65.2	45.4	66.9
	Utamua	0.6	7.1	3.4	257	1.5	106.2	36.0	62.1
	PT15	0.4	7.9	3.5	150	1.7	60.5	41.0	69.4
	PT11	0.3	7.6	3.6	119	1.5	44.9	31.6	57.1
	PT13	0.6	7.9	4.7	165	1.7	64.3	56.9	66.8
	L. Bo'ot Loes	0.5	6.5	4.6	163	2.1	52.3	40.8	66.4
	PT19	0.4	7.0	3.8	151	2.0	53.7	36.0	70.3
	PT18	0.4	6.7	4.1	152	1.8	59.7	49.4	68.6
	PT20	0.5	7.6	4.0	145	1.8	49.9	45.1	63.5
	L. Mean Bet.	0.4	8.0	2.9	184	1.7	61.1	50.0	56.0
	PT14	0.6	7.6	5.7	143	1.6	51.6	46.8	58.6
	PT17	0.3	7.0	2.1	153	1.5	57.4	41.4	55.4
	L. Darasula	0.4	7.8	3.4	162	1.9	55.3	38.8	64.7
	L. Bo'ot Bet.	0.4	9.4	2.7	161	1.8	54.5	45.6	59.7
	MEAN	0.4	7.4	3.8	161	1.7	59.6	43.5	63.4
	F prob	*0.677*	*0.007*	*0.655*	*<.001*	*0.308*	*<.001*	*0.881*	*0.278*
	%CV	*46*	*10*	*44*	*16*	*15*	*17*	*35*	*21*
	lsd	*ns*	*1.2*	*ns*	*42*	*ns*	*17.1*	*ns*	*ns*

Table 99. Peanut parameters and diseases impact, replicated trials 2008/09

Site	Variety	% emergence at 2-5 weeks	% plants with yellow-ing leaves at 2-3 months	% plants with rotten roots	% plants with spot-ted leaves	% plants with rusted leaves	% dead plants at harvest	Site	% emergence at 2-5 weeks	% plants with yellow-ing leaves at 2-3 months	% plants with rotten roots	% plants with spot-ted leaves	% plants with rusted leaves	% dead plants at harvest
BETANO	PT16	57.8	10.7	1.2	3.6	2.1	4.3	BETANO DRY	86.9	2.6	2.5	3.2	2.8	6.3
	PT12	65.0	6.3	1.2	2.7	3.1	3.0		78.1	1.7	3.1	2.1	3.0	4.7
	Utamua	60.0	4.9	0.2	3.7	4.6	4.9		52.5	3.3	3.8	0.7	7.0	10.8
	PT15	68.2	9.6	0.6	2.3	8.9	6.5		88.8	5.5	0.4	1.3	2.9	6.2
	PT11	46.0	8.0	1.8	2.9	3.3	9.5		86.9	1.4	2.4	2.1	4.1	9.2
	PT13	58.8	7.4	1.0	2.7	4.5	4.0		93.1	6.1	4.0	1.1	3.8	7.7
	Loc. Bo'ot Loes	58.9	23.8	0.2	1.0	12.7	11.4		91.1	4.9	0.7	0.9	5.2	1.9
	PT19	69.7	6.5	1.9	4.3	4.7	9.0		83.1	1.8	8.4	0.9	5.3	7.6
	PT18	68.1	11.6	0.8	3.5	6.5	12.9		91.7	3.2	5.9	1.3	6.1	9.4
	PT20	55.2	8.6	0.6	2.7	3.0	4.4		91.4	2.5	1.8	1.6	2.5	8.0
	Loc. Mean Betano	62.1	12.6	1.3	0	12.6	5.7		93.0	2.5	5.8	1.3	4.2	4.4
	PT14	60.0	2.8	0	1.1	21.8	0.8		88.8	2.8	0.5	2.2	20.5	5.8
	PT17	18.3	27.5	5.1	3.8	4.8	7.9		92.2	2.0	4.2	1.5	8.1	12.5
	Loc. Darasula	57.0	9.6	0.4	1.4	14.8	5.0		92.0	3.5	0.5	2.0	4.1	3.7
	Loc. Bo'ot Betano	66.0	22.9	0.5	0.4	18.2	8.0		90.0	0.5	0.3	2.0	5.5	3.0
	MEAN	58.1	11.5	1.1	2.4	8.4	6.5		86.6	2.9	3.0	1.6	5.7	6.7
	F prob	*<.001*	*<.001*	*0.044*	*0.045*	*<.001*	*0.752*	*F prol*	*<.001*	*0.719*	*<.001*	*0.362*	*<.001*	*0.080*
	%CV	*20*	*63*	*158*	*80*	*51*	*120*	*%CV*	*5*	*123*	*71*	*77*	*63*	*66*
	lsd	*16.6*	*10.3*	*2.5*	*2.7*	*6.0*	*ns*	*lsd*	*6.1*	*ns*	*3.0*	*ns*	*5.1*	*ns*
LOES	PT16	53.0	1.5	2.9				LOES DRY	15.8	1.6				
	PT12	64.1	2.5	2.2					17.4	3.5				
	Utamua	52.0	4.5	1.2					18.0	0.3				
	PT15	23.8	3.6	2.5					2.3	2.3				
	PT11	56.8	5.1	4.2					5.5	1.1				
	PT13	71.4	1.6	0.2					18.0	0.3				
	Loc. Bo'ot Loes	66.6	0.8	1.6					24.7	4.2				
	PT19	44.2	1.8	1.0					11.3	0				
	PT18	44.9	0.9	3.0					8.7	1.3				
	PT20	41.9	0	0.5					7.3	0.0				
	Loc. Mean Betano	55.1	2.3	2.4					17.1	4.8				
	PT14	41.8	5.5	1.4					22.3	0.3				
	PT17	38.3	5.2	3.5					17.9	1.6				
	Loc. Darasula	28.1	2.7	1.8					22.9	3.1				
	Loc. Bo'ot Betano	57.9	0.1	0.2					15.2	2.9				
	MEAN	49.3	2.5	1.9					15.0	1.8				
	χ^2 prob	*<.001*	*<.001*	*0.033*				*F pr*	*0.056*	*0.344*				
	Wald/df (14)	*2.95*	*5.71*	*1.8*				*%CV*	*54*	*138*				
	lsd	*23.2*	*2.6*	*3.0*				*lsd*	*ns*	*ns*				
BAUCAU	PT16	82.9	3.2				1.2	MALIANA		2.4				1.4
	PT12	78.2	1.2				1.0			1.7				1.0
	Utamua	81.8	3.6				0.9			1.8				0.8
	PT15	90.4	2.6				0.9			3.8				2.2
	PT11	76.9	1.0				0.1			1.6				1.3
	PT13	87.0	1.8				1.2			2.4				2.1
	Loc. Bo'ot Loes	89.7	2.6				1.2			0.3				3.3
	PT19	79.7	2.5				0.9			2.6				0.9
	PT18	73.8	3.0				1.7			2.7				2.0
	PT20	89.7	1.5				0.9			9.0				1.6
	Loc. Mean Betano	78.2	1.2				1.2			1.2				1.5
	PT14	85.2	1.0				0			1.8				1.2
	PT17	90.5	3.1				1.7			2.5				1.9
	Loc. Darasula	94.4	1.5				1.0			2.0				2.5
	L. Maliana									2.4				2.0
	Loc. Bo'ot Betano	78.2	7.6				1.7			1.4				0.8
	MEAN	83.8	2.5				1.0			2.5				1.6
	χ^2 prob	*0.006*	*0.024*				*<0.001*	*F pr*		*0.200*				*0.900*
	Wald/df	*2.19*	*1.88*				*2.65*	*%CV*		*111*				*99*
	lsd	*12.6*	*3.6*				*0.9*	*lsd*		*ns*				*ns*

Most yield components showed significant varietal differences (Table 98). Exceptions included shelling percentages (see Figure 26 above). Emergence rates varied strongly among stations, from an average of 15% in the Loes dry season trial to 85% in the Betano dry season and Baucau wet season trials (Table 99). This parameter was strongly correlated to the plant density at harvest (average: 6.6 plants/m²) (Figure 27). However, neither emergence rate nor plant density was overall correlated to the yield.

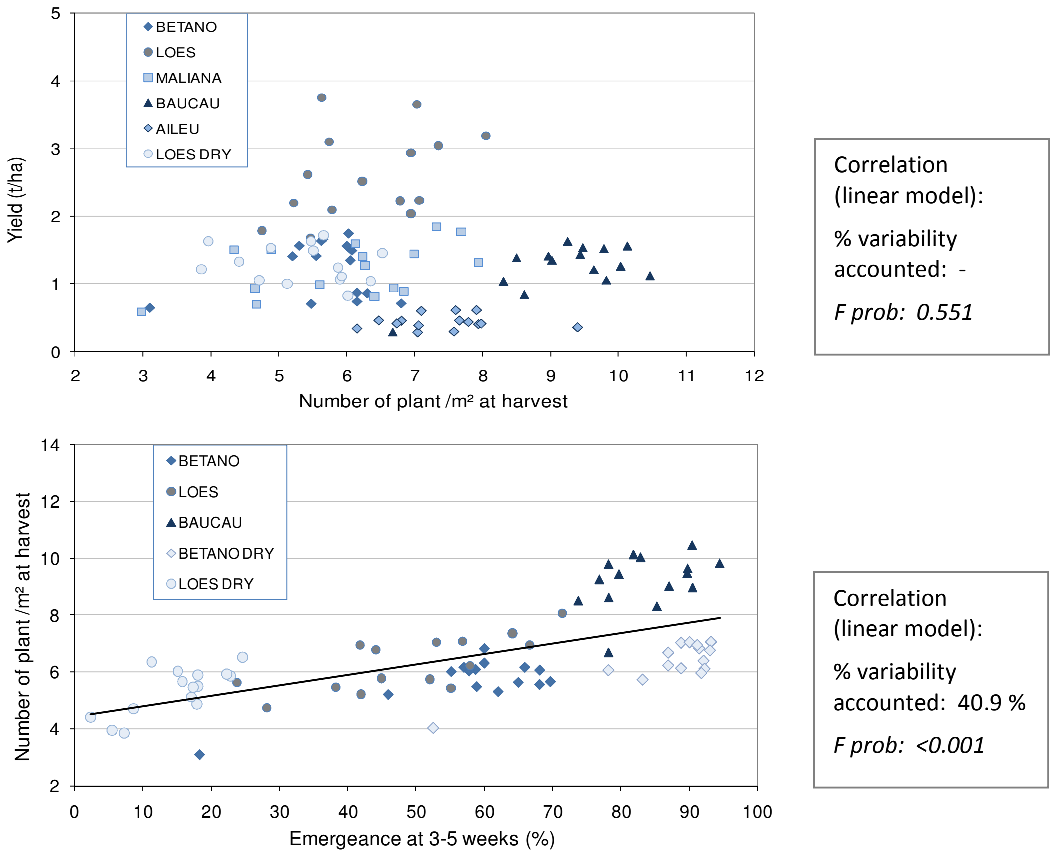

Figure 27. Plant density correlations, peanut 2008/09

The components which proved to be both significantly and highly correlated with the yield were the shelling percentage (63% of variability accounted for), the percentage of good pods (39%) and the number of pods per plant (51%), as shown in the graphs of Figure 28. The latter component showed the most often significant varietal differences within stations. Four of the five local varieties and, interestingly, Utamua, had the lowest number of pods per plant (9 to 14). The best yielding varieties of PT 16, PT 12, PT 15 and PT 11, had 17 to 19 pods per plant.

It can be noted that the local varieties, with the exception of Local Maliana, had the highest percentages of good pods (57-60%) compared to the average (52%).

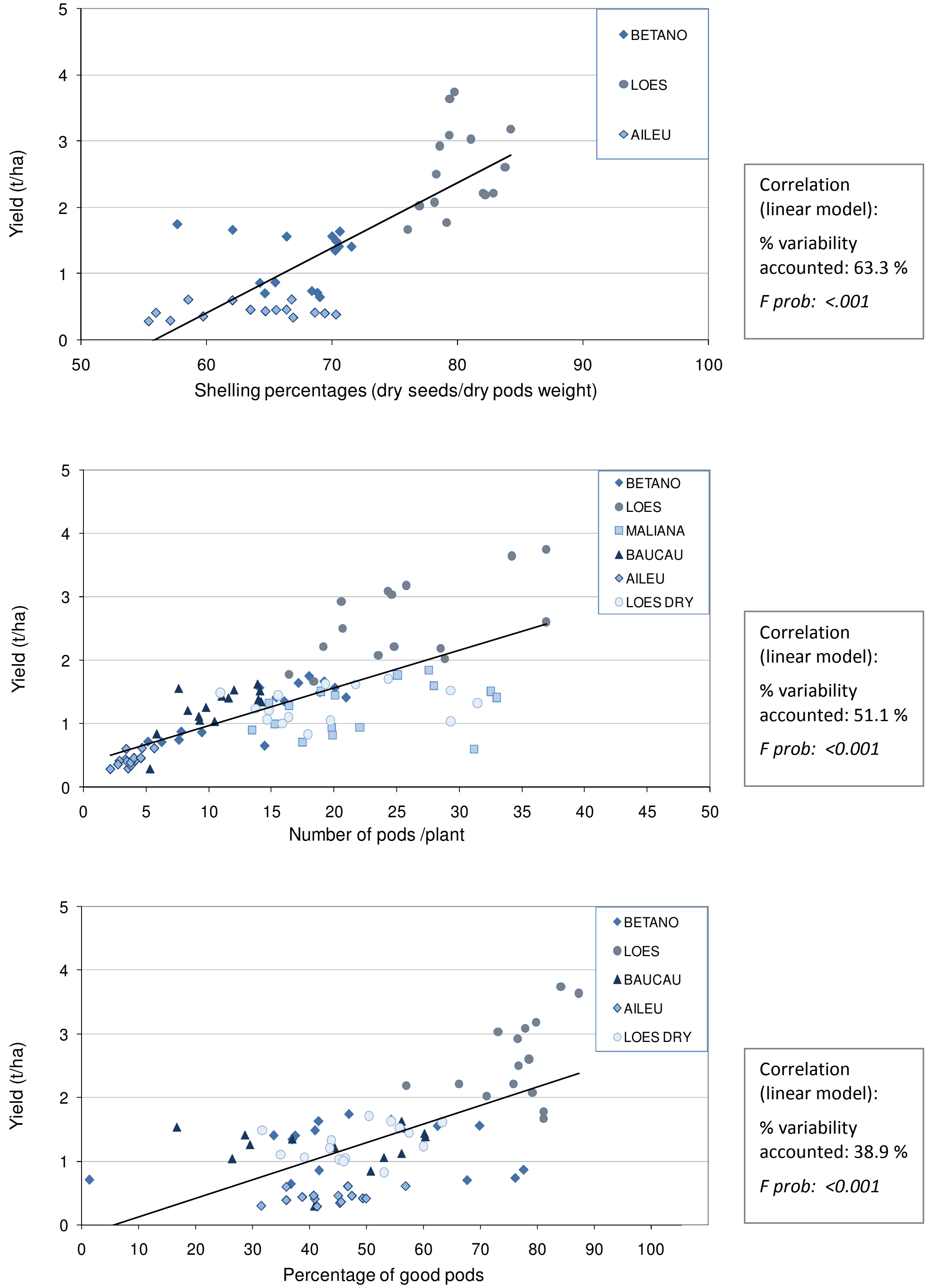

Figure 28. Correlations between peanut dry pods yields and yield components, 2008/09

In comparison with the previous parameters, the number of seeds per pod showed little correlation to yield (adjusted R^2=0.9), p=0.013). Seed weight and pod weight was not correlated to yield. However, those two yield components showed significant varietal differences within stations. This is because Utamua outweighed the averages of the other varieties by 46% for the pods weight and by 63% for seed weight (Table 100), thus strongly counterbalancing its lower number of pods per plant. However, no correlation was found between the number of seeds per pod and the seed weight.

Table 100. Comparison of the weight of pods and seeds, peanut 2008/09

Varieties, all stations	*Weight of pods (g/100)*	*Weight of seeds (g/100)*
Utamua	207	87
Average other varieties	142	53

Plant mortality and root and foliar diseases were recorded for half the trials (Table 99). These parameters sometimes showed varietal differences within stations but their impacts were too low to record any meaningful correlation with yields or plant mortality.

Significant varietal differences of yellowing leaf disease impact were found in both the Betano and Loes wet season trials. PT 17 was the highest or second highest affected variety, however no significant trend was detected so far. In the Betano wet season trial, a significant correlation was found between the plant mortality recorded at harvest and the occurrence of yellowing leaves disease (adjusted R^2=22%, p=0.043, Figure 29). This trial was the only one significantly affected, with 12% of plants presenting symptom of the yellowing leaves disease (against 2-3% for the other trials).

Betano was also the only location were rust occurred, during both dry and wet season trials (about 7% of the plants). For the later trial, a negative correlation between the yields and the percentages of plants affected by leaf rust was found (adjusted R^2=26%, p=0.031, Figure 29). Both trials showed a significant varietal difference (p <0 .001) with PT 14 being by far the most affected variety.

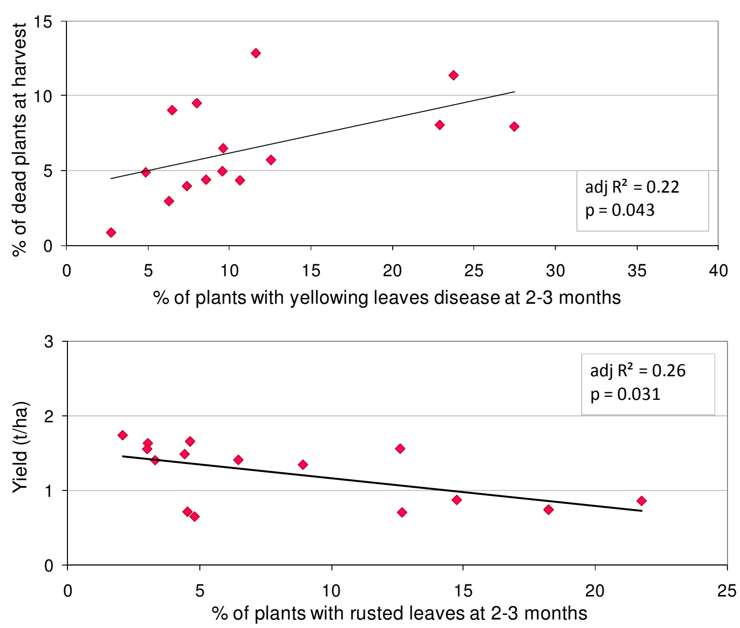

Figure 29. Correlations involving peanut foliar diseases for Betano wet season, 2008/09

Taste tests

The results of the Unbalanced ANOVA for taste tests of peanuts at farmer field days at Loes and Betano are presented in Table 101

Table 101.Unbalanced ANOVA results for the variate "Like", peanut FFD 2009

Factors	*P value*
Variety	<.001 ✓
Station	1.000
Preparation	0.210
Variety.Station	0.003 ✓
Variety.Preparation	<.001 ✓
Station.Preparation	0.657
Var.Prep.Station	0.645

Note: Participants as the blocking factor

The ANOVA results indicate that the farmers participating in the farmer field day significantly appreciated the differences in variety. The interactions Variety x Station and Variety x Preparation were also significant. However, the latter was mainly due to PT 17 and 18, among the least overall appreciated varieties, which were much more preferred (+20%) fried than, respectively, uncooked and boiled. The significant interaction Variety x Station was due to the fact that, unlike in Betano, no varietal effect was detected in Loes. The factors Station (Betano, Loes) and Preparation (Uncooked, Boiled, Fried) were not significant at all. This demonstrated that neither the location nor the way the peanuts were cooked impacted the overall appreciation of the peanuts by farmers.

The results for the variety factor as well as correlations are detailed in Table 102.

Table 102.Farmers' preferences (%) after peanut taste tests, peanut FFD 2009

Variety	*Like*	*Willing to plant*	*Big seeds*	*Oily*	*Not drying*	*Easy to open***
PT 16	91	42	27	87	73	84
L.Mean Bet.	89	40	38	86	76	77
PT 15 *	85	13	53	88	66	61
L.Loes *	84	13	41	80	75	63
L. Bo'ot Bet. *	83	8	35	82	67	60
Utamua	78	25	92	68	63	77
PT 20 *	77	8	42	70	61	45
PT 12	76	15	57	80	71	65
PT 14	75	21	26	71	60	24
PT 11 *	73	6	26	70	53	68
L.Darasula *	68	9	26	72	69	49
PT 18 *	61	4	51	67	50	68
PT 13 *	58	8	17	66	61	61
PT 19	58	9	45	57	50	61
PT 17 *	52	2	38	63	52	51
F prob	<.001	<.001	<.001	<.001	<.001	<.001
%CV	50	0	96	55	62	73
l.s.d.	11	11	12	12	12	14
Correlation) with "Like", (linear model) F prob		0.004	0.684	<.001	<.001	0.228
% variability accounted for		44.6	-	75.9	57.4	-
s.e.		8.9	ns	5.9	7.8	ns

* Tested for the "boiled" and "fried" preparations at Loes only.
** Tested in both locations for the "uncooked" preparation only. Correlation with the corresponding "Like" results. ANOVA on Var+Var.Station (others: Var+Var.Prep+Var.Station)

The lower percentages of people expressing their willingness to plant varieties (maximum of 40% for PT 16 and Local Mean Betano, 25-20% for Utamua and PT 14) were the results of many participants being just neutral or indecisive. With the exception of PT 17, 19 and 13, the test entries had nevertheless all been appreciated by more than 60% of the participants. The most liked varieties were PT 16 and local Mean Betano with 90% of farmers approvals, followed by PT 15, Local Loes, Local Bo'ot Betano and Utamua (85% to 80% approval). For that general criterion, PT 16 and Local Mean Betano performed significantly better than 77% of the other varieties and better than all of them regarding the farmers' willingness to plant them (Utamua coming third). The two top varieties were, with Utamua, considered to be easy to open by the more many people (about 80%). Eventually, no distinct pattern between local/new varieties emerged for any of the tested criteria.

About 10% of the participants were women, which did not allow for gender segregation of the results this year.

The size of seeds and the ease of shelling showed no significant correlation with farmers willingness to plant a variety, and nor did yield performances (Figure 30). Conversely, the importance of the taste qualities of the varieties was demonstrated by the strong correlation (adjusted R^2 of 45%, p=0.004) between the willingness to plant a variety and the general taste criteria (Like). The latter proved in return to be highly correlated with the "oiliness" and "not dry" criteria (65% and 57% respectively of variability explained, Figure 31), confirming their suitability in the questionnaire.

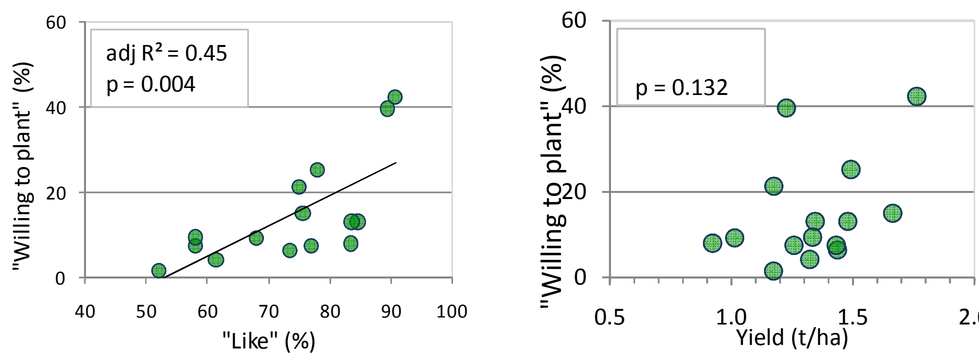

Figure 30. Correlation between farmer's preference and peanut performance.

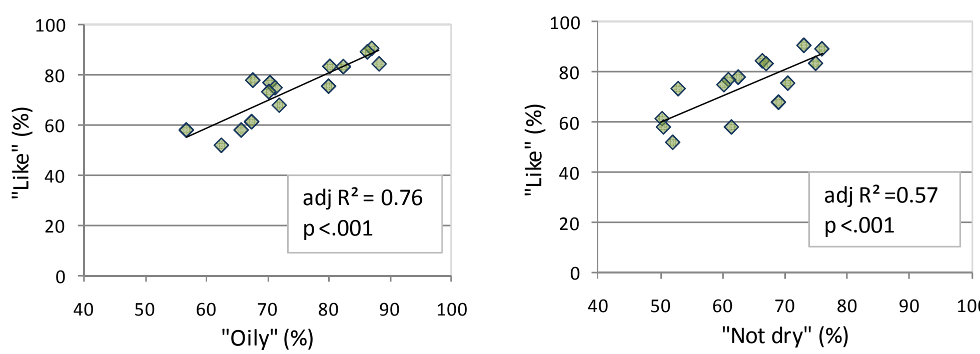

Figure 31. Correlations between farmers' taste preferences for peanuts

Conclusions

This year's best yielding varieties were PT16, PT12, Utamua and PT15, which performed 55-30% respectively above the local checks. Both PT16 and PT15 are newly introduced varieties and were highly appreciated by farmers in farmer field day evaluations, confirming the success of the entry selection process.

This results of this year's replicated trials also proved that dry pod yield is an excellent estimator of seed yield. With respect to other parameters, several yield components were found to be correlated with pod yield, in particular the number of pods per plant which often showed varietal differences. Focus could therefore be put on this component in order to screen promising varieties – as well as looking for individual exceptions, as proved to be Utamua for which the major trait is undoubtedly its large sized seeds.

Despite its promise, PT 14 proved to be rust sensitive in 2009 and should therefore be discarded from further evaluation. It could however been kept in the germplasm collection as an indicator variety, in order to detect early occurrences of rust leaf disease.

The results of the farmer field day evaluations this year showed that, in some cases, cooking preparation influenced the appreciation of peanut varieties by farmers, but this did not seem to impact on the preferred entries. Moreover, results confirmed that the "Oily" and "Not dry" criteria are central characteristics of appreciation, and that the latter is an essential component of farmers' willingness to plant a new varieties in their fields. Farmers choose a variety upon a whole range of attributes, not upon their yield performances alone.

2.2.2 Peanut replicated trials, multi-year and multi-location analysis

Materials and methods

Seventeen successful peanut trials (including two dry season trials) were implemented over the period from 2005 to 2009 (4 years) at 5 different sites (Betano, Baucau, Maliana, Aileu and Loes), testing the performances of 17 varieties. Some varieties were not included in all trials (in particular the recent local additions) and some trials were not performed at every site every year. Mean yields by available site are presented in Table 103.

Mean site yield performances varied from 0.4t/ha to a maximum of 3.1t/ha (Baucau wet season 2007), with about half the sites performing within the 1.0-1.5 t/ha range. In both Aileu and Betano, wet season yields varied according to the amount of received rainfall.

With the exception of GN11 which was discarded after one evaluation due to its very poor performance, all imported varieties performed well overall with mean yields ranging from 1.4t/ha (PT17) to 1.6t/ha (PT15). This corresponds to yield advantages of about +10-30% over a mean of the 5 local checks. Local checks represented 17% of all varieties tested. The released variety Utamua yielded overall yield at 1.5 t/ha (+25% over locals).

Table 103. Peanut mean yields and yield advantages over 2005, 2006, 2008, 2009

Variety	*Number of trials*	*Mean yield (t/ha)*	*St. dev*	*Yield advantages*
Pt15	17	1.6	0.9	28
Pt14	17	1.5	0.8	28
Utamua	16	1.5	0.9	25
Pt16	17	1.5	0.9	24
Pt11	17	1.5	0.9	23
Pt12	17	1.5	0.8	20
Pt18	17	1.4	0.8	19
Pt13	17	1.4	0.8	17
Pt19	17	1.4	0.7	16
Pt20	17	1.4	0.9	13
Pt17	17	1.4	0.7	12
Loc. Bo'ot Loes	6	1.3	0.9	11
Loc. Mean Betano	7	1.2	0.7	-2
Loc. Darasula	17	1.2	0.6	-4
Loc. Maliana	1	1.0	-	-18
Loc. Bo'ot Betano	7	0.8	0.8	-30
GN11	1	0.3	-	-75
Locals	38	1.2	0.6	-
All sites	225	1.4	0.7	-

Cross-site analyses were conducted using BiPlots (GGE BiPlot program) in order to evaluate the performances and consistency of the tested varieties across years and locations (genotype / environment). A limitation of the procedure implied that only complete datasets could be analysed.

Results

The most extensive selection on which to run a BiPlot analysis included 12 varieties (exclusion of the recent local additions) and 16 environments (exclusion of the very first trial of 2005/06 in Baucau). This dataset included 192 data points (season × variety combinations) out of a total of 225, with a lower representation of local checks (8% of the entries against 17% in the complete dataset). However, the results presented too high a degree of variability to be visually represented. Further trials will assist in providing more information to explain this variation.

A second common set of data investigates the performances of fewer environments but more many varieties. The selection included this year's data set and 15 varieties, including 4 local ones representing a fourth of the 90 entries. The corresponding BiPlot analysis is presented in Figure 32. The BiPlot shows the varieties means stability (vector with arrows) versus the environments (vector without arrow), components which accounted for 60% of the variation.

Two groups of environments emerged in the BiPlot analysis. One included the stations where crops received 700-1000mm of rainfall. The other group consisted of two stations where 1200mm and 1700mm of rainfall were recorded as well as the Loes dry season trial which received none during plant growth but performed as well. This underlines the importance of soil moisture content on crop success. The best yielding varieties for the tested environments were PT 16, PT 12 and Utamua. The latter performed equally well in all locations. PT 16 was very consistent also. Conversely, PT 12 performances varied greatly, as did those of PT11, 13 and 17. The local varieties performance was average (Local Bo'ot Loes) or below average, with, like the imported varieties, various results in term of performances consistency across environments.

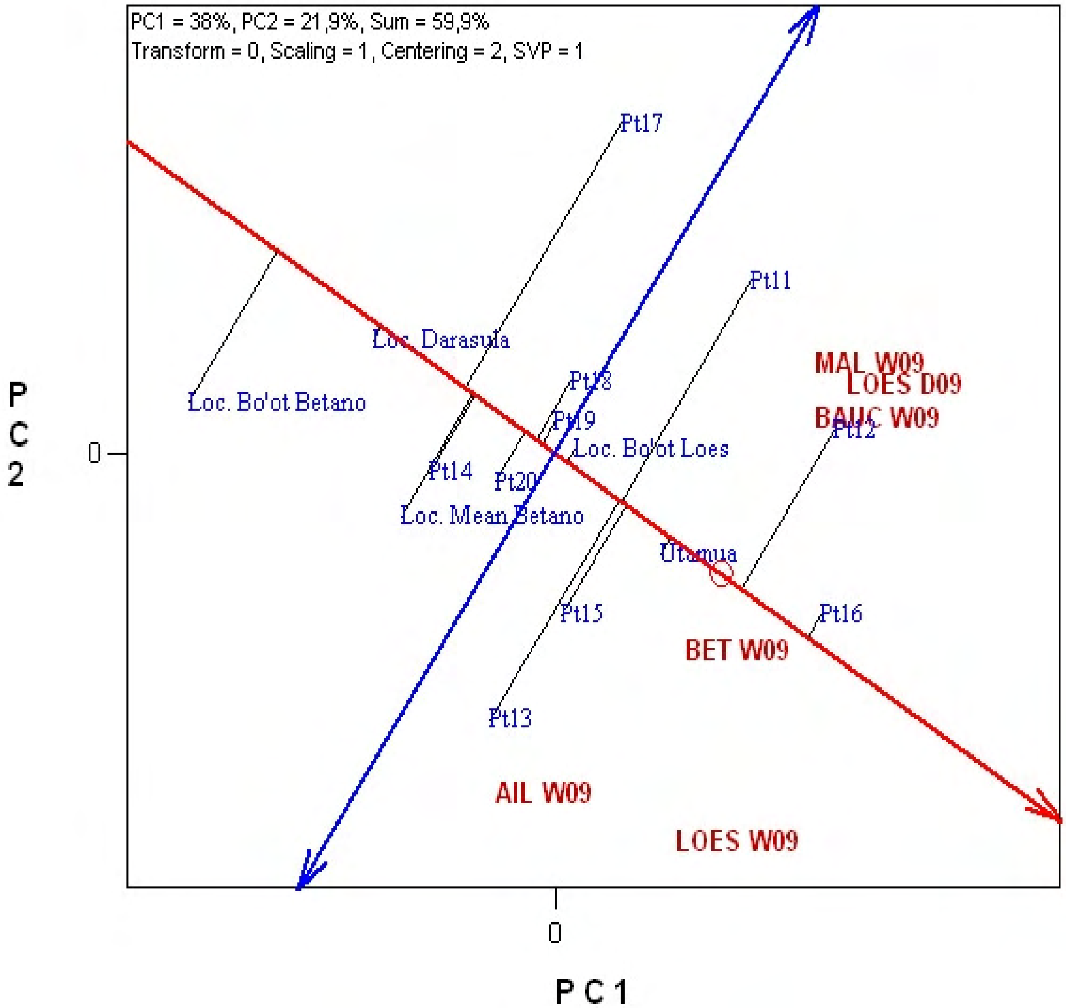

Figure 32. **BiPlot analysis of 15 peanut varieties in 6 environments, 2008/09**

Conclusions

Over 4 years, SoL conducted 17 successful peanut variety trials on 15 varieties, representing a total of 225 individual data points (season × variety combinations). Results varied significantly both by genotype (varieties) and environment (locations and years). As it can be expected, available moisture appears to be a critical factor of the later component.

The collected data allowed selecting, releasing and confirming the Utamua variety as suitable according to production (measured over four years as +25% over locals with exceptional consistency across location for 2008-2009), taste and suitability (OFDTs). The data also allowed selecting two other potential candidates, PT 15 and PT 16 (about +30% overall yield advantages), the consistency and suitability of which are currently being further investigated. PT 12 on the other hand proved to be as high yielding but was not consistent and is less appreciated by farmers.

2.5.2 Peanut On-Farm Demonstration Trials (OFDTs) 2008-2009

Peanut OFDTs were established and monitored in a similar fashion to maize OFDTs, as described in the maize chapter above. The objective of the OFDTs was to see how Utamua, a variety released in 2007 plus two new varieties, PT14 and PT15 performed compared with locally grown varieties in farmers fields. All varieties were cultivated by farmers, in farmers' fields at different locations, using local agronomy.

Utamua is a large seeded peanut variety from India, released by MAF for use by subsistence farmers. The establishment of peanut OFDTs is also a way of distributing small quantities of Utamua seed (released and recommended by MAF) to farmers for their consideration and potential adoption as a food or cash crop. In 2008 when OFDT seed was distributed, a larger quantity of Utamua (800g/farmer) was distributed than in previous years.

Materials and methods

Peanut OFDTs were established in a similar way as described in the 2008 Annual Research Report. The Research Assistants requested farmers to use their traditional planting system with the only exception being advice that pre-soaking of the Utamua seed prior to planting assists in achieving good plant stands.

194 peanut OFDTs were established in 16 Sub-Districts across Timor Leste, in 7 Districts (Aileu, Ainaro, Baucau, Bobonaro, Liquica, Manufahi and Viqueque). Viqueque was entered into for the first time with two staff covering the Sub-Districts of Ossu and Oato Lari. One Research Assistant was present in each Sub-District, with two in Baucau villa. 166 OFDTs were harvested with yield data collected. However much more data was obtained for Utamua and local varieties than PT14 and PT15.

Soil pH and texture were measured using the methodology described in the maize OFDT chapter. Yields were expressed as air dried unshelled pods unless otherwise stated.

Data was entered first into MS Excel and then GenStat Discovery Edition 3 for ANOVA (Unbalanced Model) analysis. Peanut yield data (dry weight in pods, t/ha) was analyzed by ANOVA (Unbalanced Linear Model) with variety and AEZ as constant factors in the model and plant density as a covariant. The ANOVA output was used to test for significant interactions between variety and AEZ. The influence of a wide range of factors on peanut yields was tested using an unbalanced ANOVA design. In turn, a range of factors were added to the model, one at a time. Once a significant factor was identified, the interaction of that factor and variety was also tested for significance at the F Pr. <0.05 level.

Planting and harvesting times

In the Districts tested, the peanut planting season generally started in November, and harvesting was completed by the end of April 2009. Table 104 shows that over 89% of the OFDT sites were planted in November and December 2008, and the majority of OFDT sites were harvested in April.

Table 104. Peanut OFDT planting and harvesting times, 2008/09.

Month	*OFDTs planted (%)*	*OFDTs harvested (%)*
October 2008	1	0
November 2008	38	0
December 2008	52	0
January 2009	9	0
February 2009	0	1
March 2009	0	33
April 2009	0	59
May 2009	0	6
June 2009	0	1

Of the varieties tested in the trials, PT14 had average growth duration of 128 days, Utamua, 126 days, PT15, 123 days and local varieties, 121 days.

Site Characteristics

Peanut OFDTs were conducted on a wide range of elevations, soil pH, textures and slope across the 16 Sub-Districts.

Elevation

The range of elevation of OFDT sites in 2009 was similar to 2008 (Table 105). The addition of sites close to sea level in Oatu Lari Sub-District, Viqueque District was a factor in bringing the average elevation of sites down to 413 meters above sea level (masl) from 578 masl the previous year. The highest sites measured were at Suco Namolaso in Lequidoe Sub-District (1350 masl). 91% of sites were planted at elevations less than 750 masl.

Table 105. Distribution of peanut OFDT sites by elevation (masl), 2006-2009

Elevation (m)	*Locations 2006-07 (%)*	*Locations 2007-08 (%)*	*Locations 2008-09 (%)*
0-150	21	22.7	35.6
150-350	13	9.4	16.7
350-550	13	16.3	14.6
550-750	21	14.3	10.2
750-950	11	19.2	14.0
950-1150	17	9.9	6.5
1150-1350	4	6.9	2.4
>1350	0	1.5	0

Soil pH

The average soil pH across harvested OFDT peanut test sites was 6.7 ranging from 5 to 9.0 (Table 106). This was similar to the previous year (6.8). Approximately 13% of the sites are described as alkaline (pH 8.0 or above) and 19% as acidic (pH 5.5 or less). 67% of the sites had soil pH values between 6.0 and 7.5 inclusive.

Table 106. Distribution of soil pH across peanut OFDT sites, 2006-2009

Soil pH	*Locations 2006-07 (%)*	*Locations 2007-08 (%)*	*Locations 2008-09 (%)*
4.5	2	3	
5.0	3	3	5
5.5	10	11	14
6.0	12	15	10
6.5	12	18	21
7.0	10	20	17
7.5	16	13	20
8.0	17	13	10
8.5	14	3	3
9.0	4	1	1

Aileu district tended to have soils which were more acidic than other districts (Table 107). Like last year, a significant trend between reduced soil pH with increasing elevation was found (Figure 33).

Table 107. Average soil pH and elevation of peanut OFDTs, 2008/09

District	*Sub-District*	*Locations (%)*	*Elevation*	*Soil pH*
Aileu	Aileu Vila	6.2	930	5.6
Aileu	Liquidoe	2.6	1117	5.3
Aileu	Remexio	1.5	961	5.3
Ainaro	Hato hudo	7.2	178	6.9
Baucau	Baucau	10.8	499	6.9
Baucau	Vemasse	6.7	617	6.6
Baucau	Venilale	5.7	818	8
Bobonaro	Cailaco	8.7	142	7
Bobonaro	Maliana	11.3	310	7.4
Liquica	Liquica	7.7	374	6.3
Liquica	Maubara	4.6	337	6.4
Manufahi	Alas	7.7	41	7.3
Manufahi	Same	2.6	368	6.9
Manufahi	Turiscai	2.3	1134	5.7
Viqueque	Oatu Lari	8.7	15	6.6
Viqueque	Ossu	5.7	500	6.1

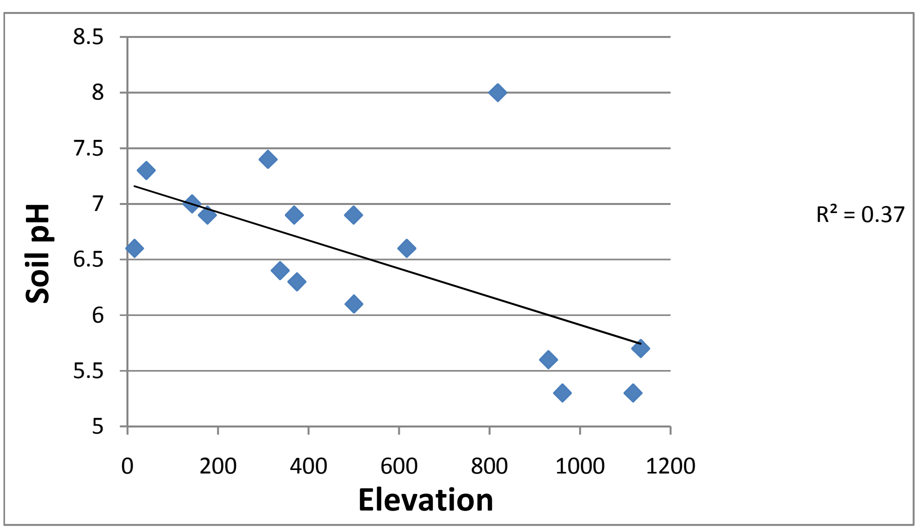

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Figure 33. Mean soil pH versus elevation for peanut OFDT Sub-Districts 2008/09.

Soil texture:

Of the OFDT soils tested, 61% were clay soils with the remainder being loamy or sandy (Table 108).

Table 108. Distribution of soil texture in peanut OFDTs, 2008/09

Soil texture	*Locations (%)*
Sandy	3
Sandy Loam	9
Silty Loam	10
Loam	16
Clay Loam	29
Fine Clay	25
Heavy Clay	8

Results and discussion

A total of 194 peanut OFDTs were established and 166 locations were harvested with results recorded. Some reasons reported for non completion were that farmers did not follow planting directions, that animals damaged the plots or the sites were affected by drought.

Yield

As with previous years, plant density was found to have a significantly positive effect on yield (Table 109). It was therefore included as covariate in the analysis.

Using the model of yield against variety and AEZ with plant density as covariate, there was a significant difference between the Local and Utamua. There was no significant difference between Local and PT14 but the yield advantage of PT15 over Local just reached significance.

Table 109. Yield components of OFDT varieties across all on-farm trials, 2008/09

Variety	*Yield (t/ha)*	*Plant density (plants/m^2)*	*Seed size (g/100 seeds)*	*Yield per plant (g/plant)*
Local	1.1	6.8	57	22
PT14	1.1	4.9	67	42
PT15	1.4	5.6	64	33
Utamua	2.0	6.6	98	40
LSD (P<0.05)	0.28	1.3	12	12

Yield components

Yield continued to increase in all varieties with increasing plant density. There was no interaction between plant density and variety on yield. PT15 did tend towards a higher rate of increase in yield with increasing plant density (Figure 34) but had few data points for plant density beyond 7 plants/m^2. It is therefore important to further investigate if this trend can be substantiated in future years.

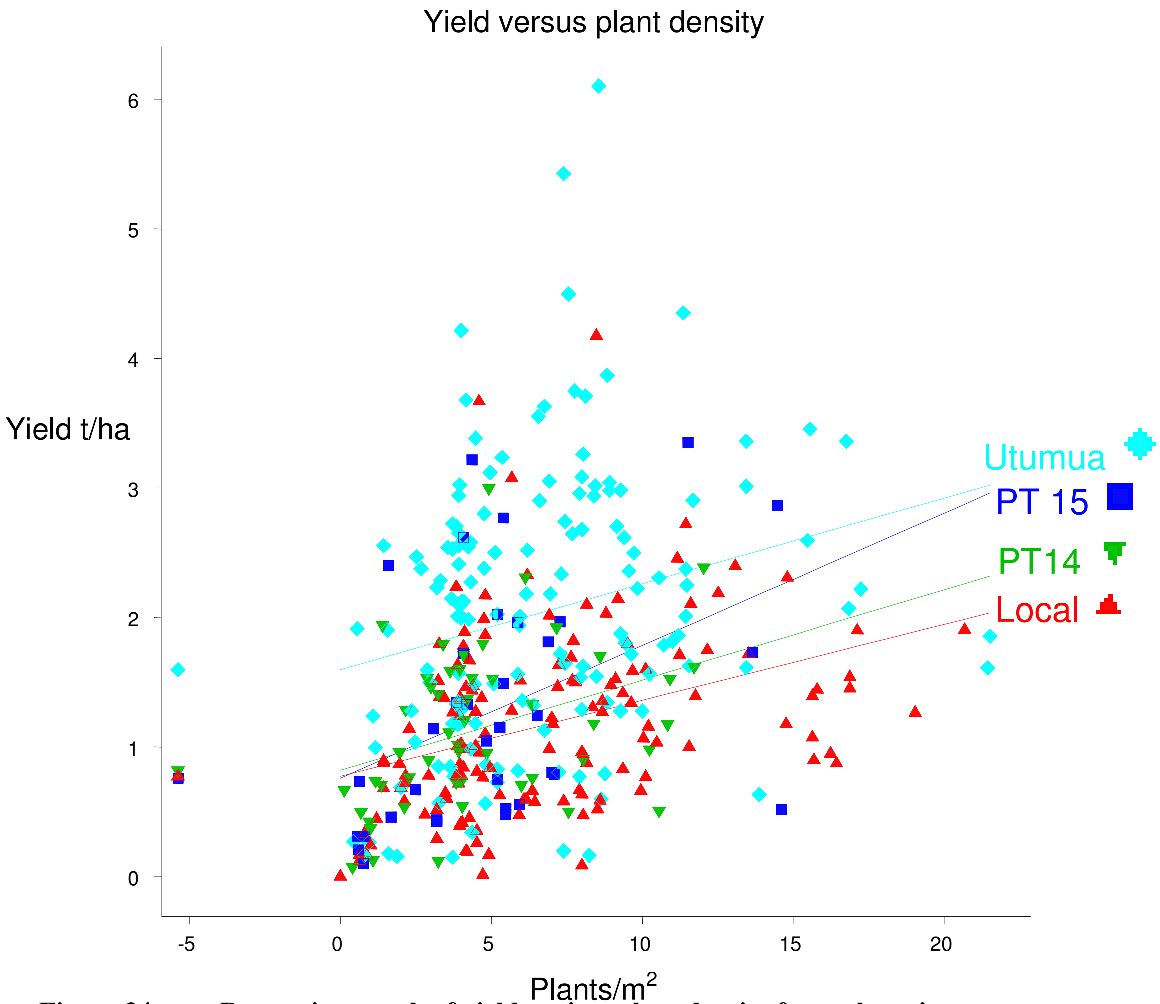


Figure 34. **Regression graph of yield against plant density for each variety**

Unlike previous years, the plant density was consistent between local and Utamua seed. The new varieties of PT14 and PT15 had lower plant densities but this did not reach significance for PT15. About half of the seeds were soaked before planting which may explain the improvement in plant density of Utamua relative to local varieties compared to other years. The seed size of Utamua is far larger than other varieties. The yield per plant was significantly different between Local and Utamua. PT14 also had a significantly higher yield per plant compared to Local but not a significantly higher overall yield. This could be explained by the poorer plant establishment of PT14.

Sub-District

The differences of yield in trial Sub-District are detailed in Table 110. Cailaco, Sub-District of Bobonaro yielded best with 3.15t/ha of Utamua with Venilale, Sub-District of Baucau yielding 2.86 t/ha of Utamua. The yield advantage of Utamua was significantly better than local varieties in five Sub-Districts ($P<0.05$) with no negative significant difference.

Unlike in previous years, while Sub-District was still found to significantly affect yield (F pr. < 0.001), no interaction between Sub-District and variety was found. Liquica Sub-District yielded better with local varieties (although non significant at $P<0.05$) than with Utamua. Although this is likely to be explained by the significantly lower Utamua plant density in Liquica (Local 8.6 plants/m^2 versus Utamua 2.4 plants/m^2), it may be necessary to be cognizant of the varying success of Utamua in the different parts of the country where it has been tested in OFDTs.

Yield data was not available for varieties PT14 in five of the Sub-Districts and PT15 in seven Sub-Districts where OFDTs were established. Of the locations where harvest data was available PT14 did not yield significantly better than local varieties in any Sub-District while PT15 yielded significantly better only in Liquica Sub-District.

Table 110. Peanut OFDT predicted mean yields by District, 2008-2009

District	*Sub-District*	*% of OFDTs*	*Mean yield of Local (t/ha)*	*Mean yield of PT14 (t/ha)*	*Mean yield of PT15 (t/ha)*	*Mean yield of Utamua (t/ha)*	*Yield advantage of Utamua (%)*
Aileu	Aileu Vila	5.3	0.6	0.7	0.5	1.4	130
	Liquidoe	1.5	0.8	-	-	0.9	3
	Remexio	1.0	0.5	-	-	0.9	78
Ainaro	Hato hudo	11.7	1.1	1.6	1.8	1.9	77
Baucau	Baucau	7.8	1.0	1.3	-	1.6	66
	Vemasse	6.3	1.3	1.3	-	2.7	112
	Venilale	4.9	1.4	-	-	2.9	103
Bobonaro	Cailaco	5.6	1.7	1.8	-	3.1	85
	Maliana	10.4	1.4	1.4	-	2.5	86
Liquica	Liquica	7.8	1.0	1.0	2.6	0.5	-49
	Maubara	3.2	1.7	-	1.4	2.5	50
Manufahi	Alas	10.4	1.4	1.3	1.8	1.9	30
	Same	3.4	0.7	0.5	1.4	2.0	173
	Turiscai	3.4	0.5	-	0.6	1.4	209
Viqueque	Oatu Lari	10.9	1.0	1.2	0.6	1.4	45
	Ossu	6.6	0.6	0.5	0.7	1.5	164
*Variety*Sub-District LSD (P<0.05)*				1.02			

AEZ

Predicted means for peanut yields were significantly influenced by AEZ. An interaction between variety and AEZ on yield just failed to reach significance (F pr. = 0.051) when using plant density as a covariate. Utamua yielded better than all other varieties in all AEZ zones (Table 111).

Unlike previous years where Utamua yield was found to be lowest in AEZ 1, Table 111 shows the opposite to be the case in 2009. On this occasion the yield of Utamua in AEZ 1 was significantly better than all other zones. The number of plots of Utamua harvested in 2009 in this zone was however lower than all other AEZs accounting for only 8% of the total Utamua harvest.

Table 111. Predicted mean peanut OFDT yields and yield advantage by AEZ

AEZ	*Yield of local (t/ha)*	*Yield of PT 14 (t/ha)*	*Yield of PT 15 (t/ha)*	*Yield of Utamua (t/ha)*	*Yield advantage of PT 15 (%)*	*Yield advantage of Utamua (%)*
1- Northern coast (0-100m)	1.6 (12)	* (0)	0.9 (3)	3.2 (13)	-41	96
2- Northern slopes (100-500m)	1.3 (31)	1.5 (9)	2.1 (4)	2.3 (29)	60	75
3- Northern uplands >500m	1.0 (50)	0.9 (13)	0.6 (7)	2.0 (57)	-39	89
4- Southern upland >500m	0.6 (9)	0.6 (2)	0.8(6)	1.6 (10)	26	156
5- Southern slopes (100-500m)	1.1 (17)	1.3 (11)	1.8 (7)	2.0 (18)	73	88
6 Southern coast (0-100m)	1.2 (33)	1.4 (19)	1.5 (14)	1.6 (33)	27	43
LSD AEZ*Variety (P<0.05)	0.75					

Figures in brackets indicate number of trials harvested

The yield of Local and PT14 varieties across AEZs tended to be more consistent apart from in AEZ 4 which had the lowest number of trials harvested overall. Both PT14 and PT15 yielded less in AEZ 3 than the Local.

Increasing elevation had a significant negative impact on yield. There was not any interaction recorded between variety and elevation for yield but this may be due to the lack of data from PT14 and PT15. A regression graph displaying this information indicated a much steeper rate of decline in yield with these varieties than with either Local or Utamua varieties (Figure 35) but no statistical significance was found. Future work with these varieties should investigate further if there is a disproportionate fall off in their yield with increasing elevation.

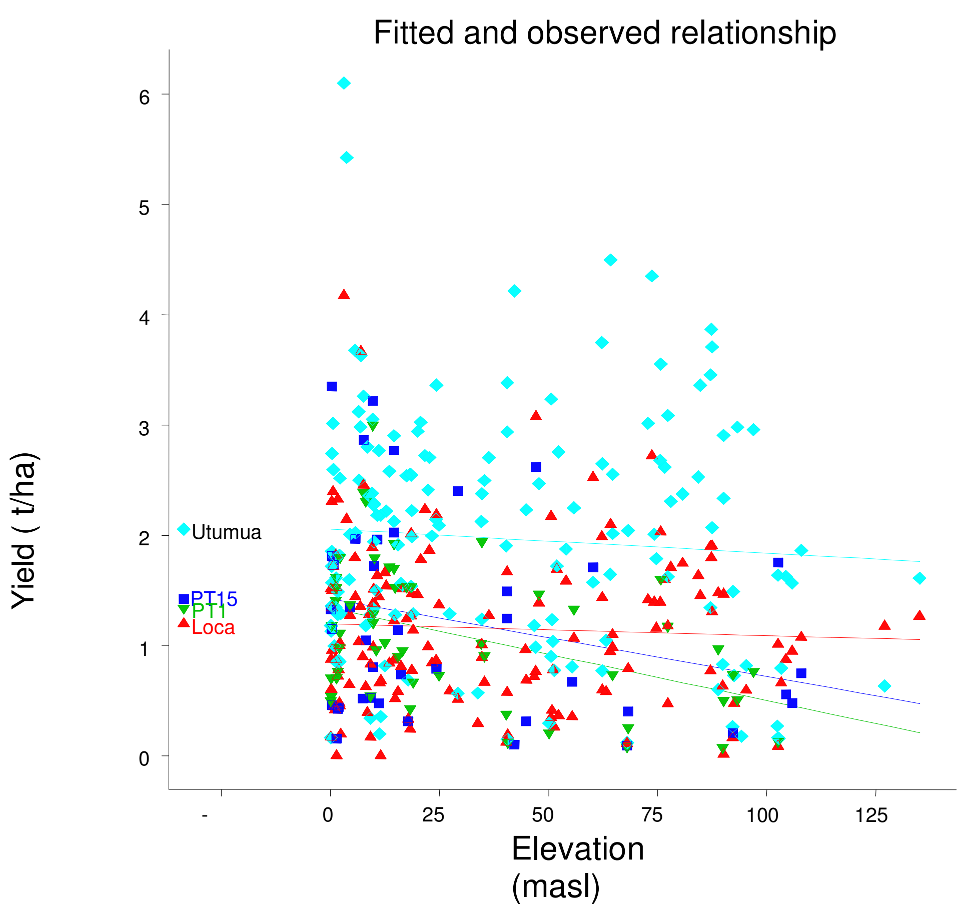


Figure 35. Effect of elevation on yield for each variety

Agronomic factors

Using an Unbalanced ANOVA model with Variety and AEZ as permanent factors and plant density as a covariate, it was found that many other factors also had a significant effect on yield (Table 112).

Table 112. Various factors affecting peanut OFDT yields, 2006-2009

Factor	*F pr. 2008-2009*	*Significant 2008-2009*	*Significant 2007-2008*	*Significant 2006-2007*
AEZ	<0.001	✓	✓	✓
Variety	<0.001	✓	✓	✓
Sub-District	<0.001	✓	✓	✓
Tools used for land preparation	0.013	✓	✓	×
Soil pH	<0.001	✓	✓	×
Soil texture	0.001	✓	✓	✓
Planting distance	-	×	✓	×
Slope class	-	×	✓	×
Number of staff visits	-	×	✓	×
Random or line planting	-	×	×	×
Number of seeds per hole	-	×	×	×
Number of weeding events	-	×	×	✓
Soil color	-	×	×	×
Mixed planting of monoculture	-	×	×	×
Gender	-	×	×	×
Seed soaked before planting	-	×	×	×

Soil texture

Soil texture had a significant effect on peanut yield in 2008–2009 as in previous years. The two soils at the extremes performed best in terms of yield achieved (Table 113). The poor result for sandy loam was surprising, particularly when compared to the much better yield data from sandy soils. The clay soils yielded much better than loam soil groups with significant yield advantages for heavy clay soils when compared to loam and sandy loam groups. Fine clays also yielded better than sandy loams.

Table 113. Effect of soil texture on peanut OFDTs, 2008-2009

Soil texture	*Yield t/ha*	*Locations (%)*
Sandy	1.6	3
Sandy Loam	0.9	9
Silty Loam	1.5	10
Loam	1.3	15
Clay Loam	1.5	28
Fine Clay	1.6	25
Heavy Clay	1.8	8
LSD (P<0.05)	*0.4*	

Tools used for land preparation

This factor reached significance for influencing peanut yield mainly because of a category with thirteen values where farmers used pick axes to dig the land (Table 114). It was therefore not kept in the model when conducting further analysis. Yields from this small group were much smaller than all other forms of land preparation. More farmers used tractors for cultivation than any other method and they did achieve better yields but not to a significant extent over the traditional forms of land preparation.

Table 114. Effect of land preparation tools on peanut OFDTs, 2008/09

Tools used for land preparation	*Percentage of OFDTs*	*Yield (t/ha)*
Hoe	31	1.4
Tractor	35	1.8
Metal bar	27	1.6
Pick axe	5	0.4
No Preparation	2	1.5
LSD (P<0.05)		*1.0*

Soil pH

Soil pH significantly impacted on yield (F pr. <0.001). Table 115 shows that the majority of sites selected for peanuts in 2008-2009 were planted in a soil with pH ranging between 5.5 and 8. Most of highest yielding OFDTs were found at pH 7.5 and pH 8. These yielded significantly better than the most acidic soils.

Table 115. Effect of soil pH on peanut OFDTs, 2008/09

Soil pH	Locations 2008/09 (%)	*Yield (t/ha)*
5	5	0.6
5.5	14	1.3
6	10	1.4
6.5	21	1.4
7	17	1.5
7.5	20	1.8
8	10	1.9
8.5	3	1.4
9	1	2.7
LSD (p<0.05)		*0.6*

A significant interaction (F pr. < 0.05) between soil pH and variety on yield was recorded but no trend could be found when yield averages were analyzed at different pH levels.

Slope class

Slope class failed to have a significant effect on the production in the 2008-2009 trials. No consistent trend was observed. Sites with greater slope than 30% yielded significantly lower than most other less sloping sites (Table 116). However yields from sites sloping 5-8% were similar to yields at much more severe grades. This was not the case for sites between 8-10% which yielded best of all.

Table 116. Effect of slope class on peanut OFDTs, 2008/09

Slope Class	*Locations 2008/09*	*Yield (t/ha)*
0-2%	61	1.6
2-5%	17	1.6
5-8%	6	1.1
8-10%	8	1.6
16-30%	5	1.5
>30%	4	1
LSD (P<0.05)		0.5

Number of staff visits

The number of times the research assistants visited the farmers did not have a significant effect on yield in contrast to the previous year. The highest yield did occur when RAs visited the farms on 5 occasions.

Farmer preferences

Farmer's choice of peanut variety varies. After the farmers harvested their OFDTs, the research assistants provided them the opportunity to comment on whether or not they would plant the varieties again, and why (Table 117).

Table 117. Farmers' reasons for replanting peanut varieties after OFDT.

	Number of replies			
Reason for replanting	*Local*	*Utamua*	*PT15*	*PT14*
Large nuts		115		
Oily seeds	99			
Tastes good	100	2	6	4
Fleshy	1	1		78
The variety belongs to the land	9			
Good colour				3

Most farmers were happy to replant Utamua because of its large seed size. Fewer responses were given for the other seeds. PT14 was preferred because of it being fleshy and sweet tasting. A couple of farmers commented on increased seed numbers and good colour with this variety. One would not plant PT14 again because of poor results. Only a few responses were obtained for PT15 which stated that they liked this variety. One did not want to grow it again because of poor germination.

Local varieties elicited the greatest variety of responses on why they would be replanted. A sweet taste ranked high on the list of responses why farmers would continue using local seed. High oil levels also rated favorably. A general liking for local varieties also featured in responses. More specifically, the fact that a local variety was 'rai main' of from that land was again this year often quoted as a reason for continuing to grow it. Low yield was stated on two occasions as a reason for not continuing to grow a local variety.

Conclusion

Utamua consistently showed a yield advantage over the local varieties in the majority of Sub-Districts. PT14 and PT15 had much less yield data recorded. PT14 yielded disappointingly, not being significantly better than local varieties while the yield advantage of PT15 just reached significance over local varieties.

The poor plant density found with Utamua previous years was not repeated with it being similar to local varieties this year. This may be attributed to the greater use of soaking of seed before planting which has been recommended based on previous experience.

2.6 Mungbean

The relatively high level of protein (7%) and other nutrients (particularly vitamins C, B1 and B2) in mung beans (*Vigna radiata*) 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 a short growing season crop that can be integrated into cereal-based crop rotations. It is usually planted as a monoculture summer crop after rice in lowland areas and intercropped with maize in the uplands. Mung bean production is suited to the low input systems found in Timor Leste. However, mung bean can not tolerate high levels of exchangeable aluminium and prefer fertile soils with a near neutral pH. They are best suited to loamy soils which can be found in upland areas up to about 700 m above sea level. The harvest is progressive to follow the varying pod maturity which spread over a two-three weeks period. Otherwise, the seeds are left for drying on the cut crop. After drying, the grain is boiled for consumption. If stored for long periods post-harvest losses result from weevils which reduce the life span of seeds in storage to 3-4 months on average. Bruchids are also a major threat. Reported yields range from 0.8 - 1.2 t/ha, the latter in Covalima.

There is an opportunity to export mung beans to West Timor and the rest of Indonesia, a major importer of the grain. Varieties with larger seeds can sell at premium prices. Overall, seed uniformity heavily influences prices for export. In 2006, Timor Leste produced about 1,300 t of mung beans, 75% of it coming from the Covalima, Manatuto and Bobonaro districts (estimations from MAF Crop Division). However, substantially larger volumes can be produced in the country. In 1997, the national recorded production exceeded 4,000 t (MAF, 2008).

2.6.1 Replicated trial

Materials and methods

Twelve mung bean varieties were evaluated in 2009. Three varieties were sourced from Indonesia (ILETRI), four were considered to be locals having been cultivated in Timor Leste for a number of years and five were sourced from the Queensland Department of Primary Industries in Australia (see Table 118). All but the Australian varieties were included in a replicated trial conducted in 2008.

Both the 2008 and 2009 trials were conducted at Betano research station. Both were installed as a randomized complete block with plot sizes of 5.5m x 2.5m. 360 holes (one seed per hole) were planted with a 25x15 cm spacing.

Mung beans usually take up to 40 days before flowering and another 30 days on average before producing seeds. However, the foreign varieties matured quicker. The trial was planted the 25th of May 2009. The local varieties were harvested the 7th of August while the other varieties produced harvestable yields by the 29th of July (74 and 65 days respectively).

Table 118. Mung bean populations details, 2009 Betano.

Population	*Origin*	*Seed size**	*Seed colour*	*Type of skin*	*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				
Satin	Australia			Dull	
Sarity	Indonesia				
Murai	Indonesia				
Merpati	Indonesia				
Besicama	Timor				
Berken	Australia	Medium-large	Green	Bright	Prone to powdery mildew and tan spot
Balibo	Timor Leste				
Suai	Timor				

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

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

Results

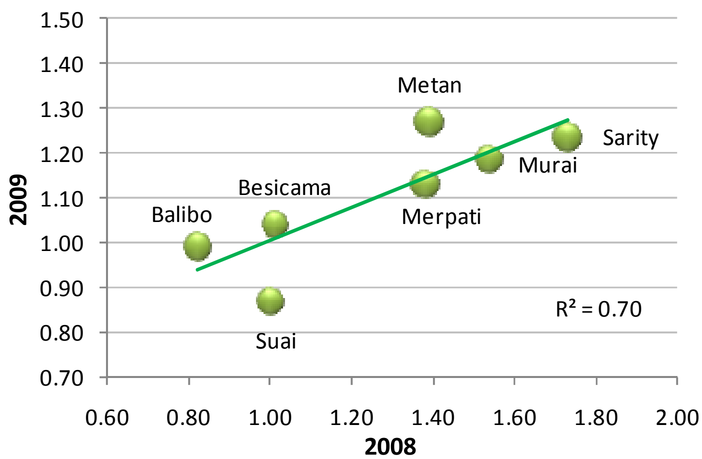
As no row nor column effect was detected in the trial, a balanced ANOVA (One-way in Randomized Blocks) was used to analyse the data. Table 119 presents the yields achieved for all tested varieties as well as other measured parameters and yield advantages:

Table 119. Mung bean replicated trial 2009 and yield advantages over 2008 and 2009

Variety	*Plant emergence at 28 days (%)*	*Plant density at harvest /m²*	*Plant mortality (%)*	*Weight of 100 seeds (g)*	*Yield (t/ha)*	*Yield (t/ha) 2008*	*Mean yield (t/ha) over 2008 and/or 2009*	*Yield advantages (%) over locals**	*Number of years trialled*
Sarity	96	24.5	6	5.7	1.24	1.73	1.49	42	2
Murai	88	22.3	6	5.0	1.19	1.54	1.37	30	2
Metan (loc.)	94	25.7	2	6.7	1.27	1.39	1.33	27	2
Celera	97	24.2	9	3.3	1.32	-	1.32	26	1
Delta	94	25.0	2	6.3	1.29	-	1.29	23	1
Diamond	92	23.1	6	3.3	1.28	-	1.28	22	1
Merpati	96	24.0	7	5.0	1.13	1.38	1.26	20	2
Satin	95	24.9	4	4.7	1.25	-	1.25	19	1
Berken	99	24.3	10	5.7	1.03	-	1.03	-2	1
Besicama (loc.)	89	23.7	3	6.7	1.04	1.01	1.03	-2	2
Suai (loc.)	87	23.6	2	6.0	0.87	1.00	0.94	-11	2
Balibo (loc.)	92	21.7	12	6.3	0.99	0.82	0.91	-14	2
Mean	93	23.9	6	5.4	1.16	1.27	1.21	-	-
P value	*0.031*	*0.111*	*0.235*	*<.001*	*0.065*	*<0.05*	** Mean yield of locals: 1.05 t/ha*		
l.s.d.	*7*	*n.s.*	*n.s.*	*0.9*	*n.s.*	*0.41*			
%CV	*4.6*	*6.1*	*84.4*	*9.6*	*14.7*	*-*			

The mean population density was approximately 25 plants/m^2 which was lower than in 2008 even though mean yields were similar with 1.2 t/ha (35 plants/m^2 for 1.3 t/ha in 2008).

No significant difference between yields were observed in 2009. Nor was there a significant correlation between yield and plant density. Seed sizes were significantly different. A strong and significant correlation was observed between the yields of the varieties trialed both in 2008 and 2009 (R^2=0.70, adjusted R^2=0.65, F prob < 0.019 from regression analysis, (see Figure 36 below), showing that results have been extremely consistant over two years. The best yielding variety across both years was the Indonesian Sarity with 1.5 t/ha achieving 42% yield advantage over the four local checks, followed by the Indonesian variety Murai and the local Metan ("black"). The other local varieties, however, yielded the least at about 1 t/ha on average, which was representative of national yields.



Correlation (linear model):

- F prob: 0.019
- % variability accounted: 64 %
- s.e.: 0.09

Figure 36. Correlation between 2008 and 2009 mung bean yields in Betano

Conclusions

Several varieties evaluated during 2008 and 2009 exceeded yields of 1.2 t/ha which was 20% better than the average national yield. The same set of varieties will be tested next year at all research sites.

A plant density of 25 plants/m^2 gave similar yields to plots possessing 35 plants/m^2 but plant density might still be an interesting factor to test in future trials. The indeterminate nature of local varieties also appeared to be a limiting factor to higher yields.

2.6.2 Time of planting trial

Seed of the variety Murai was planted into randomized blocks (three replicates) every month between December 2008 and May 2009 to determine the best month to plant mungbean in Betano. Plot sizes were 5.5m x 2.5m with plants spaced at 25x15 cm.

None of the plants produced harvestable yield in December, 2008 nor from January to May in 2009. Both flowers and pods rotted in the heavy the rain, indicating that the wet season is not a suitable period to plant mung beans. The best time to plant appeared to be at the very end of the wet season (end of May-beginning of July for the Betano area), when the soil was still moist but when rains were less frequent during the flowering stage. This trial confirmed that mung bean reproductive parts are very vulnerable to heavy rain and that suitable planting times are thus crucial to avoid crop failure.

2.7 Climbing beans

2.7.1 Climbing bean observation trials, 2008-2009

Climbing beans (red, black or white) are commonly grown in Timor and constitute a significant proportion of protein in the diets of subsistence farmers. Red bean soup is a classic Timorese side dish. Surplus beans grown by farmers at higher altitides are also sold in local markets providing a valuable source of income.

During the wet season, climbing beans are grown in association with the main maize crop which physically supports the vines. During the dry season climbing beans are grown on poles.

2009 is the first year for SoL to implement a varietal trial on climbing beans.

Materials and methods

A set of 16 varieties of climbing beans originated from Rwanda (via WorldVision) were trialed in 2008-2009 along with local checks. The origin of the entries, bean colour and trial locations are presented in Table 120.

Table 120. Climbing bean population details and trials, 2009

Variety	*Code*	*Origin*	*Bean colour*	*Trials locations* Maubisse (Ainaro)	Turiscai (Manufahi)	Venilale (Viqueque)
YOL X	CB R15	Rwanda	Red	X	X	X
MAC 28	CB R14	Rwanda	Red & White	X	X	X
RWV 1348	CB R03	Rwanda	Brown	X	X	X
Mwirasi	CB R08	Rwanda	Dark Red	X	X	X
RWV 2409	CB R05	Rwanda	Red	X	X	X
RWV 1892	CB R04	Rwanda	Red	X	X	X
Hawinurare	CB R11	Rwanda	Red	X	-	X
Decelaya	CB R06	Rwanda	Brown	X	X	X
Vuninkingi	CB R09	Rwanda	Red	X	X	X
CAB 2	CB R12	Rwanda	Brown spotted black	X	X	X
Local	Local	Timor Leste		X	X	-
Gasilida	CB R10	Rwanda	Black	X	X	X
G2331	CB R16	Rwanda	Brown	X	X	X
RWV 1002	CB R01	Rwanda	Dark red	X	X	X
RWV 1129	CB R02	Rwanda	Brown spotted black	X	X	X
Umubano	CB R07	Rwanda	Red	X	X	X
CAB 19	CB R13	Rwanda		-	-	-

Note: variety failure was due to poor germination.

Due to the small amount of available seed, the entries were only planted as small observation plots in three locations: Maubisse (Ainaro), Turiscai (Manufahi) and Venilale (Viqueque). An additional trial was planted in Maubara but was unsuccessful, probably because the soils were too acidic. Each variety was planted in 3 holes about 1m apart with 2 or 3 seeds per hole. Two-meter bamboo tripods were positioned over the hills to allow the plants to climb up. A few replantings were needed for some entries. No fertilizer nor irrigation was applied to the plots. A systemic insecticide (Furadan) was used while planting in Venilale to avoid bean fly infestation, a pest which can be disastrous when the crop is planted late. The pods were harvested up to three times to account for different maturation dates. Planting and harvesting details are as shown in Table 121.

Table 121. Climbing bean observation trial details, 2009

Location	*Season*	*No. of repli-cates*	*No. of seeds per hill*	*Planting date*	*Flowering dates*	*Harvest dates*	*Days to maturity **	*Rainfall (mm)**	*Mean yield (t/ha)*
Manufahi	Dry	1	3	21 Apr09	18 Jun 09	29 Sept 09	161	250	4.6
Turiscai	Dry	1	2	28 Apr 09	5-10 Jun 09	30 Jul - 28 Aug 09	122	280	2.6
Venilale	Wet	1	2	31 Dec 08	15-20 Mar 09	20-28 Apr 09	118	800	9.0

** From planting date to last harvest*

Results

Harvested seed number per plant, pod dry weight and total production per m^2 for each site are presented in Table 122.

Table 122. Climbing bean results from observation trials, details per location, 2009

Varieties	*No. of seeds per plant*					*Dry weight of 100 pods (g)*					*Production (g/m²)*				
	M	*T*	*V*	*mean*	*st.d.*	*M*	*T*	*V*	*mean*	*st.d.*	*M*	*T*	*V*	*mean*	*st.d.*
YOL X	16	20	59	32	24	175	146	301	207	82	140	179	1070	463	526
MAC 28	22	34	36	31	8	400	110	290	267	146	440	224	630	431	203
RWV 1348	12	64	107	61	47	171	43	142	119	67	120	140	910	390	450
Mwirasi	36	42	46	41	5	318	193	184	232	75	340	243	510	364	135
RWV 2409	30	30	56	9	15	240	112	122	158	71	360	200	410	323	110
RWV 1892	5	24	79	36	39	148	68	174	130	55	40	98	830	323	440
Hawinurare	20	-	47	33	19	233	-	139	186	67	140	-	390	265	177
Decelaya	25	28	34	29	5	226	75	211	171	83	280	84	430	265	174
Vuninkingi	7	36	65	36	29	273	12	177	154	132	60	22	690	257	375
CAB2	30	17	68	38	26	244	100	96	147	85	220	70	390	227	160
Local	39	42	-	41	2	190	55	-	122	96	300	138	-	219	115
Gasilida	9	31	31	23	13	229	136	207	190	48	80	167	380	209	154
G2331	8	36	33	25	15	258	46	219	175	113	80	100	430	203	197
RWV 1002	24	40	30	31	8	189	56	156	134	69	180	90	280	183	95
RWV 1129	10	17	25	18	7	323	86	230	213	119	100	60	350	170	157
Umubano	5	16	25	15	10	267	32	237	178	128	80	20	360	153	181
CAB19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean site	19	32	49	33	10	243	85	192	173	57	185	122	537	282	224
st.dev.	11	13	23			65	49	58			123	69	236		

Note: M: Maubisse T: Turiscai V: Venilale

Seed production differed significantly among the trial locations, ranging from 1 kg/m² in Venilale to 20 g/m² in Turiscai. Emergence was fairly variable (between 40% and 80% on average for the successful varieties) explaining part of the yield variation. Performances were by far the best in Venilale, probably because the trial was implemented during the wet season. In addition, performances between Maubisse and Turiscai were highly consistent (Figure 37), perhaps reflecting similar altitudes (Maubisse and Turiscai both about 1,500 masl while 700m at Venilale).

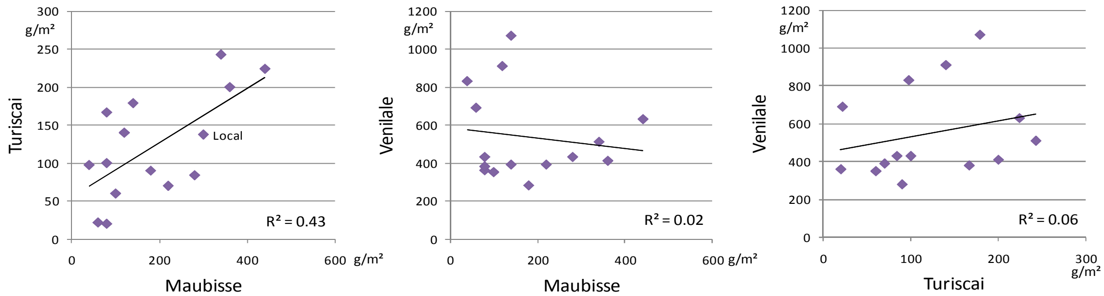


Figure 37. Correlations between climbing bean performances among sites, 2009

The average production per plot over all three locations, was of about 300 g/m² (Table 123). The best performing varieties were YOL X, MAC 28, RWV 1348 and Mwirasi, the latter being the most consistent over sites (low standard deviation). The local check was an average yielding entry against which yield advantages were compared.

Table 123. Climbing bean overall results from observation trials, 2009

Variety	*No. seeds/ plant*		*Dry weight of 100 seeds (g)*		*Production per tripod (g/m²)*		*Mean yield advantage (%)*
	Mean 3 sites	*st.d*	*Mean 3 sites*	*st.d*	*Mean 3 sites*	*st.d*	
YOL X	31.9	23.8	207	82	463	526	112
MAC 28	30.7	7.6	267	146	431	203	97
RWV 1348	60.9	47.5	119	67	390	450	78
Mwirasi	41.3	5.3	232	75	364	135	67
RWV 2409	38.6	15.1	158	71	323	110	48
RWV 1892	36.3	38.6	130	55	323	440	47
Hawinurare	33.4	19.0	186	67	265	177	21
Decelaya	28.9	4.7	171	83	265	174	21
Vuninkingi	36.2	28.8	154	132	257	375	18
CAB2	38.4	26.2	147	85	227	160	4
Local	40.8	1.8	122	96	219	115	0
Gasilida	23.3	12.6	190	48	209	154	-5
G2331	25.5	15.5	175	113	203	197	-7
RWV 1002	31.3	8.3	134	69	183	95	-16
RWV 1129	17.7	7.5	213	119	170	157	-22
Umubano	15.4	10.2	178	128	153	181	-30
CAB19	-	-	-	-	-	-	-
Overall mean	*33.2*	*10.7*	*174*	*41*	*278*	*95*	
Mean	*18.6*	*11.2*	*243*	*65*	*185*	*123*	
Mean Turiscai	*31.9*	*12.7*	*85*	*49*	*122*	*69*	
Mean Venilale	*49.4*	*23.1*	*192*	*58*	*537*	*236*	

Mwirasi and the local check were the quickest to flower at the two sites where this parameter was recorded (Table 124). No correlation was observed between the number of days to maturity and grain yield.

Table 124. Days to flowering, climbing beans, 2009

Variety	*Days to flowering* Turiscai	Venilale	Mean
Mwirasi	44	46	45
Lokal	47	-	47
CAB19	39	57	48
Decelaya	38	69	54
Umubano	35	73	54
YOL X	45	65	55
CAB2	38	73	56
RWV 2409	43	70	57
Gasilida	38	76	57
RWV 1892	37	78	58
RWV 1002	44	78	61
RWV 1129	45	78	62
RWV 1348	45	78	62
Vuninkingi	36	87	62
G2331	46	83	65
Hawinurare	-	66	66
MAC 28	51	87	69
Mean	*42*	*73*	*57*

The number of seeds per pod usually ranged from 3 to 4 but sometimes 5 or 6. Correlation between yield and the number of seeds per plant (Figure 38) was significant (adjusted R^2= 0.53) while that for seed weight (Figure 39) was less so (adjusted R^2 of 0.10).

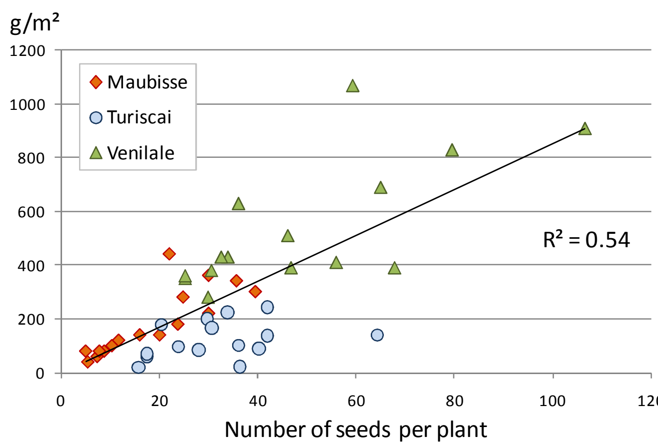


Figure 38. Correlation between bean yield and seeds per plant, 2009

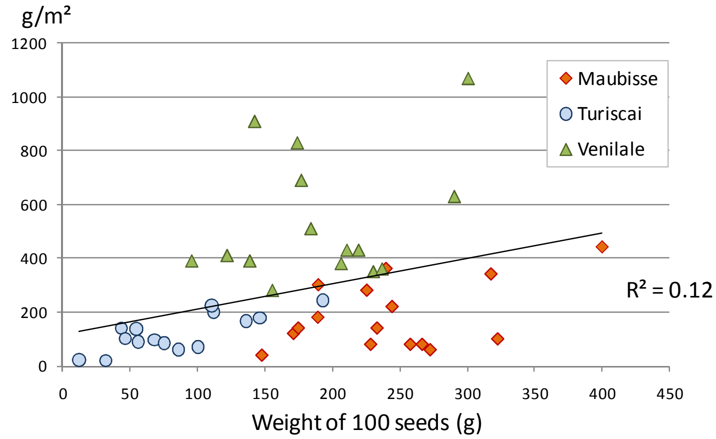


Figure 39. Correlation between bean yield and seed weight, 2009

Conclusions

These climbing bean trials were for preliminary observations only and were not replicated for statistical analysis. Plot sizes were small and only a few plants per variety were grown. However, these preliminary results were very encouraging. More than half of the test varieties were observed to perform better than the local checks. The best potential candidates identified this year were the varieties YOL X, MAC 28, RWV 1348 and Mwirasi with preliminary yield advantages ranging from +110% to +70%.

The trials also gave first indications about grain maturity differences in the new varieties. Next year, replicated trials will assist in providing larger and more reliable sets of data. Potential varietal releases will also be evaluated for taste and other consumer preferences. The differences between wet and dry season cultivation will be further investigated, as production and phenology patterns might differ sufficiently to require specific selections by season.

2.8 Timorese legumes

Additional local varieties of bush beans were collected and stored in order to start a germplasm collection of Timorese legumes. Those include lima beans (*Phaseolus lunatus* L., locally refered as "koto moruk"), lab-labs (*Lablab purpureus* L.) and soy beans (*Glycine max* L.).

Bitterness of the wild lima beans is a defence mechanism against predation when pods drop mature beans. An interesting feature of the collected lima beans is the absence of this bitterness, considered to be as a result of farmers' selection. Foraging of wild resources is practiced in almost every Timorese village and most possess one or more of those domesticated beans with special characteristics. As a result, an important genetic reservoir exists which would deserve to be preserved and tested. The initial list of collected bean populations is presented in Table 125. Trials of those populations will be planted at the research sites next cropping season.

Table 125. Bush collection population details

Population	*Code*	*Origin*	*Bean colour*
Lima bean Branca Bi-colour	Leg 01	TL Venilale	Red & White
Lima bean Branca Mutin ("white")	Leg 02	TL Venilale	White
Lima bean Metan ("black")	Leg 06	TL	Black
Lab-lab Coklat ("brown")	Leg 03	TL	Brown
Lab-lab Verde ("green")	Leg 04	TL	Green
Lehe Metan	Leg 05	TL	Black
Soy bean Metan	Leg 07	TL Maliana	Black

2.9 Potato

Potatoes (*Solanum tuberosum* L.) are often grown by farmers in cooler environments in the higher altitudes of Timor Leste. Tubers of this high value crop are an important part of Timorese cuisine, especially when fried. Potatoes have been a source of cash income for highland farmers for many years and are often found for sale in local markets. The crop does have production problems. For example, potato blight (*Phytophthora infestans*) badly infected potato crops throughout the country between 2003 and 2005. This reduced national production considerably and its existence was a disaster for potato farmers because Timor Leste appeared to be free of this otherwise common disease until then.

Preliminary trials on potatoes were conducted by SoL for the first time in 2009. The first trial was an observational trial possessing 12 entries supplied by CIP in Indonesia. In addition, two OFDTs were installed using four varieties purchased from a supermarket in Dili plus a local control. These trials were designed to both multiply planting material and to gain experience in conducting research on this crop.

2.9 1 Potato observation trial, 2009

Material and methods

An observation trial (one replicate) of a range of potato varieties was implemented in Maubisse (Ainaro) during the dry season. Twelve varieties were trialled, all from the CIP office in Bogor, Indonesia. Two of these varieties (Tenggo and Berolina) had been extensively trialled in several locations of Indonesia and proved to be resistant to Phytophthora. The Tenggo variety had previously been sourced from CIP and planted in Maubisse. This variety (Tenggo 1) was included as a control and kept separate from the newly sourced material (Tenggo 2).

Each variety was planted with 40cm spacing between and within rows (a planting density of 6.25 plants/m²) in one or two rows depending on available planting material. The harvest area was between 1.2 and 3.2 m^2. One row consisted of a maximum of 10 plants. The number of hills per variety ranged from 8 to 20 and the yields were calculating from the resulting plot areas. Planting and harvesting details are as shown in Table 126:

Table 126. Planting and harvest details of the potato observation trial, 2009

Trial location and altitude	*No. of entries*	*No. of replicates*	*Planting date*	*Harvest date*	*Days to maturity*	*Rainfall (mm)*
Maubisse (Ainaro) 1,400 masl	13*	1	19 May 2009	26 Aug. 2009	99	50

*12 varieties with two Tenggo generations kept separate

Results

The average yield for all entries was 6.7 t/ha (Table 127) which is good considering the very small amount of rain received by the trial (about 50 mm during the two weeks after planting and none thereafter). Yields ranged from 1 to 14t/ha.

Yield variations were partly due to the percentage of live plants at harvest (ranging from 40 to 95%). Low densities were was mostly a result of poor emergence, although a few plants died of disease. At harvest, more than 90% of the tubers were viable, which would have ensured a marketable yield of about 6t/ha on average.

The first generation of Tenggo (Tenggo 1) performed slightly better than the new entry (1.4 t/ha of difference), probably because the existing tubers were bigger and in better condition than those from Indonesia.

Table 127. Potato varietal observation trial results, Maubisse, 2009

Variety	*Code*	*Number of planted hills*	*% of plants alive at harvest*	*Plant density at harvest, per m²*	*Number of tubers / plant*	*Weight of 10 tubers (kg)*	*Yield (t/ha)*
390043.37	E07	17	88	5.5	3.9	0.65	14.1
396034.13	E02	17	65	4.0	5.4	0.60	12.9
39184.5	E01	18	94	5.9	4.1	0.51	12.3
393371.58	E05	13	62	3.8	3.1	0.61	7.3
Tenggo 1	ET1	17	41	2.6	5.9	0.47	7.1
391058.173	E09	8	88	5.5	2.9	0.40	6.3
395195.7	E03	18	61	3.8	2.8	0.54	5.8
Tenggo 2	ET2	17	94	5.9	2.4	0.39	5.7
391004.18	E08	17	47	2.9	3.3	0.53	5.1
Berolina	EB	20	35	2.2	1.7	0.93	3.5
396031.108	E11	11	64	4.0	2.4	0.35	3.4
393077.159	E04	17	29	1.8	1.2	1.27	2.8
393280.64	E10	17	47	2.9	1.1	0.33	1.1
	Averages	*16*	*63*	*3.9*	*3.9*	*0.58*	*6.7*
	s.e.	*3*	*23*	*1.4*	*1.4*	*0.26*	*4.1*

Significant correlations were found between the yield and the plant density and with the number of tubers per plant (Figure 40). No correlation was found between the yield and the average weight of tubers.

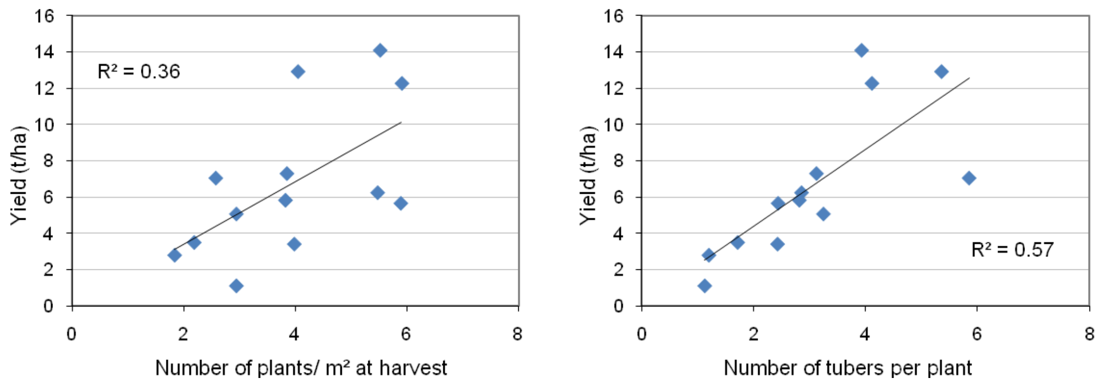


Figure 40. Correlations between yield and yield components, potato, 2009

Conclusions

This preliminary potato trial provides valuable information on and experience with the test varieties. Sufficient seed material is now available for replicated trials to be conducted in 2009-2010. In future studies, the trials will be closely monitored to ensure there are consistent plant populations as well to measure differences in disease susceptibility. Resistance to potato blight in particular will be closely examined as this characteristic is strongly valued by farmers.

2.9.2 Potato On-Farm Demonstration Trials 2009

Material and methods

Two OFDTs were implemented in Turiscai (Manufahi) for the first time during the dry season in 2009. Four varieties were trialled in each, three sourced from a supermarket in Dili and one a local check. There was one replicate for each entry.

Each OFDT consisted of one or two rows per variety with a 40 cm spacing between and within rows. Each row consisted of 10-12 plants. This corresponds to a maximum plant density of 6.25 plant/m². The number of planting hills per variety ranged from 8 to 23. Planting and harvesting details are presented in Table 128.

Table 128. Planting and harvest details of the potato OFDTs, Turiscai, 2009

Location and altitude	*Planting date*	*Harvest date*	*Days to maturity*	*Rainfall (mm)*
Matorec (Manufahi) 1,235 m	01 May 2009	05 Aug. 2009	96	260
Beremana (Manufahi) 1,270 m	04 May 2009	06 Aug. 2009	94	245

Results

Both sites in Turiscai received approximately 250 mm of rain during the growing period (Table 128) and plant growth was reasonable. As in Maubisse, plant mortality was very low (none in this case) while plant establishment was an issue but compensated here through replanting.

Of the three Australian varieties, two performed better than the local check (Table 129). Their yield advantages over the local were of +10-40%, except in one location for the White variety yielded extremely well (+300%). The white and Sebago potatoes yielded larger tubers than the red and local varieties.

Table 129. Potato OFDT results, Turiscai, 2009

Variety	*Hill no.*		*Average weight of 10 tubers (kg)*			*Yield (t/ha)*			*Yield advantage over local (%)*		
	M	*B*	*M*	*B*	*Mean*	*M*	*B*	*Mean*	*M*	*B*	*Mean*
White	17	22	0.42	0.36	0.39	21.1	6.5	13.8	347	10	159
Sebago	14	23	0.36	0.47	0.42	5.3	8.3	6.8	12	39	27
Local	18	21	0.24	0.25	0.25	4.7	6.0	5.3	0	0	0
Red	11	8	0.17	0.30	0.24	2.6	5.9	4.3	-45	0	-20
		Means	*0.30*	*0.35*	*0.32*	*8.4*	*6.7*	*7.5*	-	-	-

Note: M: Matorec, B: Beremana

With 8.4 and 6.7 t/ha, the average yields of the two OFDTs were consistent with those obtained in the Maubisse observation trial, even though the OFDTs received a lot more rain.

Conclusions

Those first potato OFDTs gave encouraging results, with two new varieties performing better than the local check. Further trials are needed to strengthen those results.

A concern with potato is the difficulty of conserving the planting material. Planting material tends to rot easily even in cool and ventilated areas. Damage from rats is also frequent. As a consequence, the best way to conserve germplasm material is to plant it. Trials will therefore be implemented continuously, which might give opportunity to determine what periods of the year are best for potato cultivation. The next trial will be installed during the 2009-2010 cropping season in Maubisse and include two replicates.

3. Seed production and distribution

Introduction

Timor Leste is yet to establish and implement a formal seed system. This is partially being addressed with the preparation of a Seed Law which has been completed and is under consideration by MAF. Before submission to Parliament, the MAF will develop regulations to complement the law and assign personnel to implement it. This will require the employment and training of seed officers and other regulators. In the meantime, new crop varieties have been officially released by MAF for cultivation in Timor Leste. These varieties were selected through the SoL varietal evaluation program and approved for release by the Government led by Varietal release committee. The named varieties include Sele and Suwan 5 (maize), Utamua (peanut), Nakroma (rice), Hohrae 1, 2 and 3 (sweet potato) and Ai-luka II and Ai-luka IV (cassava). Sufficient seed of the released varieties now needs to be multiplied for distribution to farmers.

For the past year (2008-2009), SoL has produced an increasing amount of quality seed for distribution to farmers through structured distribution channels established by a) MAF, b) NGOs and other organizations, c) the establishment of OFDTs and d) by directly assisting progressive farmers. It is envisaged that the amount of available seed will also expand as the farmers multiply and store seed themselves and exchange it with neighbours and family members.

Informal seed multiplication generally has a low level of quality control. It is therefore, the government's role to support seed multiplication by regularly (every 3 to 5 years) injecting better quality seed into the system. This is particularly important in Timor Leste where improved seed production is in its infancy.

Human resources on seed production

In 2008-2009, SOL supported MAF with fielding 7 seed officers in 6 districts (Aileu, Baucau, Bobonaro, Liquica, Manufahi, and Viqueque). All seed officers possessed a BSc in agronomy but had little experience with seed production when first assigned to the program. Their knowledge and skills improved tremendously over the 12 month period, but there is room for improvement. It is important for all seed officers to understand the importance of a) seed source, b) land history, c) proper isolation, and d) timely roguing to ensure the seed remains true to type. Knowledge of seed drying, processing, and storage techniques are also important for the seed officers to maintain high seed germination rates and ensure the seed contains low levels of inert matter.

During the year, each seed officer underwent intensive training courses in-country and abroad. Courses attended by the seven seed officers include:

- Basic rice seed production skills
- Seed handling and storage,
- Seed processing,
- Seed invigoration,
- Basic maize and peanut seed production

Production and distribution of rice, maize, and peanut seed

Planning of seed production can be based on a demand approach, a resource approach or combination of both. The fact that a) the newly assigned seed officers lacked experience, b) that seed growers were untrained plus c) the fact that storage facilities and seed processing equipment was in short supply at the time, made the resource based approach the best option to start the program. The plan for the first year of seed production (in 2008/2009) was for 5 ha of maize, rice and peanuts to be produced in each of the six districts. Seed of Nakroma (rice), Sele and Suwan 5 (corn), Utamua (peanut) was multiplied in selected farmer fields. The seed officers provided guidance to the seed growers on how best to cultivate seed crops.

In general there are several aspects that should be considered in selection of seed production areas and seed growers. Ideally, a seed grower should be either a progressive farmer or be within a progressive farmer group. The seed production area should at least 3-5 ha in area located in fields within close proximity to important infrastructure such as main roads, irrigation, drying floors, warehouses, etc. Seed growers and production areas should be nominated at least 1–2 months before the start of the season. In 2009, farmers, located in reasonable proximity to roads were nominated in a timely manner leading to seed being harvested from approximately 28 ha rice, 24 ha maize, and 15 ha peanut.

Farmers were exposed to the newly released varieties by inviting them to field day. One field day was hold for Sele in Maliana on 17 May 2009 and two other for Nakroma in Laga-Baucau on 31 May 2009 and in Seisal-Baucau on August 2009. Farmers had the opportunity to observe and discuss the new varieties on those occasions.

Seed production was increased substantially from 2008 when it was conducted in the 2 districts, Baucau and Manufahi. Seed produced in 2008 was at 9 tons of Nakroma, 14.7 tons of Sele and 4.8 tons of Utamua. Seed production in 2009 was conducted in 6 Districts and yields were 63 tons of Nakroma, 25 tons of Sele, 1 ton of Suwan 5, and 17 tons of Utamua (Table 130).

Table 130. Seed production of Nakroma, Sele and Utamua 2008 and 2009

	Nakroma		*Sele*		*Utamua*	
Year	*2009*	*2008*	*2009*	*2008*	*2009*	*2008*
District	(t)	(t)	(t)	(t)	(t)	(t)
Aileu	4.2	0	1.8	0	0	0
Baucau	29.0	5.1	1.4	0	9.5	4.8
Bobonaro	6.4	0	4.6	0	2.8	0
Liquica	10.9	0	0.6	0	0.8	0
Manufahi	3.8	0	16.2*	0	1.7	0
Viqueque	8.5	3.8	1.4	14.8	2.9	0
Total	*62.8*	*8.9*	*26.0*	*14.8*	*17.3*	*4.8*

*= 1.1 ton Suwan 5

It is preferable for seed stored in warehouses to be distributed within a year of harvest. During 2008/09 Sol seed was distributed to support SoL activities (research, OFDT, and seed production), MAF activities, and to support NGO programs. Between Sept 08 – August 09 about 15 ton of Nakroma, 13 ton of Sele, 1 ton of Suwan 5 and 5 ton of Utamua was distributed (Table 131). More seed will be distributed over the last few months of 2009 to supply seed needs for the 2009/10 planting season.

Table 131. Rice, maize and peanut seed distribution (Sept 08 – Aug 09)

Commodity/variety	*NGOs* *(t)*	*MAF* *(t)*	*Total* *(t)*
Nakroma	1.1	13.7	14.7
Utamua	1.2	3.4	4.5
Suwan 5	0.5	0.3	0.8
Sele	6.5	6.7	13.2
Total	*9.8*	*24.3*	*33.2*

SoL/MAF seed was distributed a) directly to farmers, b) used for OFDTs and demonstrations, and c) for seed production. Seed provided to NGOs was generally gifted to the organization if the amounts were less than 20 kg. Over that amount, the organization was requested to pay 50c per Kg for maize and rice and $1 per kg for peanuts. Movements of the seed was entered in the seed book and recorded. Typical entries and use of seed is presented in Table 132. Also recorded are the crop variety, date and amount of seed.

Table 132. Typical entry in seed transfer register in 2009

NGO recipient	*General or specified use of seed*
Lafaek Diak	Farmers
Alola Foundation	Farmers
World Vision	Farmers
CTID Madre canossa	Farmer seed production
CCF	ICM, Manatuto
NGO CHARLI, Viqueque	Farmers, Ossu
CARE	Farmers Bobonaro and Suai
USC Canada	Farmers
GTZ	Farmers
USAID	Suai farmers
Juventudi/Gariuai	Baucau/ Gariuai
OXFAM	Oecussi
USAID	Manufahi

Production of sweet potato and cassava stem cuttings

Sweet potato stem cuttings of three varieties released in 2007 were multiplied in 5 districts during 2008. The districts were Manufahi, Aileu, Viqueque, Liquica and Baucau. The total seed bed area for multiplication was 0.5 ha. Each square metre possessed approximately 8 plants, each of which can produce 4–8 stem cuttings. Harvests can be done every 1.5–2 months. The estimated total number of cuttings that can produced from 0.5 ha of seed bed, therefore, is 160 000 cuttings/harvest. With two harvests per season it should be possible to cultivate 320,000 cuttings per hectare per annum.

In August 2009, the variety release committee of Timor Leste approved the release of two cassava clones coded Ca 15 and Ca 26. These were name by the MAF as Ai-luka 2 and Ai-luka 4. Both varieties were initially introduced by CIAT to Timor Leste for evaluation in 2001. One half hectare each of stem cutting production of Ai-luka 2 and Ai-luka 4 was initiated in Loes, Liquica research station. Another 1 ha (0.5 ha for each variety) will be established at Corluli-Bobonaro research station later in 2009. Cassava stem cuttings for Loes and Corluli were initially sourced from mother blocks at Betano Research Station, Manufahi. It is expected that by July 2010, about 160,000 stem cuttings will be produced from the Loes cassava fields and another 160,000 from Corluli by Dec. 2010.

Sweet potato cuttings were distributed to a similar range of organizations as presented in Table 132. Because of the large size and tender state of the fresh material, only small amounts were distributed at one time. Generally one farmer received approximately 50 stems and used this mainly for their own seed production as well as for roots. The number of stems distributed in 2008-2009 by district is presented in Table 133.

Table 133. Production area and distributed sweet potato and cassava (2008/09)

District	*Sweet potato*		*Cassava*	
	Area (m^2)	*No. of distributed cuttings*	*Area (ha)*	*No. of distributed cuttings*
Aileu	1,000	24,700	0	0
Baucau	1,250	28,440	0	0
Bobonaro	0	0	0	0
Liquica	200	4,163	1	0
Manufahi	600	38,610	0	0
Viqueque	200	0	0	0
Total	*3,250*	*95,913*	*1*	*0*

Potential planting area from SoL seed production

Seed production of SoL released varieties of maize, rice and peanuts and planting material multiplication for sweet potatoes and cassava was in its infancy in 2008-2009. As indicated above, the seed officers were assigned in 2008 and seed multiplication commenced soon after. The quantity and quality of seed production will expand in 2010 and into Phase III of SoL.

Producing sufficient seed and planting material for all food crops in Timor Leste is not the goal of SoL. National seed requirements are large. According to MAF statistics (MAF Directorate of Agriculture and Horticulture, 2008) the total area of rice, maize, peanut and sweet potato in Timor Leste during 2008 was 37,297 ha, 77,613 ha, 1,213 ha and 3,615ha respectively (Table 134). Using excellent farming practices, rice seed rates are considered to be at 25 kg/ha, maize at 20 kg/ha, peanut at 200 kg ha and sweet potato at 40,000 cuttings per ha. Distributed seed and planting material (Sept 08- Aug 09) was sufficient to cover 1.6 % rice-fields (588 ha), 0.9% of maize-fields (700 ha), 1.9 % peanut-fields (23 ha) and 0.07% of sweet potato (2.3ha). Seed production in SoL will expand in 2009-2010.

Table 134. SoL seed distribution as proportion of national needs

Crop	*Current area (ha)*	*Minimum seed requirement (kg/ha)*	*National seed requirement (t)*	*SoL Seed distribution 2008/09 (t).*	*SoL seed distribution as % of national requirement*
Rice	37,297	25	932	15	1.6
Maize	77,613	20	1552	14	0.9
Peanut	1,213	200	242	4.5	1.9
Sweet potato	3615	50,000**	145 mill**.	96,000**	0.07

** Cuttings

Seed processing facilities and warehouses

Seed processing equipment and good storage facilities play an important role in keeping the seed supply flowing. At the beginning of 2009, few districts possessed adequate storage and little seed processing equipment was in use. By August, 2009 serviceable warehouse facilities were available in Manufahi, Baucau, and Maliana (Table 135). Those at Manufahi and Baucau were equipped with batch driers (3 ton capacity), air screen cleaner (capacity of cleaning 300 - 400 kg seed/hours) and plastic sealers for bagging. There were also two germinators and a seed divider at Betano. To improve seed processing efficiency, seed officers encourage seed growers to dry and to clean the harvested seeds as much as possible before purchase.

Seed officers assist the farmers to dry and process the seed. Prior to seed purchase, seed cleanliness is observed visually by seed officer and the seed moisture content is monitored using a digital seed moisture tester. All purchased seed is then transported to seed warehouses for further processing and handling.

Table 135. Selected seed storage and processing facilities at the end of Aug. 2009

District	*Warehouse*	*200 l silo*	*1000 l silo*	*Air screen cleaner*	*Seed moisture tester*
Aileu	Not available (In farmer's house)	0	0	0	1
Baucau	Triloka Research Station	28	3	1	1 + 1 DoleType
Bobonaro	Agriculture school	13	2	0	1
Liquica	Not available (In farmer's house)	1	8	0	1
Manufahi	Betano Research Station)	8	6	1	1 + 1 Dole Type
Viqueque	NGO warehouse	10	0	0	1
Total		*60*	*19*	*2*	*6 + 2 Dole Type*

4. Farmer adoption of tested and released varieties

4.1 Areas of adoption

Introduction

Early adoption surveys were conducted in 2006 and 2007 to measure the level of adoption/replanting among farming households involved in conducting SoL OFDTs. Among others, this survey included questions about the area of test varieties replanted by farming households one year after they initially installed the OFDT. Field areas were mostly estimated by the farmer during the interview, and sometimes measured or estimated on site by the research assistants. Farmers were generally guided by being asked "how many paces" down each side of the site to improve accuracy of the estimates. The reliability of area estimation and the implication of these on adoption rates themselves were evaluated in this 2009 study.

Methodology

The study was conducted in 5 districts (7 sub-districts, 14 sucos) during May, 2009. Twenty three farmers, both men and women, were interviewed and 44 fields surveyed. The households were chosen from the 2007 adoption survey of second-year OFDT farmers. Farmers replanted one to three new varieties each. Crops were of maize (Sele, Har12), sweet potatoes (Hohrae 1,2 and 3), peanuts (Utamua), cassava (Ca 45, 35, 42 and 107) and/or rice (Nakroma) (Table 136).

The interviews were firstly conducted by the RAs as they had done previously. Additional questions about planting intentions for the next cropping season and underlying reasons were then asked, before taking field measurements on-site using a tape measure accompanied by the farmer and the RAs.

As presented in Table 136, a distinction was made between crops which are usually planted in an area of a few hundred square metres or less (sweet potatoes and peanuts) and those which cover larger areas of up to several thousand square metres (maize, rice, cassava). This allowed the results of the species dominantly planted in small areas to be visible despite their low load in the total area measured. Secondly, the groups were made by crop species rather than field size in order to allow easier application of the following results to total cropping areas.

Table 136. Number and characteristics of surveyed fields

Crop	*Number of fields surveyed (total: 44)*	*Type of field*	*75% of field areas between (m²):*	*Field areas: minimum and maximum (m²)*	*Average fields area (m²)*
Maize	23	"Large"	400 - 4 500	140 - 19 000	2,336
Rice	3				
Cassava	2				
Sweet Potatoes	12	"Small"	15 - 200	16 - 561	128
Peanuts	4				

Number of households surveyed: 23. Districts: Liquiça (Liquiça-Villa, Maubara, Atabae), Ainaro (Maubisse) Manufahi (Turiscai), Aileu (Aileu-Villa), Baucau (Vemasse).

Results

The percentage of farmers who were reluctant to give information about their fields areas was low (~10%), which could be taken as an indication that, on average, relationships between SoL and OFDTs farmers were good. About 20% of the interviewed farmers (mostly women) had very little idea of their field sizes by length or breath. Nevertheless, those results were included in the study, as part of the range of answers to be expected.

In general, farmers under-estimated their field size more often (60% of the measured fields, Table 137a) than they over-estimated them. This was true especially for women, and, to a lesser extent, for large types of fields without regard to the gender interviewed. The farmer's general dislike to expose wealth might be an explanation but was not confirmed.

Table 137. Proportion of fields under or over estimated by farmers

Table 137a

Type of field	*Under-estimated fields (%)*	*Over-estimated fields (%)*
Large (28)	64	36
Small (16)	56	44
All (44)	61	39

Gender	*Under-estimated fields (%)*	*Over-estimated fields (%)*
Men (26)	54	46
Women (18)	72	28
All (44)	61	39

Table 137b

Type of field	*Fields (%) estimated with an error of:*		
	<-50%	*-50%;+50%*	*>+50%*
Large (28)	36	43	21
Small (16)	31	50	19
All (44)	34	46	21

Gender	*Fields (%) estimated with an error of:*		
	<-50%	*-50%;+50%*	*>+50%*
Men (26)	23	54	23
Women (18)	50	33	17
All (44)	34	46	21

Table 138c.

Type of field	*Fields (%) estimated with an error of:*		
	<-75%	*-75%;+100%*	*>+100%*
Large (28)	18	64	18
Small (16)	6	81	13
All (44)	14	70	16

Gender	*Fields (%) estimated with an error of:*		
	<-75%	*-75%;+100%*	*>+100%*
Men (26)	8	73	19
Women (18)	22	66	11
All (44)	14	70	16

Errors of estimation for single fields ranged from -93% to +1132% (Figure 41). However, it was found that 70% of the time the farmers interviewed gave an estimation of their field area in a smaller range of -75% and +100% of the actual measured area (Table 137c). Almost half the time (46%), answers were even included between -50% and +50% of error (Table 137b). Error was only slightly more frequent for larger types of fields and when women were interviewed.

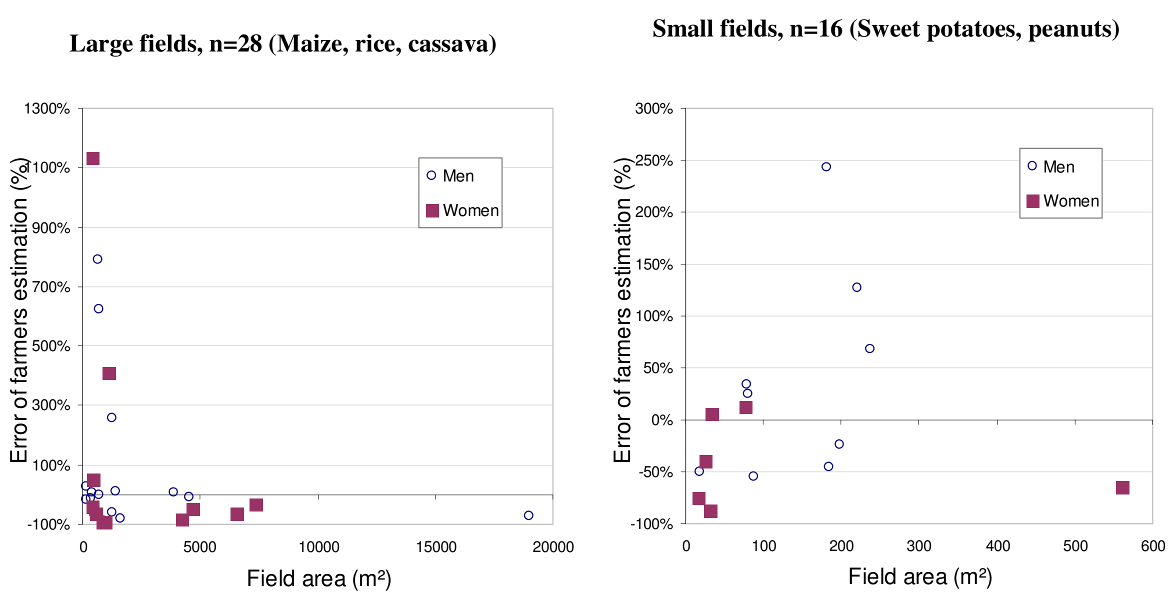


Figure 41. Distribution of farmers' estimation errors related to field areas (m^2)

Additionally, the overall error for the total areas per type of crops was found to be very low: "large" crops (maize, rice and cassava) areas were under-estimated by only 14% while "small" crops (sweet potatoes and peanuts) areas were over-estimated by 16% (Table 138). The fact that under- and over-estimations roughly compensate each other and that most of the estimations showed relatively low errors might both explain those results.

Table 138. Accumulated field area: error of estimation from interviewed farmers

Type of field (number)	*Accumulated area estimated by farmers (m²)*	*Accumulated area measured (m²)*	*Estimation error (%)*
Large (28)	56,396	65,413	-14
Small (16)	2,377	2,046	16
All (44)	56,396	65,413	-14

Conclusions and recommendations

The outcomes of this study clearly show that farmers provided fairly accurate estimates of crop areas during adoption survey interviews. Individual error can be high, but the majority of the farmers interviewed answered realistically. Importantly, the accumulated estimated areas were fairly representative of the measured areas if distinction was made between species planted.

In order to better the estimation, it would be appropriate to take a few measurements, but only in some specific situations. The most important of those are when the interviewed person answers with evidently too large areas (ex: 10,000x10m). As such answers may impact heavily on the accuracy of the final cumulated indicator, RAs should then always perform estimations by themselves on site. Other circumstances could include answered estimations seemingly too small for large type of crops (ex: 10x10m for maize) or too large for small type of crops (ex: 30x30m for sweet potatoes). The RAs local knowledge of the farming households should also be put to use for specific situations (ex: farmer owning half a rice valley, farmer in urban environment, shifting systems, etc.).

Nevertheless, because of the very encouraging results of this study and because of the high number of households to be surveyed when evaluating adoption and replanting, the need for quick and efficient interviews should make estimation by farmers prevail over time consuming field measurements.

4.2 Adoption areas three years after conducting OFDT

Introduction

Previous adoption surveys conducted in 2007 and 2008 determined the level of adoption/replanting of SoL varieties of farming households involved in successful OFDTs. Those surveys identified adoption rates one year after 2006/07 and 2007/08 OFDTs and two years after 2005/06 OFDTs. The survey presented here is aimed to identify adoption rates three years after the 2005/06 OFDTs, the level of seed dissemination and reasons for farmers to cease cultivating newly released varieties.

Methodology

The survey was conducted over a five week period in May-July 2009 in the 4 districts where SoL implemented OFDTs during the 2005/06 cropping season (Manufahi, Aileu, Liquiça, Baucau). Ninety households (23% of them female-headed) were randomly sampled. These households implemented 131 OFDTs (28% of the total) with each cropping 1 to 3 OFDTs. Test varieties were maize (Sele, Suwan5), sweet potatoes (Hohrae 1,2,3), peanuts (Utamua, Pt15, GN11) and/or rice (Nakroma). Seven sub-districts (out of 8), 28 sucos and 48 aldeas were represented.

This survey used an open ended (instead of structured) questionaire. The main questions included a) planting times since the initial 2005/06 OFDT, b) size and production of the last two harvested areas planted in new varieties, c) if need be, reasons for abandoning the new varieties, d) planting intention for next cropping season, e) reasons for liking or disliking varieties, and f) questions about seed dissemination (quantities of seeds given to other farming households and relationships). The farmers were also given the opportunity to ask questions about SoL and the OFDTs varieties.

This report presents results regarding adoption rates, dissemination, and reasons for dis-adoption (ceasing to use the varieties).

Results

Adoption rates

Table 139 compares the adoption rates from the structured survey conducted in 2006 with the 2009 open ended survey . The first set of data presents the results of earlier structured surveys. Those data were considered to be an underestimate of the real adoption rates. This hypothesis is supported by the fact that the former questionnaire relied on asking farmers how many times they planted a tested variety after the OFDT. Such a question is difficult to answer for several reasons. First, there may be one or two cropping cycles each year (two in Same for instance). Moreover, some planting periods start later in the season (such as rice) and can be missed in the survey or thought not to belong to the current cropping season. Sweet potatoes may be planted once only and kept alive from one year to the next. This does not signify dis-adoption.

The second set of data presents results from the open ended survey. This survey avoided the issues mentioned above by asking farmers precisely what months and what years he/she planted a tested variety, how many times harvest was completed and if no harvest, why not. The subsequent reported adoption rates were found to be considerably higher than those obtained during the previous years, confirming the hypothesis that previous surveys under-estimated true adoption rates.

Table 139. Adoption rate of one or more tested varieties after initial OFDT

Data source	*Crop (1 or more varieties)*	*Adoption rates (% of households) after:* 1 year	2 years	3 years	4 years (anticipated)
Data from 2007 and 2008 early adoption surveys (structured; all OFDTs)	Maize	75	58	-	-
	Sweet potato	29	3	-	-
	Peanuts	48	6	-	-
	Rice	50	48	-	-
	Overall*	-	-	-	-
Data from 2009 survey (open; 90 households)	Maize (42)**	98	64	45	38
	Sweet potato (37)	76	49	32	30
	Peanuts (40)	75	38	15	13
	Rice (12)	92	67	58	58
	Overall* (90)	82	59	38	34

* Proportion of farmers planting at least one test variety regardless of species
** Figures in brackets represent number of households

Another objective of the survey was to determine the rate of adoption rates 3 years after the earliest OFDTs were implemented. The percentage of households which kept replanting during the 2008/09 cropping season were found to be 45%, 32%, 15% and 58% for maize, sweet potatoes, peanuts and rice respectively. The overall adoption rate of at least one test variety was 38%.

Collected data also allowed the calculation of anticipated adoption rates for the following 2009/10 cropping season, i.e. a possible 4th year of adoption after the 2005/06 OFDTs were installed. The rates were 38%, 30%, 13% and 58% for maize, sweet potatoes, peanuts and rice respectively. The overall adoption rate of at least one variety was expected to be 34%. These projections relied on that the farmer intended to replant and secondly he/she actually had enough seed to do so.

Table 140 presents the same data as the proportion of farmers who kept planting from one year to the next. The proportion of households replanting after the OFDTs was very high. The figures indicate that the following years (from year 1 to 2 and from year 2 to 3) show lower rates of planting. However, there is evidence that by the 3rd year after the OFDT, most of the farmers will replant the following year. This may be due to the fact that they have sufficient seed stocks and the chance of losing appropriate seed stocks through disasters had diminished. An explanation of this could be that if the farmer was able to keep seed a few years, the chances are that he/she will lose seed decreases afterwards. The less enthusiastic adopters may also have run out of seed.

Table 140. Proportion of households planting test varieties one year to next

Data source	*Crop (1 or more varieties)*	*Proportion of households (%) replanting from:* OFDT to 1st year	1st to 2nd year	2nd to 3rd year	3rd to 4th year (anticipated)
Data from 2009 survey (open; 90 households)	Maize (42)**	98	66	70	84
	Sweet potato (37)	76	64	67	92
	Peanuts (40)	75	50	40	83
	Rice (12)	92	73	88	100
	Overall* (90)	82	72	64	91

* Proportion of farmers planting at least one test variety regardless of species
** Figures in brackets represent number of households

Adoption by gender

Data collected on adoption was gender disaggregated to determine whether male and female headed household presented different adoption rates. No difference was found to be significant when tested by Chi²-test (Table 141).

Table 141. Adoption rates by gender 3 years after 2005/06 OFDT

Crop		Maize	Sweet P.	Peanuts	Rice	Overall (at least 1 var. of any species)
Adoption levels % (ratio)	*All*	45 (19/42)	32 (12/37)	15 (6/40)	58 (7/12)	38 (34/90)
	Male	47 (16/34)	28 (8/29)	17 (5/29)	55 (6/11)	36 (25/69)
	Female	38 (3/8)	50 (4/8)	9 (1/11)	100 (1/1)	43 (9/21)

Note: Female headed households represent 30% of the survey data

Increase in planted area from 2nd to 3rd year after 2005-2006 OFDTs

Results of work reported in the section above showed that adopting farmers usually increase the areas replanted with tested varieties, from OFDT to one year after and from one to two years after. The results in Table 142 suggest that the total area replanted from two years to three years after the OFDTs was still increasing.

However, this increase was quiet low for sweet potatoes and peanuts which remain planted in relatively small areas (always less than 500 m², often less than 100 m²), probably because of the difficulty for farmers to keep enough sweet potato stems alive over the dry season, while peanuts remain highly labour intensive.

For maize and rice, the larger area increase is masked by the fact that some farmers did not have sufficient seed while others could not plant more because they had already reached their maximum labour or area capacity. Very few farmers had decreasing areas.

Table 142. Expansion of the cropped area from 2008 to 2009* from 2006 OFDT seed

Crop	Maize	Sweet potatoes	Peanuts	Rice
Number of households which kept planting in 2008 and 2009	19	12	6	7
Areas planted in 2008 per household (m²) of this sample	2,580	210	245	5,500
Areas planted in 2009 to date per household (m²)	4,200	230	260	7,220
Area increase (%) from 2008 to 2009	+ 63 %	+ 10 %	+ 7 %	+ 31 %

* Depending on the district, planting in 2008 can belong to 2007-2008 or 2008-2009 to 2009

Dissemination / spreading

Thirty four percent of farmers who installed successful OFDTs gave seed to friends and neighbours. Half of these farmers gave seed to 1 or 2 other households. Ten percent of farmers spread the new seed among 10-25 friends and neighbours over a two year period (Figure 42).

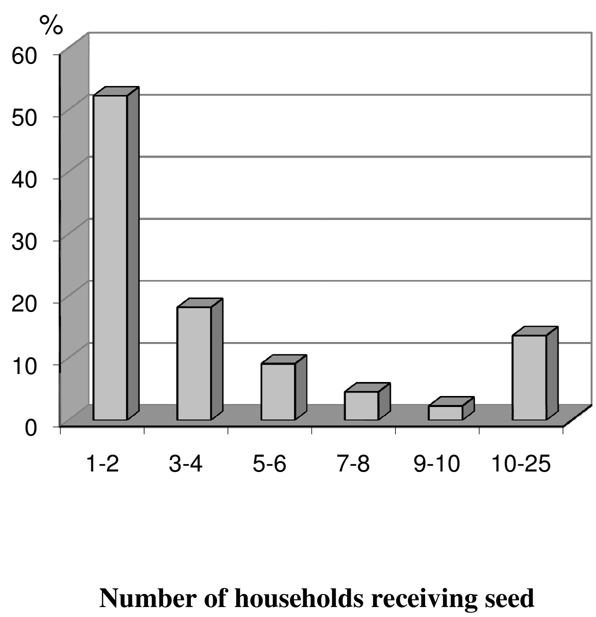


Figure 42. Number of households given seed by OFDT households.

Maize and rice seed is easier to multiply and therefore has the capacity to spread more quickly. Farmers tend to gift maize and rice seed at higher weights and to more people (Table 143) resulting in a higher "multiplicaton factor". Sweet potato cuttings are bulky and fragile. Therefore, despite the "multiplicaton factor" being reasonably high, small amounts were gifted resulting in a smaller area. Peanuts are considered to be a valuable commodity and is not gifted as often as other crops.

Extrapolating the the seed dispersal over the number of recipients indicate that this informal distribution of seed from OFDTs conducted in 2005/06 had the potential to plant 200 ha of maize, 800 ha of rice and smaller areas of sweet potato and peanuts in 2009 (Table 143).

Table 143. Dissemination of seed from 2005/06 OFDT farmers between 2006 and 2009

Crop	Maize	Sweet potatoes	Peanuts	Rice
Number of OFDT households in the sample	42	37	40	12
Number (%) of OFDT households giving seed to other families	18 (43%)	10 (27%)	10 (25%)	6 (50%)
Number of non-OFDT households receiving seed from ODFT households*	103	52	29	44
Average multiplication factor (ex: 15 OFDT families giving seed to 45 families = × 3)	× 5.7	× 5.2	× 2.9	× 7.3 ***
Average quantity of seed (kg) or cuttings (stems) given per non-OFDT household	8 kg	25 stems	1.8 kg **	60 kg
% of each varieties	Sele: 70% Sw 5: 30%	H1: 35% H2: 35% H3: 30%	Utamua: 54% GN11: 37% PT15: 9%	Nakroma: 100%
Average area planted per non-OFDTs household if 75% of the received seeds are sown	0.2 ha	6 m²	300 m²	2.3 ha
Total number of 2005-2006 successful OFDTs households, nation-wide	170	83	168	47
Extrapolation of the total number of non-OFDT households receiving seeds from OFDT households*	970	430	490	340
Extrapolation of the approximate total area planted by non-OFDTs households	200 ha	2 600 m²	50 ha	800 ha

* A family can receive seed samples of different crops from the same OFDT household
** Peanut quantities are likely to have been over estimated by farmers
*** Over estimation may come from 1) small sample size and 2) one interviewed farmer represented a group with above average distribution of seed to other families

Reasons for dis-adoption

Dis-adoption is defined as the abandonment of a formally adopted species or variety. When asked why they had stopped planting the new crops, farmers usually gave one or two reasons. Only 3% of farmers gave up the technology because they disliked the variety. The remaining 97% stated that they were unable to replant because they ran out of seed. Whole areas suffered the same fate. For instance, Alas was affected by floods in 2006 which destroyed all low-land crops. In a similar way, Liquiça-Dato was severely affected by a lack of rain, whereas Liquidoe and Vemasse suffered from above-average damage from rats and various wandering animals. Nevertheless, a nation-wide trend clearly appeared for most crops (Table 144). Destruction by animals (rats, pigs, cattle, dogs and goats) was by far the most common reason for the losses of crops before harvest, followed by inhospitipal weather. Only for rice was this trend reversed. Irrigated rice crops may have been more affected by drought when there was insufficient water to finish off the crop. Post harvest losses (consumption of the seed and weevil damage) and losses due to insects of diseases were also common problems. A small number of farmers also reported cases of poor germination (peanuts only), dislike of the variety (Suwan 5 mostly), sickness/pregnancy, moving to other location, labour or land limitations, rotten seeds.

Table 144. Main reasons for ceasing to grow test varieties (2005-2009)

	Crop	Maize* (42)	Sweet P. (29)	Peanuts (48)	Rice (7)	All (126)
% of reasons for ceasing to grow variety following destruction caused by:	- Animals	31	66	35	14	40 **
	- Drought & floods	29	21	27	43	27 ***
	- Post-harvest issues	19	3	8	14	11
	- Insects & diseases	10	3	4	14	6

* Number of farmers in brackets
** Rats: 13%, Pigs: 10%, Cattle: 9%, Dogs: 5%, Goats: 3%
*** Drought: 16%, Floods: 11%

Conclusion

The open ended questionnaire used in the survey discussed here led to a different interpretation of the adoption or lack of adoption of newly released crop varieties. The new questionnaire, while collecting more precise and diverse data was also quicker to complete than the previous time-consuming adoption surveys.

The results indicate that the number of farmers continuing to grow the new varieties steadily decreased each year. The usual farming problems such as diseases, pests and post-harvest issues were rarely the cause for dis-adoption. The main reasons were clearly the complete destruction of crops by rats, wandering animals and weather extremes. Socio-economic factors also likely influenced adoption rates as they strongly determine the level of resilience of farming households to hazards. Consequently, the results presented in this chapter also support the studies reported in other parts of Chapter 5 and in Chapter 6 in this report.

Natural hazards are, very likely, the primary reason behind dis-adoption and are difficult to control. As a result, it is difficult for farmers to control small seed stocks of new varieties. They rely on their local network for seed of which may provide only local varieties. Alternative channels may be needed to make seed available. The use of OFDTs, in addition to be a testing tool, as an efficient dissemination device is questionable. The evidence suggests that farmers simply don't have enough seed to give significant amounts to friends and family. However, given the large number of OFDTs which have been implemented by SoL (more than 2 500 between 2005 and 2009), informal dissemination is appreciable. In addition, OFDT farmers spread the word to other farmers in the community that the new varieties possess valuable characters.

4.3 Constraints to farmers growing Nakroma rice variety

Introduction

A survey of selected participating farmers involved in SoL research that continued to or did not continue to plant Nakroma after being supplied with a small amount of seed was undertaken from November 2008 through to May 2009. The study was an initial step for a much broader study of constraints to adoption of new varieties

Methodology

The list of farmer households was obtained from the initial early adoption survey (EAS) conducted in 2007.

The survey tool consisted of two questionnaires which sought to define differences in socio-economic status, education levels, assets, reasons for not replanting, years of experience as a rice farmer, labour group organization, biodiversity, characteristics, observed characteristics of Nakroma, and for those farmers who sold surplus, what they bought with the money.

The two questionnaires were each carried out with three categories of farmers. The categories included:

1. 'Continuing to plant farmers': defined as those farmers who had planted over successive seasons
2. 'Non continuing to plant': defined as farmers who only planted once or twice after implementing an OFDT
3. 'OFDT only': defined as farmers who undertook the OFDT but did not replant Nakroma

From a total of 47 farmer households, the initial EAS survey suggested that only 11 of these were 'continuing to plant'. However, this study found that 23 of these farmers were 'continuing to plant' and the remaining 24 were 'non continuing to plant' and 'OFDT only' (Table 145). The year the OFDT was undertaken per category is presented in Table 146.

Table 145. Locations of Nakroma study participants

No.	*District*	*'Continuing to plant'*	*'Non continuing to plant'*	*'OFDT only'*	*Total*
1	Aileu	5	10	3	18
2	Baucau	15	3	6	24
3	Liquica	2	-	2	4
4	Manufahi	1	-	-	1
Total		23	13	11	47

Table 146. Year OFDT was undertaken

Category	*2006*	*2007*	*Total*
'Continuing to plant'	15	8	23
'Non continuing to plant'	13		13
'OFDT only'	2	9	11
TOTAL	30	17	47

Results

Socio-economic and demographic characteristics of study participants

All participants included in this study were involved in Seeds of Life rice activities from 2006-2007. The farming practice of all of the respondent households can be categorized as subsistence; namely they have no off-farm income, and their sole cash was derived from the occasional sale of surplus produce. From a total of 47 participants, 51.0% were from Baucau, 38.3% were from Aileu, 8.5% were from Liquica and 2.1% were from Manufahi. The majority of participants were married with families and 2.1% (one farmer) was single. Most households had between 6-10 members (65.9%). A significant portion of households had between 1-5 members (23.4%) and 11-15 members constituted 10.6% of total households. Large households are both an advantage and disadvantage because they act as a labour source however the labour they provide is not commensurate with scales of produce to feed the household all year. The 'OFDT only' category was the only category showing roughly equal numbers of members for the bigger sized households (frequency of households between 1-5 and 6-10 members was 45%) where as the majority of 'Non continuing to plant' and 'continuing to plant' households had between 6-10 members. It is difficult to ascertain the impact of having a higher frequency of 1-5 members for the 'OFDT only' category. As would be expected from such a socio-demographic grouping, most had received very little education, 44.6% had no schooling at all, 29.8%, had completed primary school, 12.6% had completed junior high school and none had attended university.

Assets

Water buffalo ownership was a significant asset for the surveyed rice farmers as they served as labour in plowing fields. There was a significant difference between the three categories. The 'Continuing to plant' category (23 farmers) had a total of 117 water buffalo; the 'Non Continuing to plant' category (13 farmers) had a total of 10; similarly the 'OFDT only' category (11 farmers) had a total of 7 water buffalo thus significantly diminishing their ability for output.

Land ownership

All land used for farming by the three categories was their own land or land owned by the family. The only striking difference between the categories in regards to land ownership was that the 'Continuing to plant' farmers were the only category to report a shared cropping system (8.6%) in which they supplied the land and others worked on their land (Table 147, Table 148, Table 149).

Table 147. Land ownership of 'Continuing to plant' farmers

Rice field status	*District (23 farmers)*				*Total*
	Aileu	Baucau	Liquica	Manufahi	
Own land	5	13	1	1	20
Rent	-	-	-	-	-
Government	-	-	-	-	-
Church	-	-	-	-	-
Family	-	1	-	-	1
Shared cropping	-	1	1	-	2

Table 148. Land ownership of 'Non continuing to plant' farmers

Rice field status	*District (13 farmers)*		*Total*
	Aileu	Baucau	
Own land	7	2	9
Rent	-	-	-
Government	-	-	-
Church	-	-	-
Family	3	1	4
Shared cropping	-	-	-

Table 149. Land ownership of 'OFDT only' farmers

Rice Field Status	*District (11 farmers)*			*Total*
	Aileu	*Baucau*	*Liquica*	
Own land	*3*	*5*	*1*	*9*
Rent	-	-	-	-
Government	-	-	-	-
Church	-	-	-	-
Family	-	*1*	*1*	*2*
Shared cropping	-	-	-	-

Mutual labour organization for rice farmers

Most farmers used a range of working methods simultaneously and this was dependent upon harvest size and the amount of labour required. The most common method of mutual labour for all three categories is known as 'exchanging hands' (*troka liman*) (Table 150, Table 151, Table 152). A total of 82% of farmers offered labour in return for receiving labour in the 'Continuing to plant' category; 45% in the 'Non Continuing to plant' category and 72% of 'OFDT only' farmers.

The method known as 'shared resources' was the second most common form of mutual labour organization (25%) (Sharing resources may include labour, land or assets such as buffalo or tractors). For the 'Continuing to plant' category the payment of money and meat through the killing of animals occurred in almost the same frequency 8.5%, 6.3%. Meat was given in the form of a cooked meal at harvest time. The farmers who paid others in cash or meat may not participate in the mutual labour organization themselves.

It is noted that none of the 'Non continuing to plant' and only one 'OFDT only' farmers paid labourers with money. A reliance on the household unit only was also not very common among the three categories. This testifies to the importance of sharing skills and resources among Timorese rice farmers.

Table 150. Mutual labour organization of 'Continuing to plant' farmers

Type of mutual labour organization	*District (23 farmers)*				*Total*
	Aileu	*Baucau*	*Liquica*	*Manufahi*	
Exchanging hands	*5*	*12*	*1*	*1*	*19*
Household only	*1*	*1*	-	-	*2*
Kill animals/ or help one another	-	*3*	-	-	*3*
Pay with money	-	*3*	-	*1*	*4*
Shared resources	*3*	*8*	*1*	-	*12*

Table 151. Mutual labour organization of 'Non continuing to plant' farmers

Type of mutual labour organization	*District (13 farmers)*		Total
	Aileu	Baucau	
Exchanging hands	10	1	11
Household only	-	2	2
Kill animals/ or help one another	1	-	1
Pay with money	-	-	-
Shared resources	8	2	10

Table 152. Mutual labour organization of 'OFDT only' farmers

Type of mutual labour organization	*District (11 farmers)*			*Total*
	Aileu	Baucau	Liquica	
Exchanging hands	2	5	1	8
Household only	1	1	1	3
Kill animals/ or help one another	-	1	-	1
Pay with money	-	1	-	1
Shared resources	1	3	-	4

Constraints for continuing to plant Nakroma

The main constraint to farmers replanting Nakroma was the loss of seed from external environmental factors (38% of total Nakroma farmers interviewed) (Table 153). This was primarily because of lack of water. The reasons farmers cited were late rains (for rain-fed farms), broken irrigation systems, and dry irrigation systems (Table 154). Pest damage was the next most significant limiting factor to seed loss.

Table 153. Farmer's reasons for not replanting

Farmer's reasons for not replanting	*Percentage of respondents*
Lack of water	38
Small harvests that yielded no seeds	6
Rotten seeds	2
Pests	14
Seeds were mixed with local seeds	2
Birds	4
Late planting	4

Table 154. Farmer's reasons for lack of water

Farmer's reasons for lack of water (from total reasons for not planting)	*Percentage of respondents*
Broken irrigation systems (lack of water)	11
Lack of rainfall (lack of water)	22
Dry irrigation systems (lack of water)	33
Rice plant grew but seed was empty (no water)	33

'Continuing to plant' and 'Non continuing to plant' Nakroma planting opportunities

The number of times a farmer replanted was largely dependent upon the number of seasonal opportunities to replant. (i.e. What year the OFDT was undertaken and potential number of rice crops per year).

For those farmers continuing to plant (a total of 23), 15 farmers established their OFDT in 2006 and 8 in 2007 (Table 155). The farmers, who established their OFDTs in 2006, had the opportunity to plant a minimum of 3 times and maximum of 6 times (dependent upon rainfall and whether a second season could be planted). Consistent with the early adoption survey data, the majority of farmers were found to be losing seed after the first planting (after the OFDT trial) (Table 156) which means there was less seed available for planting following seasons.

Table 155. 'Continuing to plant' number of times planted

District	*Number of times planted SoL variety*					
	I	II	III	IV	V	VI
Aileu (2006)	-	2	2	-	-	1
Baucau (06/07) (2 seasons)	1	8	4	1	1	-
Liquica (06)	-	2	-	-	-	-
Manufahi (06) (2 seasons)	-	-	-	-	-	1
Total	1	12	6	1	1	2

Table 156. 'Non continuing to plant' number of times planted

District	Number of times planted SoL variety		
	I	II	III
Aileu (2006)	8	1	1
Baucau (2006/2007)	2	1	-
Total	10	2	1

Differences in yields/areas

Willingness for farmers to replant was related to the perception of yield. In total, 55.3% of farmers reported that Nakroma yielded higher than local varieties in the same area; 22.3% of farmers reported that there was no difference in yield between local and Nakroma varieties; and 8.5% of farmers reported that local in fact yielded higher than Nakroma. 100% of 'Continuing to plant' farmers cited that their local variety yielded lower than Nakroma, a clear reason why they adopted Nakroma (Table 157). Equal numbers of 'Non continuing to plant' farmers reported that Nakroma yielded higher and that there was no difference in yield- this could be a significant factor in why they did not continue to plant (Table 158).

None of the eleven 'OFDT only' farmers reported that Nakroma yielded higher than the local variety two 'OFDT only' farmers reported that the local variety yielded higher and 3 'OFDT only' farmers reported that there was no difference in yield (Table 158). A total of 6 'OFDT only' farmers failed to get any yield at all from the OFDT site and thus were unable to comment on whether the Nakroma yield was higher or not (more than half of the respondents had no yield and therefore no opportunity to replant).

Table 157. 'Continuing to plant' differences in yield

District	*Local higher yield*	*Nakroma higher yield*	*No difference in yield*
Aileu	-	5	-
Baucau	-	13	2
Liquica	-	2	-
Manufahi	-	1	-
Total respondents	-	21	2

Table 158. 'Non continuing to plant' differences in yield

District	*Local higher yield*	*Nakroma higher yield*	*No difference in yield*
Aileu	1	5	4
Baucau	2	-	1
Total respondents	3	5	5

Table 159. 'OFDT only' differences in yield

District	*Local higher yield*	*Nakroma higher yield*	*No difference in yield*	*Failed OFDT*	*Total*
Aileu	1	-	1	1	3
Baucau	1	-	1	4	6
Liquica	-	-	1	1	2
Total respondents	2	-	3	6	11

Correlation between years of experience and the possibility to continue planting Nakroma

There was no substantial difference between the three categories for the length of time a farmer had been cultivating rice. Most farmers had been cultivating rice for more than ten years. For the 'Continuing to plant' category, 85% of farmers (20/23) had cultivated rice for more than ten years (Table 160); 84% of farmers (11/23) of 'Non continuing to plant' farmers had cultivated rice for more than 10 years (Table 161) and; 72% of 'OFDT only' farmers have cultivated rice for more than ten years (Table 162).

Table 160. 'Continuing to plant' Years cultivating rice

Years cultivating rice	*Respondents/district*				*Total respondents*
	Aileu	Baucau	Liquica	Manufahi	
1-10 Years	-	2	1	-	3
>10 Years	5	13	1	1	20
TOTAL					23

Table 161. 'Non continuing to plant' Years cultivating rice

Years cultivating rice	*Respondents/district*		*Total*
	Aileu	*Baucau*	
1-10 Years	*2*	*-*	*2*
>10 Years	*8*	*3*	*11*
TOTAL			*13*

Table 162. 'OFDT only' Years cultivating rice

Years cultivated rice	*Respondents/district*			*Total*
	Aileu	*Baucau*	*Liquica*	
1-10 Years	-	*1*	*2*	*3*
>10 Years	*3*	*5*	-	*8*
TOTAL	*3*	*6*	*2*	*11*

Prioritising diversity for continuing to plant farmers

The farmers, who continued to plant Nakroma, demonstrated an interest in maintaining diversity by continuing to plant their local varieties (Table 163). The reasons they provided included consideration of the risks associated by relying on only one variety. Because of such variable weather conditions, diversity becomes a key risk strategy but there is not a direct relationship shown in the data collected. A total of 21.7% farmers of the 'Continuing to plant' category had decided to completely replace the local variety with Nakroma because of its high-yield capacity.

Table 163. Number of farmers growing local varieties

District	*Local Varieties*		*Total*
	'Continuing to plant' local varieties	'Non continuing to plant' local varieties	
Aileu	5	-	5
Baucau	12	3	15
Liquica	1	1	2
Manufahi	-	1	1
Total respondents	18	5	23

Of the 18 farmers who continued to plant both Nakroma and local varieties, the most commonly planted 'local' rice varieties included those referred to as Fulon, Silaun and Membrano (Table 164). It is not uncommon for farmers to plant 2-3 varieties of rice which they have been growing since the time of their forefathers.

Table 164. Local varieties grown by district

Variety	*District*				*Total*
	Aileu	*Baucau*	*Liquica*	*Manufahi*	
IR64	-	*1*	-	-	*1*
Fulon	*4*	-	-	-	*4*
IR8	-	*1*	-	-	*1*
Ismani	-	*1*	-	-	*1*
Silaun	-	*4*	-	-	*4*
Membramo	-	*2*	*1*	-	*3*
Insus	-	*2*	-	-	*2*
Hare mean	*1*	-	-	-	*1*
Laku resa	-	*1*	-	-	*1*
Total number of respondents	*5*	*12*	*1*	-	*18*

Characteristics found in Nakroma desired by farmers

The question on observed characteristics of Nakroma illustrates important knowledge on farmer preferences. For the 'Continuing to plant' category, farmers were unanimous in their observations that Nakroma was high yielding (Table 165). Eight of the reported characteristics relate to food processing and highlight the importance farmer's value on taste characteristics as well as yield in their choice of crop.

Table 165. Characteristics of Nakroma desired by farmers

High yielding	100
Sweet smell	94
Long storage time	94
Good market price	79
Easy to thresh	77
Good to make porridge (a common breakfast food)	70
Easy to pound	70
Soft to eat	53
Oily texture	47
Sufficiently good tasting without vegetables	41
Sweet flavour	27
Sticky	6
Good size seed	6
Good colour	2
Cooks more than local variety (fills the pot)	2

Produce uses

All farmers continuing to plant Nakroma used the produce for household consumption and seed storage. The frequency for gifting to neighbours and family was similar in this study (Table 166). Only a very slim majority of the total produce was sold (only 13% of the farmers who continued to plant Nakroma reported selling their produce). Farmers selling rice were from Aileu, Baucau and Manufahi. Two farmers sold their produce in the market and two farmers sold seed to SoL in a contractual arrangement.

Table 166. Uses of rice harvest apart from home consumption

District	*Produce uses*					
	Gifted to family	Gifted to neighbours	Household consumption	Saved for seeds	Sold	Distributed to working group members
Aileu	1	1	5	5	1	-
Baucau	8	8	15	15	1	-
Liquica	-	-	2	2	-	1
Manufahi	1	1	1	1	1	-
Total respondents	10	10	23	23	3	1

For those three farmers that sold their produce, the proceeds was used to purchase necessities, such as clothes and children's schooling, and to invest further in livelihood investments by the purchase of a coconut processing machine and an animal (Table 167). These are important investments that go toward securing livelihoods in the future and a further indirect benefit of participation in the SoL program.

Table 167. Use of funds from rice sales

District	*Necessities purchased*			
	Clothes purchases	Coconut processing machine	Animal purchases	School fees
Aileu	1	-	-	1
Baucau	-	1	-	-
Liquica	-	-	-	-
Manufahi	-	-	1	1

Conclusion

The purpose of this short survey was to understand the challenges for farmers adopting new varieties and to define the characteristics of farmers to assist in forecasting those more likely to adopt SoL varieties.

The main challenge to farmers identified in this Nakroma rice study was the loss of seed due to lack of rainfall, therefore the removal of the possibility to replant. This problem could be addressed if farmers had a readily available source of seed at a local level. No farmers reported a rejection of the variety's characteristics.

The perception of a yield difference was a significant factor in determining whether a farmer would replant a variety. The farmers who continued to plant Nakroma recorded significant yield advantages over local varieties, whereas for those farmers who ceased planting reported the same or less yield. Diversity of varieties was being maintained by farmers continuing to plant Nakroma.

From the participants included in the research, data demonstrates that farmers who had a higher socio-economic status (with assets such as buffalo), and those who share cropped and able to pay workers, were more likely to continue planting Nakroma, or have the opportunity to replant.

4.4 Constraints to farmers growing Utamua peanuts

Introduction

A survey of selected participating farmers involved in the SoL program who at one time grew or continued to grow the Utamua variety of peanut was undertaken during the months between June and September, 2009. This chapter summarizes the main results of that study.

Methodology

The list of farmer households for the study was obtained from the initial Early Adoption Survey conducted in 2007 (see SoL, 2007).

The survey tool consisted of a questionnaire which sought to define differences in socio-economic status, education levels, livelihoods, livestock ownership, assets, reasons for replanting after the initial OFDT or not replanting, main crops planted, sources of income, objective of planting Utamua, storage systems, availability of sources of aid, involvement in working groups systems, land ownership histories, biodiversity in the field and other issues.

The questionnaire was carried out with three categories of farmers. The categories included:

1. 'Continuing to plant' farmers: defined as those farmers who had planted over successive seasons
2. 'Non continuing to plant': defined as farmers who only planted once or twice after the OFDT
3. 'OFDT only': defined as farmers who undertook the OFDT but did not replant Utamua

The locations and farmer classification and year that the OFDT was conducted are presented in Table 168 and Table 169, respectively.

Table 168. Locations of Utamua study participants

No.	*District*	*'Continuing to plant'*	*'Non continuing to plant'*	*'OFDT only'*	*Total*
1.	Aileu	0	5	4	9
2.	Baucau	8	2	8	18
3.	Liquica	3	4	5	12
4.	Manufahi	2	3	6	11
5	Ainaro	1	1	2	4
TOTAL		*14*	*15*	*25*	*54*

Table 169. Year OFDT was undertaken

Category	*2006*	*2007*	*Total*
'Continuing to plant'	6	8	14
'Non continuing to plant'	10	5	15
'OFDT only'	12	13	25
TOTAL	*28*	*26*	*54*

Differences with the Early Adoption Survey (EAS)

More farmers were found to be regularly planting Utamua than in the early adoption survey (EAS) completed in 2007. The EAS found that 12 farmers were "Continuing to plant" whereas the current constraints survey found there were in fact 14 farmers. In addition, while the EAS found that a total of 19 farmers had ceased planting ('Non-continuing to plant'), the current constraints survey found there were just 15 farmers who had ceased planting. There was only one more farmer found to be belonging to the "OFDT only" category than originally found in the EAS (from 24 to 25 farmers).

Table 170. Differences with early adoption survey (EAS)

Category	*EAS*	*Current constraints survey*
'Continuing to plant'	12	14
'Non continuing to plant'	19	15
'OFDT only'	24	25
TOTAL	*54*	*54*

Socio-economic and demographic characteristics of study participants

All participants in this study had been involved in the OFDT program of SoL since 2006-2007. The farming practice of the majority respondent households was categorised as subsistence; just 5% respondents noted their main income was off-farm and included a teacher, church official, running a small kiosk, and carpenter. The majority (95%) of respondents derived their income from the occasional sale of surplus produce and animals. From a total of 54 respondents, 33% were from Baucau, 17% from Aileu, 8% from Ainaro, 22% from Liquica, and 20% from Manufahi. A total of 83% of household heads were male, the remaining 17% were self-identified as female household heads (because the husband had passed away). The majority of respondents from all three categories including the 'continuing', 'non-continuing' and 'OFDT only' farmers were married with families. A total of 71% of 'Continuing to plant' farmers were reported as married, the remaining 29% were widowed. A total of 88% of 'Non-continuing to plant' farmers were married, the remaining 12% constituted single and widowed. For the 'OFDT only' category, 84% were married; 16% constituted singled and widowed. In terms of household size, the majority of households consisted of between 6-10 family members. A total of 35% of the 'Continuing to plant' farmer households; 66% of 'Non continuing' farmers and 56% of the 'OFDT only' farmers had between 6-10 family members. It is significant that none of the widowers in any of the three categories lived alone. As would be expected from such a socio-demographic grouping, most had received very little education. An average of 40% of all three categories received no education at all. There was no significance between the three groups in the number who completed high school – averaging 8% from all categories.

Assets

Water buffalo was a significant asset for farmers. Buffaloes that can be sold or traded for a high price. There was a significant difference between the three categories. The 'Continuing to plant' category (14 farmers) owned a total of 74% (68) of all buffalo. The 'Non continuing' to plant owned 16% (15 buffalo). The 'OFDT only' category owned slightly more buffalo, a total of 27% (25 buffalo) suggesting these farmers were more engaged in other activities than peanut farming.

Land Ownership

Most land used for farming for all three categories was the farmers own land or land owned by the family. The 'OFDT only' category was the exception with one case of a widower using government owned land for farming. A significant majority of all three categories was involved in an exchange form of labour known as 'exchanging hands' (*troka liman*) where members offer labour to fellow members and receive labour in return. For the 'Continuing to plant' category (14 farmers), 57% used the 'exchanging hands' labour system, 66% of the 'Non continuing' farmers and 68% of the 'OFDT only' category. It is noted that while none of the

'Non continuing' farmers or 'OFDT only' farmers paid labourers with money, a total of 28% of the 'Continuing to plant' farmers use this system of labour. This suggests the 'Continuing to plant' category of farmers constituted a higher socio-economic standing than the other two categories.

Livelihoods

Respondents in this study shared similarities in the livelihoods they engage in terms of their primary crops, the range of crops planted in the field and their primary source of income. For the 'Continuing to plant' category (14 farmers), 85% reported that their main crop was maize and the remaining 15% reported that coffee was their main crop and thus the main source of income. All farmers in the 'Continuing to plant' category reported four or more crops growing in their fields. A large majority grew horticulture crops (pumpkin, green vegetables, beans etc), tree crops (coconut, banana, avocado) and food crops (cassava, sweet potato, wild yams, taro) and all grew peanuts. In addition, 35% reported peanuts or Utamua amongst their main source of income. For the 'Non continuing to plant' category (15 farmers), all farmers reported that maize was their main crop however main sources of income were inconsistent. A total of 46% of farmers grew peanuts but just 7% sold peanuts (before planting Utamua). A total of 13% of 'Non continuing to plant' farmers reported off-farm income as their main income (by opening a small kiosk). A further 33% reported that a selling a combination of maize and animals constituted their main source of income. The vast majority of 'OFDT only' farmers (75%) sold a combination of horticulture and food crops. A total of 12% reported that their main income was drawn from selling coffee beans and animals. A further 12% reported that peanuts were amongst the main crops from which they drew their income. A total of 8% recorded that their main income was gained through off-farm activities (a small kiosk, church functionary, carpenter).

Objective of planting Utamua

Respondents were asked what their intention or objective was for planting Utamua. While all three categories of farmers intended to either consume or sell the produce, there were slightly different nuances of intention recorded between the groups. The 'Continuing to plant' category reported that 42% intended to eat and sell the produce; 28% intended to solely sell the produce; 14% intended to focus on increasing seed production before selling the produce when there was a surplus and 14% reported that the produce was for consumption only. For the 'Non continuing to plant' category, a slightly higher total of farmers (73%) reported that they intended to both eat and sell the produce. A total of 26% reported that the produce was intended for consumption only. The 'OFDT only' category was the exception to the pattern of selling Utamua produce. A total of 44% reported that the produce was intended for consumption only; 32% reported that the produce was intended for both consumption and trade and a further 20% suggested that the produce was purely for trade.

Constraints to replanting Utamua

The main constraint to farmers replanting Utamua was the loss of seed from external factors. Lack of water was the most cited reason (31%) for not replanting (Table 171). This was expressed as 1) lack of rain 2) the long dry-season that dried up the soil 3) the river water source dried up. The second most cited reason (25%) for not replanting was loss of seed due to rats eating the seed either in storage or when it was in the ground. Thirdly, 9% of farmers cited rotten seed as a reason for not replanting. In addition, 6% of farmers thought that the soil was inappropriate for growing Utamua. None of the farmers interviewed in Aileu were able to replant due to a lack of seed – all of their crops died in the ground due to lack of water.

Table 171. Reasons for not replanting

Farmers reasons for not replanting	*Percentage of respondents*
Lack of water	31
Rats	25
No labour	11
Rotten seed	9
Flood	2
Eaten by animals/ants	6
Unsuitable soil	6
Ate seed	6
Too long in the ground (died)	6
Total number of respondents	*44*

Intention to replant (if seed available)

A question was asked of the 44 'Non continuing to plant' and 'OFDT only' farmers of their intention to replant if seed was made available to them and if possible, to provide the main reason why they thought it was worth replanting. A total of 50% reported they would like to replant in order to give an accurate assessment to the variety's characteristics (Table 172). A further 15% reported that they would replant to sell the produce. A further 15% said because they still had a field available which could be used for Utamua. The large majority of respondents who said they would not replant even if seed reported that they did not have the labour available (57% of farmers); they were coffee farmers or vegetable producers from which they reaped a better labour/profit margin. A further 14% of farmers said they would not replant because they thought Utamua needed too long in the ground before harvesting (on average 2 weeks longer than the local varieties).

Table 172. Reasons for intention to replant if seed available and not to replant

Intention to replant	*Percentage*	*Intention not to replant*	*Percentage %*
To sell	15	No labour	57
Liked big seed	10	Harvest period too long	14
Would like to try again	50	Animals/rats	21
High yield	15	No water	7
Still have a field	15		
Increase food reserves	10		
No of respondents	*20*		*14*

A total of 63% of farmers reported that they would replant if seed was made available. The vast majority (80%) did not know any other farmers who had Utamua seed. Just 20% of these farmers knew of other farmers nearby who had Utamua seed and who they presumed would give them seed if they asked.

The entire 'Continuing to plant' category intended to plant Utamua in the following season. A total of 64% reported that they intended to sell the produce; the remaining 36% reported that they would plant again because of the high yield/big seed.

Prioritizing diversity

The majority of farmers continued to plant a local variety of peanut alongside Utamua. The 'Continuing to plant' category recorded the highest frequency (79%) of planting local varieties from all of the categories. The reasons cited included high yield (27%) (Table 173) and that the seed had become adapted to the land or that they had planted it since the time of their ancestors (commonly expressed as *fini toman ona* or *desde tempo avo sira*) (27%). A total of 18%

reported that they continued to grow the local variety of peanut because of its sweet taste and because they could sell it in the market. The remaining 9% reported that they continued to grow the local variety of peanut because it constituted an important source of food for the family. Correspondingly, a total of 21% of 'Continuing to plant' farmers reported that they had ceased planting their local variety of peanut because the price had dropped in the market (34%), had a low yield (33%), and because they did not have enough labour (33%) meaning that the farmer preferred to channel his resources into other crops.

Table 173. Reasons for planting local varieties. "Continuing to plant" farmers

Reasons for continuing to plant local variety	*Total percentage of farmers*	*Reason for stopping plant local variety*	*Total percentage of farmers*
High yield	27	Dropped price in market	34
Adapted to the land	27	Low yield	33
Sweet taste and smell	18	No labour	33
Sell	18		
For food	9		

A total of 53% of 'Non continuing to plant' Utamua farmers continued to plant a local variety of peanut. Similarly, a total of 38% reported high yield as a motivating reason for planting local varieties. A total of 25% reported that they continued to plant local varieties of peanut because it fetched a good price in the market. (A total of 12% reported that they continued to plant local varieties because it was sweeter in smell and taste than Utamua. Similarly, a total of 12% confirmed the continuity of local varieties because they planted it since the time of their ancestors and that it constituted a key source of food security for the family. Not having enough labour was the most frequently cited reason (43%) for not continuing to plant local varieties (and by extension, Utamua). Other reasons cited for not continuing to plant local varieties included always being eaten by animals (29%); no more seed (14%); lack of rain (14%).

Table 174. Reasons for planting local varieties "Non continuing to plant" farmers

Reasons for continuing to plant local variety	*Total percentage of farmers*	*Reason for stopping plant local variety*	*Total percentage of farmers*
High yield	38	No labour	43
Good price	25	Eaten by animals	29
Adapted to the land	27	Lack of rain	14
Sweeter taste and smell (compared to Utamua)	12	No seed	14
Since ancestor times (adapted to the land)	12		
For food	9		

A total of 56% of 'OFDT only' farmers continued to plant local varieties. The main reason was they had grown the varieties since ancestor times and it was adapted to the land (57%) and because the local variety got a good price in the market (43%) (Table 175). A total of 44% reported that they had stopped planting local varieties mainly because of limited labour (55%); rats (18%); flood (9%) and because they had never grown peanuts (9%).

Table 175. Reasons for planting local varieties for "OFDT only" farmers

Plan to continue planting local	*Total percentage of farmers*	*Stop planting local variety*	*Total percentage of farmers*
Adapted to the land	57	No labour	55
		Eaten by rats	18
Sell		Low production	9
	43	Flood	9
		Never grown peanuts before	9

Land histories

There was no significant difference in the length of time that the respondents from all three categories had farmed peanuts and most had begun farming peanuts within the previous ten years. A total of 85% of the 'Continuing to plant' category; 60% of the 'Non continuing' to plant category; and 88% of 'OFDT only' farmers had farmed peanuts for less than 10 years.

The three categories were also similar in the rate of dislocation, or the frequency in which farmers moved from another hamlet to their current hamlet. A total of 50% of 'Continuing to plant' farmers; 46% 'Non continuing' farmers and 56% of 'OFDT only' farmers moved to their current hamlet from either another hamlet in the same village, another village or district. The high frequency of the dislocation could be accounted by the high numbers of widowers included in the study as usually the women move away from her family to the husband's property.

Less than a quarter of all participants had to walk more than one hour to reach their peanut fields. A total of 28% of 'Continuing to plant' farmers; 20% of 'Non continuing' and 16% of 'OFDT only' farmers lived more than an hour from their peanut fields.

Aid from government/NGOs

All farmers in each of the three categories received aid in some form however the 'OFDT only' category received 8% more aid than the 'Continuing to plant' category thus disproving the hypothesis that those with more access to aid would be more likely to continue planting but suggesting that the OFDT may not have succeeded because of involvement in aid activities. A total of 36% of 'OFDT only' farmers received aid, 44% (4) were in the form of seeds and the remaining were agricultural aid of a tractor (1), (imported) rice (1), a silo (1), animal (1), medical (1). A total of 28% of the 'Continuing to plant' farmers received agricultural aid in the form of seeds (1), a silo (1) and teak trees (1). A total of 20% of 'Non-continuing to plant' farmers received agricultural aid which constituted a tractor (1), teak trees (1), and a well (1).

Observed characteristics

Farmers were asked to make a comparison between Utamua and their local variety of peanut on pests, drought, and wind susceptibility. For the 14 'Continuing to plant' farmers, there was no difference between Utamua and local peanut variety (Table 176). A total of 71% of 'Continuing to plant' farmers thought that both the local and Utamua variety were susceptible to rat damage illustrating the shortfall in storage options.

Table 176. "Continuing to plant" peanut susceptibility comparison

Local	*Percentage of locals susceptible*	*Percentage of Utamua susceptible*
Pests	42 (6)*	42 (6)
Drought	35 (5)	35 (5)
Wind	0 (0)	0 (0)
Rats	71 (10)	71 (10)
Ants	14 (2)	14 (2)

*Farmer numbers in brackets

For the 15 'Non continuing to plant' farmers, the pattern of frequency of susceptibility for the local variety and Utamua was the same for all but one measured parameters (Table 177). The only exception was the case of flooding in which Utamua proved non-resistant.

Table 177. "Non continuing to plant" peanut susceptibility comparison

Local	*Percentage of locals susceptibility*	*Percentage of Utamua resistance*
Pests	13 (2)	13 (2)
Drought	28 (4)	28 (4)
Winds	6 (1)	6 (1)
Rats	28 (4)	28 (4)
Ants	6 (1)	
Flood		6 (1)

*Farmer numbers in brackets

For the 25 farmers who only planted an OFDT, the pattern of susceptibility observed for both local and Utamua were the same for all measured parameters (Table 178). The only exception was that slightly more farmers reported rat damage for Utamua. In other words, the local variety was reported as being 8% more resistant to rat damage than Utamua. This could be due to the fact that Utamua has a longer harvest period than most local varieties and thus is more susceptible to such pests.

Table 178. "OFDT only" peanut susceptibility comparison

Local	*Percentage of locals susceptibility*	*Percentage of Utamua susceptibility*
Pests	3 (2)	3 (2)
Drought	44 (11)	44 (11)
Winds	0 (0)	0 (0)
Rats	44% (11)	52% (13)
Ants	2% (1)	2% (1)

*Farmer numbers in brackets

Perceptions of yield differences on replanting decision

The desire of farmers to replant was related to the perception of yield advantage (Table 179). This was clearly illustrated by the "Continuing to plant" category of farmers, 64% of whom reported that Utamua yielded higher than the local varieties. A surplus in yield also means the farmer is more likely to store seed/planting material for next season.

Table 179. Perception of yield on "Continuing to plant" farmers'

District	*Local higher yielding %*	*Utamua higher yielding %*	*No difference in yield %*
Ainaro	7 (1)	0	0
Baucau	7 (1)	28 (4)	3
Liquica		22 (3)	0
Manufahi		14 (2)	0
Total respondents	*14 (2)*	*64 (9)*	*21 (3)*

*Farmer numbers in brackets

For the 15 "Non continuing farmers", the majority (78%) reported no difference in yield between Utamua and their local varieties (Table 180). There was a 51% difference between the number of 'Continuing to plant' farmers who reported a higher yield for Utamua (64%) and those 'Non continuing' to plant (13%).

Table 180. Perceptions of yield on "Non continuing to plant" farmers

District	*Local higher yield* %	*Utamua higher yield* %	*No difference in yield* %
Aileu	6 (1)	6 (1)	13 (2)
Baucau			13 (2)
Liquica			40 (6)
Manufahi	6 (1)	6 (1)	(6) 1
Total respondents	*13 (2)*	*13 (2)*	*78 (11)*

*Farmer numbers in brackets

Following this pattern of the falling likelihood of replanting with a lower yield is illustrated by responses of the "OFDT Only" category of farmers (Table 181). The majority of OFDT farmers could not provide comment on which variety had a higher yield because the OFDT had failed. A total of 32% reported that there was no significant yield difference between the two varieties. A significant 20% reported that the local variety yielded higher than Utamua. Just .5% of the 25 OFDT farmers reported that Utamua yielded higher than the local variety.

Table 181. Perceptions of yield on "OFDT only" farmers

District	*Local higher yield* %	*Utamua higher yield* %	*No difference in yield* %	*Failed OFDT* %
Aileu	0.5 (1)		1 (2)	1 (2)
Baucau		0.5 (1)	1 (2)	20 (5)
Liquica	0.5 (1)			
Manufahi	0.5 (1)		0.5 (1)	1 (2)
Ainaro	1 (2)		12 (3)	1 (2)
Total respondents	*20 (5)*	*0.5 (1)*	*32 (8)*	*44 11*

*Farmer numbers in brackets

Produce uses

Gifting and consumption were the most common reported uses for Utamua (Table 182). For the 'Continuing to plant' category, all said that the produce was for consumption. Interestingly, a total of 42% gift to family or neighbours and a further 7% take the produce to gift when visiting family or friends. A total of 36% sold the produce in the market but mostly from their homes.

Table 182. "Continuing to plant" category produce uses

Produce uses for 'Continuing to plant' farmers	*Percentage of farmers*
Consume	100
Gifted to family/neighbours to plant	42
Sell	36
Take to family/neighbours	7

A similar pattern emerged for the uses of Utamua for the 'Non continuing to plant' category (Table 183). A total of 93% of farmers said they consumed the produce. A further 36% reported that they gifted to family or neighbours. Just 7% reported selling the produce. However, this category of farmers obviously valued the variety because a total of 40% reported they saved the seed – although this was later lost.

Table 183. "Non continuing to plant" category produce uses

Produce uses for 'Non Continuing to plant' farmers	*Percentage of farmers*
Consume	93
Stored seeds	40
Gifted to family/neighbours	36
Sell	7

None of the 'OFDT only' farmers made a sale on their OFDT produce. The majority (24%) consumed the produce and just 4% attempted to save the produce or had any to save for the following planting season.

Table 184. "OFDT only" category produce uses

Produce uses for 'OFDT only' farmers	*Percentage of farmers*
Consume	24
Stored seeds	4

Storage systems

While it was noted that farmers in all three categories received a plastic bag from SoL to store seed, only one farmer reported the continued use of this bag after the OFDT. The majority of farmers reported that they returned to their former method of storage with a few key differences. For the 14 'Continuing to plant' farmers, 79% reported that they used a sack and stored it on the floor, in the rafters or tied from the roof (Table 185). There was a drop in the number of farmers who used this method after they planted Utamua. A total of 14% (2) farmers reported they now had access to either a drum or a silo, providing much more secure storage with less likelihood of seed damage.

Table 185. "Continuing to plant" storage systems

Method of storage before planting Utamua	*Percentage of farmers*	*Percentage of farmers after planting Utamua*
Sack	79	71
Gallon drum	7	0
Woven basket	7	0
Pleated sago leaves basket	7	0
Silo	0	7
Drum	0	7

For the 15 'Non-continuing to plant' farmers, the method of storage did not change before and after planting Utamua. The majority stored their seed in a sack (93%) and just 7% used a plastic container.

Table 186. "Non continuing to plant" farmers storage systems

Method of storage	*Percentage of farmers*	*Percentage of farmers after planting Utamua*
Sack	93	93
Plastic container	7	7

The 'OFDT only' farmers demonstrated the greatest range of traditional methods of storage in bound leaves and hollowed out bamboo (Table 187). However, like the other categories, the majority of farmers stored their seed in a sack. The 'OFDT only' category also had the highest percentage of drum use (16%) as storage for seed. There is a possible correlation between modern storage and access to aid.

Table 187. "OFDT only" farmer's storage systems

Method of storage	*Percentage of farmers before planting Utamua*	*Percentage of farmers after planting Utamua*
Sack	68	63
Drum	16	15
Gerry can	8	8
Bound leaves	4	4
Hollowed out bamboo	4	4

Desired characteristics

A question was asked of all three categories of farmers about characteristics they looked for in peanut seeds before planting and after harvest (Table 188) (Table 189). The answers to this question provided an indication of what farmers were familiar with and therefore, possibly more likely to adopt. Most farmers (61%) suggested that they look for seed that is pest resistant. While a lot of loss from pests occurs in the field, a substantial amount of loss occurs in storage, thus demonstrating the lack of reliable storage options for farmers. The prevalence of a quick harvest (33%) was also significant. There was also a reported preference for red seed, most local seed is red and thus anything else would be regarded as unfamiliar. The majority of farmers (98%-100%) reported that they preferred high yielding peanut varieties. Equally important to high yield was taste where 93% of all farmers sought seed that was both sweet tasting and sweet smelling. Oil content of the seed was also a valued characteristic (19% of farmers). It was noted that 17% of farmers (54) reported that eating Utamua made them feel nauseous. This could be because the taste and size of Utamua was unfamiliar.

Table 188. Preferred characteristics pre-planting

Preferred chacteristics pre-planting	*'Continuing to plant' farmers (14) %*	*'Non continuing to plant' farmers (15) %*	*'OFDT only' farmers (25) %*	*Total farmers (54) %*
Pest resistant	71 (10)	60 (9)	56 (14)	61 (33)
Clean, smooth seed	71 (10)	53 (8)	56 (14)	59 (32)
Big seed	57 (8)	47 (7)	44 (11)	48 (26)
Quick harvest	14 (2)	40 (6)	40 (10)	33 (18)
Drought resistant	21 (3)	40 (6)	36 (9)	33 (18)
Mould resistant	-	13 (2)	16 (4)	11 (6)
Red seed	7 (1)	7 (1)	-	4 (2)
Heat resistant	-	7 (1)	-	2 (1)
Adapted to the soil	-	7 (1)	-	2 (1)

*Farmer numbers in brackets

Table 189. Preferred characteristics after harvest

Prefered chacteristics after harvest	*'Continuing to plant' farmers (14) %*	*'Non-continuing to plant' farmers (15) %*	*'OFDT only' farmers (25) %*	*Total farmers (54) %*
High yield	100 (14)	100 (15)	96 (24)	98 (53)
Sweet taste and sweet smell	100 (14)	80 (12)	96 (24)	93 (50)
Oily	14 (2)	27 (4)	16 (4)	19 (10)
Sell for a good price	14 (2)	20 (3)	16 (4)	17 (9)
Can store for a long time	7 (1)	27 (4)	12 (3)	15 (8)
Easy to pull out of the ground	-	7 (1)	8 (2)	6 (3)

*Farmer numbers in brackets

Conclusion

The purpose of this survey was to understand the challenges for farmers adopting new varieties and to define the socio-economic characteristics of farmers in order to assist in forecasting those more likely to adopt SoL varieties.

The main challenge to farmers was the loss of seed due to lack of water, therefore the difficulty in being able to replant. The intention of farmers to replant Utamua was reassuring with 50% of farmers stating that they would replant in order to assess the result. This highlights the need for an increasing availability of seed to farmers at the village level.

The second highest recorded reason for seed loss was due to rat damage. The loss of seed in storage demonstrates the shortfall in reliable storage options. Storage systems also pose a problem for farmers who ceased planting Utamua. A total of 79% of the 'Continuing to plant' farmers; 93% of the 'Non continuing to plant' farmers; and 63% of the 'OFDT only' farmers use a sack to store their seed – vulnerable to rotting and rats

Availability of seed defines the intention to replant. All of the 'Continuing to plant' Utamua farmers reported they intended to replant. A total of 44% of 'Non continuing to plant' farmers reported that they would replant if seed was available

The vast majority (80%) did not know any other farmers who had Utamua seed. Just 20% of these farmers knew of other farmers nearby who had Utamua seed and who they presumed would give them seed if they asked

The majority of farmers (57%) who reported that they would not replant Utamua stated it was because they did not have the labour to put into producing peanuts (other activities yielded a higher labour/profit margin)

Farmers who sold peanuts were more likely to continually replant Utamua. A total of 35% of farmers who were 'Continuing to plant' Utamua reported that peanuts constituted their main source of income. Just 7% of 'Non continuing to plant' farmers and 10% of OFDT farmers reported that peanuts constituted one of their main sources of income.

Utamua peanuts are common as a food of exchange – its portability makes it a convenient food gift. A total of 42% of 'Continuing to plant' farmers reported that they gifted peanuts to family or neighbours

Peanuts are not a main crop but are commonly intercropped with other food, tree and horticulture crops. All of the 'Continuing to plant' farmers; 46% of 'Non-continuing to plant' farmers and 44% of 'OFDT only' farmers were growing peanuts before they participated in the Utamua OFDT trial amongst other food crops, tree crops, horticulture and animal rearing.

Farmers 'Continuing to plant' Utamua have a higher socio-economic standing who are more likely to be engaged in trade and own the majority of buffalo (74%) compared to those who ceased planting Utamua.

All farmers intended to use the Utamua produce to either sell or consume. The 'OFDT only' farmers reported the highest frequency (44%) of 'consumption only' while just 14% of the 'Continuing to plant' category reported that they intended to use the produce solely for consumption.

Farmers 'Continuing to plant' Utamua were more likely to maintain biodiversity. A total of 79% of 'Continuing to plant' farmers also continued to plant a local variety of peanut along with Utamua where as just over half (53%) of 'Non continuing to plant' farmers and 56% of OFDT farmers continued to plant a local variety alongside Utamua.

Taste was just as important as high yield in farmer preferences for peanuts after harvest. Between 93%-100% of all farmers reported that they preferred sweet tasting and smelling peanuts along with peanuts with a high yield (between 98%-100%). This should guide the selection of peanuts to be trialed.

4.5 Farmer benefits from variety releases

Introduction

This Benefits study was conducted in the districts of Aileu, Baucau, Liquica, Maliana, and Manufahi during 2009. It describes farmers' experiences and livelihood improvements gained from planting improved varieties released by SoL/MAF. The staple crops released at the time of the study were sweet potato (Hohrae), peanut (Utamua), maize (Sele), and rice (Nakroma). The study further describes the indirect benefits of the SoL program had due to a) the creation of new seed distribution channels (formal and informal) through various NGOs that have sourced SoL seeds and b) farmers who obtained seeds or cuttings from participating SoL OFDT farmers.

Materials and methods

Sixteen farmers in the five districts who had benefitted from receiving SoL seed were interviewed from January through September 2009. Respondents were selected to include a) current OFDT farmers who were trialing new SoL seed varieties; b) previous OFDT farmers that had increased the size of their SoL cultivation plots and c) farmers who had benefitted indirectly from the SoL program either through NGO-led initiatives or those who had obtained SoL seed from participating farmer households. The questionnaire followed a similar structure to the previous Economic Benefits Survey (September 2007 to August 2008) featured in SoL, 2008. Questions included planting area; yield; amount sold; amount money earned from sales; how the farmers used the income (or intended use); farmer preferences with varieties and the perceived difference between the local and new varieties. Their narrative stories were also recorded.

Results

Increased crop yield, sweeter taste and colour, bigger tubers, and high market value were amongst the positive characteristics used to describe the four introduced staple crop varieties by farmers (summarised in Table 190). Maize was characterised as yielding good coloured, bigger seeds and cobs. Utamua peanuts were preferred for its larger seeds and higher yield. Sweet potato and rice varieties were perceived to fetch premium market prices. Hohrae fetched $7 to $8 per sack (each sack is 25kg) as compared to $5 per sack for local sweet potato varieties. Similarly, Nakroma sold for $5 per tin (each tin weighing 12kg) as compared to local varieties which sold for $3 per tin.

Table 190. Respondent variety characters preference over locals

SoL variety	*Farmer preferences and perceived differences between new varieties and locals*
Sele (maize)	Bigger cobs, more fragrant and sweeter
Utamua (peanut)	Bigger seed and higher yield
Nakroma (rice)	More tillers, fragrant, oily and good to make porridge with, rounded seeds, sweet taste, higher market value
Hohrae (sweet potato)	Higher yield, bigger tuber, value in the market, fragrant, good colour

Improved livelihoods

All 16 respondents highlighted that improved livelihoods resulted from participating in the SoL Program. Many participating farmers had gained surplus yields and subsequently sold their surplus in the markets. Table 191 captures income earned by 8 farmers from selling SoL varieties. Household incomes from selling SoL seeds have enabled farmers to pay for their children's education, to buy additional food and other necessities such as soap and oil.

Table 191. Income obtained from selling SoL staple crop varieties.

Farmers name	*Staple Crop*	*Selling method ($/unit)*	*Total Income $*
Maria natalia freitas	Peanut	7.00/sack	117.00
Juliao Ximenes	Rice	5.00/kerosene tin	120.00
Palbina	Sweet potato	8.00/sack	24.00
Domingas Soares	Sweet potato	7.00/sack	21.00
Agida Soares	Sweet potato	1.00/bunch	25.00
Maria do Rego	Sweet potato	1.00/bunch	20.00
Domingos Da Silva	Sweet potato	0.50/bunch	16.00
Filomena da Silva	Sweet potato	0.50/kg	24.00

One of the respondents, Juliao Ximemes from Tequinomata, a village in the coastal lowlands of the Laga sub-district of Baucau grew Nakroma, a high-yielding rice variety tested and distributed by SoL. The income that he received from selling Nakroma was helping him to support his children through school and university. Juliao had been involved with the SoL program since 2006 when he planted Nakroma for the first time in an OFDT plot size of 25m². He replanted Nakroma in the following two seasons, expanding the area of Nakroma to one hectare. He continued to plant a local rice variety in addition to Nakroma. He said that was because the local variety had been traditionally planted since the time of his ancestors and he was accustomed to selling it. However in 2009 he grew the local variety to secure his family's food consumption, and was selling Nakroma for cash. The yield from his most recent Nakroma harvest was 1,140 kg, measured as 95 kerosene tins weighing 12kg each. This did not include rice that he shared with three neighbours who had some of their local rice stores destroyed by pests. From this yield he sold 24 kerosene tins of Nakroma (288kg), at US$5.00 per tin, earning US$120.00 in total. He used the money to support the daily needs of his household, including education costs for his children. This included one son studying at the Universidade Nacional de Timor-Lorasae (UNTL) in Dili, a daughter in senior high school in the town of Baucau, and two daughters in junior high school.

Juliao suggested that Nakroma had many more tillers than the local variety and rated Nakroma as higher yielding, but this depended on how closely the local variety was monitored for weeds. He also rated Nakroma as more resistant to pests during the dry season. Juliao said that there was significant demand for Nakroma in the local market when it was available, and at US$5.00 per kerosene tin Nakroma sold for significantly more than the local variety at US$3.00 per kerosene tin.

Potential income increase from selling SoL crop surplus as highlighted in the above table further motivated several farmers to increase the land area of planting the new varieties. Maria Tavares from Maliana District is one such farmer. She reported that "*Firstly in 2007 I plant Nakroma seed 4 kg in area 40m x 15m so at the end when harvest I got 6 sacks (50 kg/sack), following season I plant 2 sacks in area 85m x 75m so at the end I got 60 sacks (50 kg/sack), Nakroma is good variety because high yield compare with local including very nice taste (fragrant, good to make porridge for baby), I do not sell Nakroma because I want to secure food for my family in the long year. Maybe I will sell it in the future when I got more yield*".

Indirect beneficiaries

As more households benefit directly from participating either as SoL OFDT farmers or through NGOs that source SoL seeds, the number of indirect beneficiaries had grown steadily, with participating farmers either selling or giving cuttings and seeds to non-participating farmers. In a village named Liurai in Aileu district, a sweet potato farmer named Palbina de deus was gifted a Hohrae cutting from an OFDT farmer she met in the Aileu Market. Miss Palbina was not a SoL participating farmer but she had adopted growing Hohrae 1 and 3 varieties for two successive growing seasons, and moreover sold the surplus which led to significant improvements in her livelihood. Mrs. Palbina elaborated, *"In January 2007 I got sweet potato cutting from Mr. Abril in Aileu Market. Currently, I already sold Hohrae 1 and 3 twice. First in January 2008 and second this month (January 2009) few weeks ago. For this month I have not finished harvesting. Last week I just sold 3 sacks so a sack for $8.00. From that amount I gave to my son who is studying in senior high school in Becora".* According to Mrs. Palbina, the local sweet potato variety did not have a long storage life as compared to Hohrae 1. Also, the yield of Hohrae was considerably larger than the local variety. She added that to date, she had not given sweet potato cuttings to other farmers as she wants to ensure that her family's food stock is secured first.

Similarly, Agida Soares, a farmer from Triloca village in Baucau was not involved in SoL program but in 2009 she was given a sweet potato cutting (Hohrae) from a SoL staff member. It would be the first time she had planted Hohrae in her garden. She preferred Hohrae to the local variety because in 2008 she bought Hohrae roots from Baucau market and re-sold it along the road of Triloca. She highlighted that many consumers bought Hohrae as they preferred the big tuber and good colour. In addition, Agida said that when people travel from Baucau, Los Palos and Viqueque to Dili they always bought sweet potato from her. She added, "This *week (in 2009) I bought 1 sack of Hohrae in Baucau market which was sold by a farmer who came from Fatumaka so each sack was $10.00. I bought one sack then I resold the sweet potatoes in bunches of $1.00, so I earned $20. 00.* Agida further mentioned that she had already sold Hohrae three times. The money that she had earned was used to buy perishables goods such as rice, sugar, and salt.

Collaborating NGOs

New seed distribution channels are considered as a positive outcome of SoL. Distribution has occurred through formal institutional mechanisms and informal familial networks. In 2009, SoL seeds were bought by international NGOs and development agencies such as FAO, CARE, World Vision and Child Fund and subsequently distributed through their respective programs to participating farmers. For the 2009/10 growing season, World Vision procured 1 ton of Utamua peanut variety for distribution through a credit loan system to 500 households in Baucau and Bobonaro districts. A further 2.8 tons of Nakroma rice variety was distributed to 2,800 households (1kg per household) by World Vision which promoted farmers to apply the ICM method in demonstration plots in the same districts where peanuts were distributed. Monitoring and evaluation of these new seed distribution networks will assist in identifying indirect beneficiaries of SoL.

Farmer groups

SoL indirectly benefited more farmers through self-organising or NGO-led farming groups. Field days held by SoL and its collaborating NGOs provide an opportunity for interested farmers to receive training on how to grow new improved seed varieties. Field days further allowed participating farmers who had trialed SoL varieties to share their experiences. For example, more than 150 farmers, national government officials, local authorities and international NGOs attended field days in Baucau and Maliana districts which was led by SoL district staff in March and April 2009 to demonstrate Sele (maize) and Nakroma (rice) seed production. The first field day was attended by the Secretary State of Agriculture and Arboriculture Mr. Marcus Da Cruz, along with international and national NGOs. Farmer groups attending this field day were provided with seed for multiplication and distribution amongst the group members. In Maliana district, an all women farmer group attended the field day. This group organized the multiplication of 7ha of Sele seed in Ritabou village, Maliana Sub-District.

According to a group member, Mrs. Francisca Madalena Pinto, although the group had not completed harvesting the maize, they have already observed a higher yield. She added that although this was their first time planting Sele, they had observed that Sele had big cobs, good colour and taste. They were hopeful that Sele would be more resistant to pests and have a longer storage life. Moreover she said they will produce more seeds in the future so it can be distributed to other farmers not directly involved in the SoL program.

Discussion

There is increasing evidence that some OFDT farmers who were able to replant the newly released varieties had moved away from growing crops solely for household-consumption to selling surplus grain. As the number of direct participating farmers in the program continues to grow, the number of indirect beneficiaries has also steadily expanded. At the household level, food security remains a priority and farmers have shown a tendency to practice risk aversion by continuing to plant local seed varieties to ensure food stock is secured. Higher crop yields have induced farmers to expand their cultivation plots and to share SoL seed varieties with family and friends. In most cases surplus from SoL varieties was sold at a higher market price as compared to local varieties which are grown to meet household consumption needs. The revenue from selling new crop varieties was mainly invested in children's education and household goods.

Seed distribution channels have diversified and expanded to include international and national NGOs (such as World Vision, CARE international, and Child Fund) that source SoL seeds for their respective programs, and participating farmers that share their SoL seed with family and friends. Extra intermediaries such as market 'middle men' and traders that re-sell seeds will be included in future studies to capture as many of the actors involved in seed sourcing and dissemination as possible. Cooperation with collaborating NGOs which source seeds from the SoL programme should be included to assess the indirect social-economic livelihood impacts of SoL.

5. Farming systems

5.1 The effect of applied phosphorus on peanut yield.

Introduction

Peanut yield in Timor Leste is considered to be low (1 t/ha) by international standards. Part of the problem is a lack of available high yielding varieties. This is being addressed through the MAF-SoL research program with the release of Utamua and research into other varieties. Poor soils also limit productivity. Some concern is that the acid soils found in Baucau and Viqueque may limit availability of phosphorus for plant growth. The preliminary study reported in this chapter investigated three rates of phosphorus on peanuts in the districts of Baucau and Viqueque.

Methodology

Baucau. The trial was conducted on a farmer's field located at Darasula, Guariwai, Baucau. It was laid out in randomized complete block design with 3 replications. Treatments included applications of Triple Super Phosphate (TSP) at 0, 40 and 80 kg/ha (0, 7.4 and 14.7 kg of elemental P per hectare) which were applied one month after planting. Hills were spaced at a distance of 30cm x 30cm. Plots were 5m by 5m in size. Planting was on 16 December 2008 and all plots were harvested on 21 April 2009.

Viqueque. Conducted on a farmer's field in Rataho, Viqueque this trial was laid out in randomized complete block design with 3 replications. Triple Super Phosphate (TSP) was applied at 0, 100, and 200 kg/ha (0, kg, 18.4 kg and 36.8 kg of elemental P per hectare). Plot size was 5m x 5m and hills spaced at 25cm x 25cm. The trial was established on 18 December 2008 and harvested on 25 April 2009.

At harvest, all plants were dug, dried and weighed. Three sample plants were kept aside for measurement of the yield components. Variables observed were: sun dried pod yield, number of pods/plant, number of empty pods/plant, weight of seeds/plant, and sundried weight of pod/plant. Gen-Stat was used to analyze the data.

Results and discussion

Both trial sites were reasonably uniform and no significant insect infestations or diseases were observed during the trial periods. A statistical analysis of trial results at both sites indicated that there was no significant effect of the treatments on yield (Table 192). At Baucau there were significantly more pods per plant with applied P but many of these were empty.

A similar trial conducted during 2008 (see SoL, 2008) indicated a significant response to 40kg/ha of applied TSP on four of the five sites in Baucau. The yields in these sites ranged from 1.0 to 2.2 t/ha. In 2009, pod yield at both Baucau and Viqueque were in the range of 2.3 to 4.3 t/ha. The large yield improvement indicates that the sites in 2009 may have not suffered from P constraints.

Table 192. Effect of applied P on peanut yield at Baucau and Viqueque

Treatment	*Pod yield (t/ha)*	*Number of pods/plant*	*Number of empty pods/ plant*	*Weight of seeds/plant (g)*	*Pod weight/plant (g)*
			Baucau		
Control	4.3	16.4	2.2	24.1	40.0
40 kg/ha TSP	4.2	25.0	6.7	39.4	60.0
80 kg/ha TSP	3.6	20.6	4.1	31.2	46.7
LSD	NS	2.79	2.4	NS	NS
			Viqueque		
Control	2.29	12.1	3.27	21.5	37.4
100 kg/ha TSP	2.65	11.3	3.13	28.9	41.8
200 kg/ha TSP	2.94	12.7	3.53	21.0	39.3
LSD	NS	NS	NS	NS	NS

5.2 Effect of planting distance on peanut yield

Introduction

Low seed multiplication rates are an unattractive aspect of peanut cultivation. Because of its large seed, Utamua is particularly affected and farmer's interest will increase further if the seeding rate can be minimized. Increasing multiplication rates can be achieved by either increasing yield/ha or by reducing the seeding rates while hoping to increase productivity per hill. This trial was conducted to evaluate the effect of planting distance on peanut yield.

Methodology

The trial was conducted on a farmer's field surrounded by a large Utamua production area in Darasula, Guariwai, Baucau district. It was laid out in randomized complete block design with 3 replications. Treatments were hill spacing of a) 20 cm x 20 cm, b) 30 cm x 30 cm, and c) 40 cm x 40 cm on a plot size of 5m x 5m. The trial was planted on 13 December 2008 and harvested on 21 April 2009. No fertilizer was applied during the trial period.

At harvest, all plants in the plot were dug, dried and weighed. In addition, 3 sample plants were harvested separately, and the pods of these plants used for measuring yield components. Variables observed were: sun dried pod yield, number of pods/plant, number of good seed/plant, weight of good seed/plant. Gen-Stat was used to analyze the collected data.

Results

The experimental area was reasonably uniform and there were no significant symptoms of pest or disease attack during the trial period. As a result, sun dried pod yields were high, exceeding 3 t/ha (Table 193). Based on analysis of variance, significant effects of planting distance were observed for dry pod weight/ha, number pods/plant, weight of seeds/plant, and weight of pods/plant (Table 193). There was no significant difference in the number of empty pods/plant.

Theoretically, a lower plant density should increase yield/ plant due to less competition between plants. It is possible that higher yields per single plant could compensate low density populations. The results of this trial indicate that higher density plots tend to have greater yields overall despite the lower yield per plant. Yields of the higher density population increased dry pod yields by approximately 18%.

Wider planting distance however, will provide several benefits to the farmer, particularly if he has only a small amount of seed. Assuming the 100 seed weight of Utamua seed is 100 g, farmers need only about 63 kg of seed/ha for planting at a spacing of 40 cm x 40 cm compared with 250 kg/ha of a spacing of 20 cm x 20 cm.

Table 193. Effect of planting distance on yield and yield factors of peanuts

Treatment	*Sun-dried pod yield (t/ha)*	*Number of pods/plant*	*Number of empty pods/ plant*	*Seed weight /plant(g)*	*Fresh pod weight /plant (g)*	*Sun dried pod weight /plant (g)*
20 x 20 cm	4.0	18.9	4.78	26.0	57.7	30.4
30 x 30 cm	3.8	32.8	6.22	45.0	117.7	63.1
40 x 40 cm	3.4	44.0	6.56	68.3	191.0	95.0
LSD	0.5	15.3	NS	13.3	58.3	22.2

Conclusion

Wider planting distance will reduce seed need/ha. Under presently cultivation techniques in Timor Leste, however, there is no yield advantage by planting at a wider spacing than currently used.

5.3 Effect of sweet potato cutting planting position on yield.

Introduction

Sweet potato (*Ipomoea batatas* (L.) Lam) is an important crop in Timor Leste. Farmers planted more than 3,500 ha of the crop in 2008, yielding about 2.5t/ha of roots (Directorate of Crop Production, MAF). Sweet potatoes are almost exclusively for table consumption because no starch industry exists in the country. They are harvested as needed to avoid storage problems.

Sweet potatoes in Timor Leste are grown with minimum inputs. Farmers usually collect suitable runners from their previous plantation or from neighbors. The runners are generally planted after minimum soil preparation with no applied fertilizer.

It has been reported that planting sweet potato runner cuttings in an up-right position could lead to less marketable root production. The assumption is that cuttings planted in this way have less free space for root enlargement. Planting horizontally or in a slanted position may improve storage roots quality/performance. This trial aims to evaluate the effect of stem cutting position on sweet potato yield.

Methodology

The trial was conducted on a farmer field located at Fatubosa-Aileu. It was installed as a randomized complete block design with 3 replications. The stem cutting positions evaluated in the trial were: a) upright, b) mid slanted position (about 45 degrees), and c) very slanted position (almost horizontal). Trial plot size was 5m by 5m and the planting distance between runners was 75 cm x 25 cm. The planting date was 9 February 2009 and harvesting was on 21 August 2009. Sweet potato cuttings, about 25 cm in length were inserted approximately 10-15 cm into the soil. Field maintenance was uniform across the plots throughout the duration of the trial.

Variables observed at harvest were: Total number of harvested roots, number of marketable roots, number of unmarketable roots, weight of marketable roots, and weight of unmarketable roots. A root was considered as marketable when it'd weight ≥ 180 g. All data were measured from 5 randomly selected sample plants.

Data analysis was by Gen stat.

Results and discussion

The trial was harvested at about 190 days after planting. In general, the plants grew well and there were no significant pest and disease attacks during its growing period. In summary, the trial data showed significant treatment effects (Table 194).

Table 194. Effect of stem cutting position on sweet potato roots.

Stem cutting position	*Total number of roots/plant*	*No of marketable roots/plant*	*No of un-marketable roots/plant*	*Yield of marketable roots (t/ha)*	*Yield of un-marketable roots (t/ha)*	*Total yield of roots (t/ha)*
Upright	4.4	1.0	3.4	9.9	6.4	16.3
Mid-slanted	3.5	1.6	1.9	21.8	3.3	25.1
Very-slanted	2.5	2.0	0.5	26.3	0.6	26.9
LSD	1.0	0.4	1.0	4.9	2.8	5.8

The highest root yield was achieved by planting cuttings on a very-slanted (almost horizontal) position, producing 26.9 t/ha. This treatment was followed by cuttings planted on a mid-slanted position (25.1 t/ha). The lowest yield was when cuttings were planted vertically (16.3 t/ha). Total yields were related to the number of marketable roots/plant and weight of marketable roots/ha (Table 194).

Under good field maintenance, a sweet potato plant has the potential to produce approximately 200 g of root. The results presented in Table 194 indicate that average root yield per plant was about 330g, 470g, and 500g for up-right, mid slanted and very slanted cutting positions, respectively. Overall root yield resulting from this trial is considered as being very good because farmer average yields in Indonesia are about 10 ton/ha (190 g/plant) and in China about 20 ton/ha (380 g/plant).

Conclusion

The results of this trial clearly show that cuttings planted on an angle or towards horizontally have the potential for significantly increasing root yields.

5.4 Effect of weeding on maize yield

Introduction

Maize is one of the staple food crops of Timor Leste and is cultivated on approximately 77,600 ha of land (2008 MAF statistics) across the country. Productivity remains low at 0.8 t/ha (MAF, 2008) but has considerable potential for increase.

The use of high yielding varieties and application of better cultivation methods are the most basic approaches expected to lead to yield improvements. The use of improved varieties such as Sele increase yields to a degree. This yield potential will increase further when cultivated under better cultural practices.

Maize is a rainfed crop and generally planted after the first rains of the wet season. Weed competition for nutrients, moisture, and other resources soon take a toll on maize plant growth unless the weeds are controlled. Compared to other cultural practices such as fertilizer application or pest and disease control, weeding is one of the most affordable agronomy techniques for Timor Leste farmers to increase grain yields. This study was carried out to determine the effect of weeding on maize in Viqueque.

Methodology

The trial was conducted on a farmer's field located at Ratahu in the District of Viqueque. It was laid out as a randomized complete block design with 3 replications. Treatments applied in the trial were a) no weeding, b) weeding once during the season and c) weeding 2 times during the growing season. Plot size was 5m by 5m and planting distance between hills, 100 cm x 25 cm. The trial was planted on 5 December 2008 and harvested on 15 March 2009. The first weeding was conducted at 45 days after planting and the second at 75 days. Weeding was done manually.

Variables measured included a) the number of weeds/plot, plant height, stem diameter, un-shelled cob yield, shelled cob yield, and grain yield. Plant height and stem diameter were measured from 5 sample plants/plot. Weed population was measured by counting number of weeds/plot at harvest.

The trial was harvested at about 130 days after planting.

Gen stat was used to analyze collected data.

Results and discussion

In general, plant growth was good and there was no significant pest or disease attack during its growing period. As expected, weeding significantly reduced the number of weeds in the field at harvest. There were approximately 184 weeds in the un-weeded plot, 18 weeds a plot weeded once and less than 1 weed in each plot receiving 2 weedings (Table 195).

Cob and grain yields were correlated with weed populations. Whole cob weight yields for unweeded plots were 1.3 ton/ha and after one weeding at 1.8 ton/ha. When weeded twice, cob yields almost double at 2.3 t/ha (Table 195). Grain yields were also almost double in weeded plots compared with unweeded treatments.

Table 195. Effect of weeding on yield components of maize.

Treatment	*Whole cob weight (t/ha)*	*Husked cob weight (t/ha)*	*Grain weight (t/ha)*	*Plant height (cm)*	*Stem diameter (cm)*	*No of weeds/plot*
No weeding	1.3	1.2	0.7	171	5.9	184
1 x weeding	1.8	1.6	1.3	175	6.2	18
2 x weeding	2.3	2.1	1.3	168	6.2	1
LSD	0.34	0.28	0.34	NS	NS	9.3

Plant height and stem diameter were not significantly influenced by weeding (Table 195).

Conclusion

Weeding significantly increased grain yield. In this trial, grain yield increased by more than 90% when weeded twice during the growing season.

6. Farm household surveys

6.1 Baseline data survey (Buka Data Los)

Farmers participating in the OFDT program were surveyed during the year to determine their livelihood details. Completed data was formulated into a Buka Data Los (means 'looking for true or reliable data' in Tetun language) (BDL) survey report. During the 2008-2009 year, data was collected from the districts of Aileu, Ainaro, Baucau, Liquiça, Bobonaro, Viqueque and Manufahi. A total of 598 farm households were surveyed. Complete information was not collected from all households.

The BDL results provide information on household size, activities by gender, the type of food consumed in the household and when the household first entered periods of food insufficiency. This portion of the survey gave an indication of the socio-economic status and level of wellbeing in the household. More importantly the collected information helps the development of a research program responsive to changing socio-economic conditions.

The second part of the survey examined the crops grown by each farmer and recorded the broad range of factors affecting crop yields and post harvest losses over the 2008/9 season. This information assists target the research program for the following year.

Farmer households and gender participation

Farm households across Timor Leste are family production units. Each family member is required to contribute to farming operations. Young boys, for example, tend animals and older family members perform light duties such as milling grain. Most farm households have between 4 and 8 members to distribute the workload (Table 196). A good proportion of these was children and is a reflection of the nation's high annual birth rate (3.85%) in 2009. Larger households (greater than 10) accounted for approximately 10% of the population and most likely represents the inclusion of extended (grand parents) family members. Overall, comparing this year's figures with 2008, it would appear that the family size had increased by one person.

Table 196. Members of households by District

Members/household	*Aileu (%)*	*Ainaro (%)*	*Baucau (%)*	*Bobonaro (%)*	*Liquica (%)*	*Manufahi (%)*	*Viqueque (%)*	*Average (%)*
1	0	0	11	1	6	0	0	4
2	0	0	4	4	4	7	2	3
3	5	20	5	7	4	7	10	7
4	17	25	8	9	6	7	17	11
5	12	20	17	18	26	0	15	16
6	14	20	20	15	13	17	12	16
7	21	5	8	18	4	20	20	14
8	10	0	8	15	6	13	12	10
9	7	10	5	7	6	23	7	8
10	7	0	4	7	9	0	5	5
11	2	0	6	0	6	3	0	3
12	2	0	1	0	4	0	2	1
13	2	0	2	0	0	3	0	1
14	0	0	0	0	4	0	0	1

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 2008/9 30% of the surveyed OFDT households were considered to be headed by women and 70% by men (Table 197). This compares with 25% and 75% respectively in 2007/8.

Table 197. Gender participation as heads of households, 2008/9

District	*Sub-District*	*Female (%)*	*Total Female*	*Male (%)*	*Total Male*	*Total (no)*
Aileu	Aileu	43	23	57	31	54
	Laulara	0	0	100	1	1
	Liquidoe	42	5	46	7	12
	Remexio	43	6	47	8	14
Ainaro	Hatudo	7	2	93	25	27
	Maubisse	12	2	88	15	17
Baucau	Baucau	37	30	63	52	82
	Laga	29	7	71	17	24
	Vemasse	44	15	56	19	34
	Venilale	20	8	80	32	40
Bobonaro	Atabae	0	0	100	5	5
	Balibo	0	0	100	2	2
	Cailaco	4	1	96	24	25
	Maliana	52	30	48	28	58
Liquica	Liquica	39	19	61	30	49
	Maubara	30	9	70	21	30
Manufahi	Alas	28	8	72	21	29
	Same	0	0	100	12	12
	Turiscai	5	1	95	20	21
Viqueque	Ossu	28	9	72	23	32
	Uatulari	10	3	90	27	30
Total		*30*	*178*	*70*	*420*	*598*

Cropping patterns

A list of food crops cultivated by farmers conducting OFDTs in 2008/9 is presented in Table 198. Most farmers grew a wide range of crops. This practice is indicative of East Timorese farms where risk of crop failure is reduced though intercropping and diversification. The key food crops of maize, sweet potato, cassava and peanuts were grown by most upland farmers. Household consumption from harvest of these was supplemented with pumpkins, beans, taro and a wide range of other traditionally grown species. Approximately 20% of the OFDT farmers reported planting irrigated rice which is consistent with other surveys in Timor Leste and reflects the greater emphasis on upland and dryland food cropping among the majority of Timorese farming households.

Surprisingly, only a small number of farmers reported growing bananas,

Table 198. Food crops planted in house gardens or bush gardens

Crops planted	*Total*	*% of total respondents*
Cassava	326	55
Long season maize	298	50
Pumpkin	286	48
Sweet potato	284	47
Long bean	250	42
Short season maize	250	42
Peanut	230	38
Cucumber	190	32
Taro	189	32
Arrowroot	185	31
Kumbili (wild yam)	163	27
Sinkumas tuber (yam bean)	135	23
Irrigated rice	127	21
Sorgham	109	18
Maek (elephant foot's yam)	92	15
Red bean	81	14
Bitter bean (wild lima bean)	69	12
Mung bean	49	8
Upland rice	33	6
Potato	32	5
Banana	14	2
Papaya	8	1

Tuber crops were prominent in the key staples (Table 199) of 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 are also harvested opportunistically as wild products from surrounding forests (see SoL, 2007).

Table 199. Tubers cultivated

Tuber crop	*%*
Cassava	55
Sweet potato	47
Taro	32
Arrowroot	31
Kumbili (wild yam)	27
Singkumas (yam bean)	23
Maek (elephant foot's yam)	15
Potato	5

Food Security

Data from the survey provided an indication of food production adequacy for domestic consumption among the participant farmers. (Table 200). Respondents were asked whether they considered their last harvest was insufficient to cover their annual needs, sufficient or they considered they had a surplus. This was a measure of production yields and was dependent to some extent on the availability of supplementary or alternative food supplies by particular households. Significant numbers (29%) of farmers reported that they had insufficient or just sufficient maize (54%) to last the year. This compared with 38% and 47% respectively in 2007/8 (SoL, 2008). Maize insufficiency was considered to be very serious in the districts of Liquica and Manufahi which recorded 68% and 62% insufficiency respectively. These results highlight the importance of crop diversification into tubers and other crops to spread the risk of a poor maize harvest. Only 15% of farmers considered they had a surplus for sale or for animal production.

Table 200. Respondent measures of food sufficiency (maize)

District	*Insufficient*	*%*	*Surplus*	*%*	*Sufficient*	*%*	*Total*
Aileu	7	18	26	65	7	18	40
Ainaro	9	45	9	45	2	10	20
Baucau	16	14	4	4	94	82	114
Bobonaro	16	22	8	11	49	67	73
Liquica	27	68	2	5	11	28	40
Manufahi	16	62	1	4	9	35	26
Viqueque	13	27	13	27	23	47	49
Total	104	29	63	17	195	54	362

Another perspective on food security is presented in Figure 43. The first line in the graph presents the point during 2009 when stored maize harvest was exhausted in the 29% of farmers who had insufficient stored maize (Table 200). The data for 2008 is graphed on the second line. All national surveys indicate that some Timor Leste farmers suffer a "lean season" during which food reserves are low or completely depleted. The data presented in Figure 43 indicates that in 2009, nearly 60% of farmers in the "insufficient food" category (15% of all surveyed farmers) reported maize stores to be fully consumed by August which is little more than four months following harvest. Eighty percent of "food insufficient" households had exhausted their maize stocks by September and 95% reported no supplies by November, three to four months before the new maize harvest can be secured. This food reserve depletion is at a faster rate than in 2008.

Data was collected from a different suite of farmers each year and the graph in Figure 43 does not indicate a reduction in food security for a set of farmers from one year to the next. The data does indicate, however, that the poorest farmers in 2009 were worse off than the poorest farmers in 2008 (although there were fewer of them). Over years it is hoped that the graph will "move forward" indicating an improvement in the level of stored maize for the poorest farmers or that food insufficiency in the rural areas will be eliminated altogether.

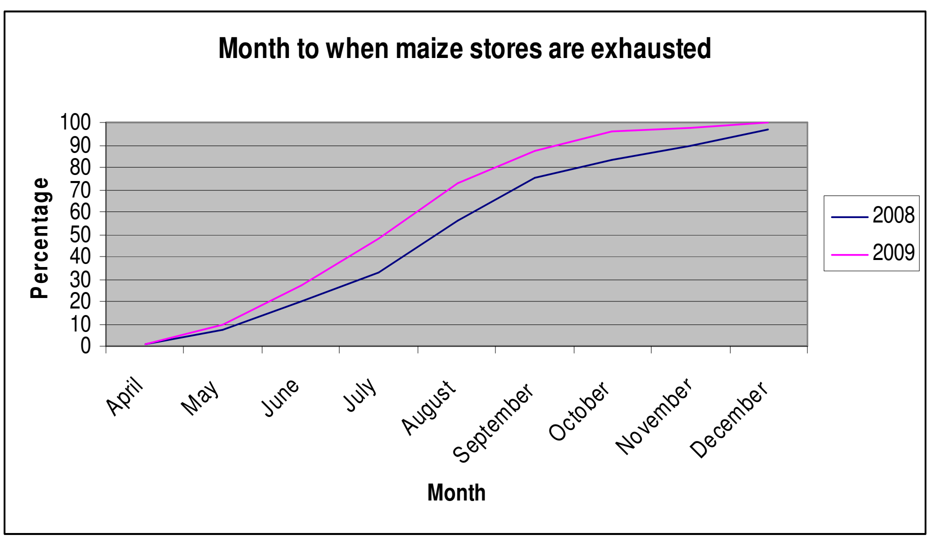


Figure 43. Maize sufficiency in farm households

Follow up questions were made to farmers who reported poor food crop harvests or considered that they were short of food stocks during the year. They were asked the reasons why yields were lower. The main reasons for reduced harvests given were poor rainfall (32% of respondents), livestock damage (15%) or strong winds that damaged the crops (16%). Insect pests, rats or other reasons made up the remainder (Table 201). Damage to maize crops from strong winds is particularly high in local varieties which tend to be taller. Farmers from areas where these winds occur may benefit from growing shorter statured varieties. Such varieties and those which display an advantage when cultivated under lower rainfall conditions will be investigated in the SoL varietal evaluation program.

Table 201. Farmer's perceptions of factors reducing harvest yields by district

District	*Lack of rain*	*Weed effects*	*Damage by livestock*	*Pests*	*Rats*	*Strong winds*	*Other*
Aileu	2	0	0	2	2	1	0
Ainaro	3	0	0	0	0	0	3
Baucau	6	0	4	0	0	1	1
Bobonaro	3	0	1	3	0	3	1
Liquica	5	2	6	1	1	4	4
Manufahi	5	0	0	0	0	2	6
Viqueque					2	1	
Total	*24*	*2*	*11*	*6*	*5*	*12*	*15*
Percentage	*32*	*3*	*15*	*8*	*7*	*16*	*20*

The most common practices of storage for maize and other crops are presented in Table 202. Farmers often store their maize above the fireplace (50% of respondents). It is believed that the smoke and dry atmosphere above the fireplace reduces weevil damage. Other storage techniques include storage in a tree (to reduce rat and other animal damage) or in baskets. In recent years improved storage techniques have been introduced by FAO (Silos), SoL (Jerry cans and grainpro plastic bags) and NGOs (drums). All improved storage techniques are designed to reduce oxygen levels in the containers to a level in which weevils cannot survive. The large number of drums in use in Ainaro indicates the presence of outside assistance to purchase them. Drums use was also commonly sited in Ainaro in 2008 (SoL, 2008). The wider use of sealed drums and other improved storage techniques will reduce post harvest storage losses considerably.

Table 202. Storage methods for maize (and other crops)

Method	*Aileu %*	*Ainaro %*	*Baucau %*	*Bobonaro %*	*Liquica %*	*Manufahi %*	*Viqueque %*	*Mean (%)*
Above the fireplace	53	7	66	64	79	70	8	50
In a branch of a tree	32	4	26	10	0	0	10	12
Drum	0	74	0	0	15	22	0	16
Above the hearth	0	15	2	24	4	6	0	7
Inside house	16	0	2	3	0	0	28	7
Bamboo platform	0	0	2	0	0	0	0	0
Big basket	0	0	0	0	0	0	2	0
Sack	0	0	2	0	0	0	46	7
Jerry can	0	0	0	0	0	3	4	1
Silo	0	0	0	0	2	0	2	1
Total no. respondents	38	54	103	72	46	32	50	396

Economic status and strategies

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 203. 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 (69%) of participating farmers did have iron or board roofs in 2009 although in Ainaro this was not the case. Approximately the same percentage (76%) possessed solid roofs in 2008 (SoL, 2008). Walls were generally sago palm (bebak) (54%), half walls or full walls. In 2009, the percentage of farmers possessing cement floors was much lower than in 2008 (22% compared with 34%). The most basic level of housing was in the districts of Ainaro and Viqueque.

Table 203. House types across the seven Districts

Description	Aileu %	Ainaro %	Baucau %	Bobonaro %	Liquica %	Manufahi %	Viqueque %	Average %
Basic thatch roof	5	85	37	29	2	32	45	31
Tin/board roof	95	15	63	71	98	68	55	69
Tin walls	20	0	4	0	10	0	4	9
Sago tree walls	36	85	40	63	54	61	80	54
Half wall	14	15	33	23	7	32	2	20
Full wall	30	0	23	15	29	6	15	17
Non-cement floor	64	95	77	69	85	81	96	78
Cement/floor tiles	36	5	23	31	15	19	4	22

Ownership of vehicles, mobile phones or generators was extremely low for farmers participating in the OFDTs (Table 204). More than 88% of farmers possessed none of these items. Ownership of high value goods was generally correlated with areas where higher housing standards were reported – namely Aileu and Baucau. Mobile phone ownership appears to be improving. In 2007 the percentage of OFDT farmers possessing mobile phones was 3% increasing to 10% in 2008 and 6% in 2009.

Table 204. Wealth measures by key commodities

Description	*Aileu (%)*	*Ainaro (%)*	*Baucau (%)*	*Bobonaro (%)*	*Liquica (%)*	*Manufahi (%)*	*Viqueque (%)*	*Average (%)*
Car	0	0	0	0	0	1	0	1
Motorbike	2	0	12	1	2	2	1	3
Mobile phone	6	0	28	3	2	2	2	6
Diesel generator	0	0	5	1	0	0	0	2

* BDL information on key commodities for Bobonaro was not collected.

Another measure of economic activity is to determine the level that farmer households were able to generate cash income to purchase basic household necessities such as soap, shampoo, kerosene for lamps, seasonings, salt and sugar. Many households also need to generate funds for schooling costs and transport requirements. A detailed survey was not conducted in 2009, however, there is increasing evidence that farmers growing SoL/MAF released varieties are selling surplus products for cash and using the resulting income to support the household. Some details of this trend are presented in the SoL 2008 Annual Research Report (SoL, 2008) and in Chapter 4 of this report.

Conclusion

The BDL survey provides a measurement of the farmer households participating in SoL OFDTs. The results of this survey indicate that most participating farmers remain on the lower socio-economic scale, living in houses possessing limited possessions. The farmers suffer food shortages to a similar level measured in past BDL surveys and by other studies. Household food consumption surveys also add to these measurements to determine whether the SoL/MAF released varieties are impacting on the farm household. This survey also highlights a number of practices that may be investigated further.

6.2 Patterns of household food stocks and flows

The objective of this study was to collect base-line quantitative data on the patterns of daily and monthly food flows and household strategies to secure food in two upland and lowland areas of Baucau and Manufahi during 2007-2008. The study was conducted over three seasons including the dry season (June-October), the wet season (November-May), and the hungry season (November-March) during 2007-2008. The study measured quantities of a range of staple and wild foods coming into the household including foods that were consumed, bought, sold and gifted, as part of a longer-term study to track changes, coping strategies and possible increases of staple food production through participation in the SoL program.

Materials and methods

The methods for this study included monthly visits over a twelve-month period to eight households in two of the four districts (Manufahi and Baucau) in the original *Household Stocks and Flows* study reported in SoL, 2007. The four sub-districts included Alas, Same, Vermasse and Baucau. All of the households were OFDT farmer participants. Interviews were conducted with each household on a monthly basis to ascertain the level of food on a 24-hour recall. A monthly recall was used for foods bought, sold and gifted. The measurements were various but consistent with those used by farmers including a glass, condensed milk tin (Enaak), powder milk tin (SGM), plastic bucket (small, big, medium), plaited basket, flat basket and a sack. Ultimately, these measurements were an approximation and therefore, the following results provide only an estimation of food flows over the year. Despite this, the results of this study provide a general pattern of the differences of food flows in highland and lowland areas. Table 205 presents the months according to the dry, wet and hungry seasons in Baucau and Manufahi. The locations at which the surveys were conducted are presented in Table 206.

Table 205. Months according to the seasons

Dry Season	*Wet Season*	*Hungry Season*
June	November	November
July	December	December
August	January	January
September	March	March
October	April	

Table 206. List of locations for the SoL longitudinal case study on food flows

District/Sub-District	*Village*	*Hamlet*	*Household respondent*	*Local language*	*Elevation*	*Classification of AEZ*	*Rice or Maize Dominant*	*SoL variety*
Manufahi Alas	Maha kidan	Welaku	Juginda da Costa	Tetun Terik	20m	6	Maize	Cassava
Manufahi Same	Betano	Selihasan	Domingas da Costa	Tetun Terik	4m	6	Maize	Cassava and Sele
Manufahi Aalas	Dotik	Datulor	Juliana Soares	Tetun Terik	32m	6	Maize	Cassava
Manufahi Same	Letefoho	Ladiki	Julieta da Silva	Mambae	408m	4	Maize	Sele
Baucau Vemasse	Watulari	Naulale	Fausta da Costa	Waimua	733m	2	Maize	Hohrae
Baucau Vemasse	Waigai	Lari	Tereza Soares	Waimua	27m	1	Maize	Sele
Baucau Baucau	Bucoli	Waisemu	Henriketa da Silva	Waimua	343m	2	Rice	Sele Hohrae
Baucau Baucau	Seisal	Ague	Luis Correia	Makasae	7m	1	Ric	Nakroma

Results

Staple food consumption

The quantity of food consumed by the farmer households over a year period was dependent on a number of variables including household size and food availability. Food availability itself was dependent on climate conditions, natural disasters, pests and availability of income to purchase foods when reserves were finished. Figure 44 illustrates the prominence of maize in the Manufahi district. Manufahi produced and consumed the most staple crops over the twelve-month period – principally due to the possibility of harvesting maize twice in one year – however, disaggregated frequency illustrates key differences of levels of buying, selling and gifting.

Maize consumption

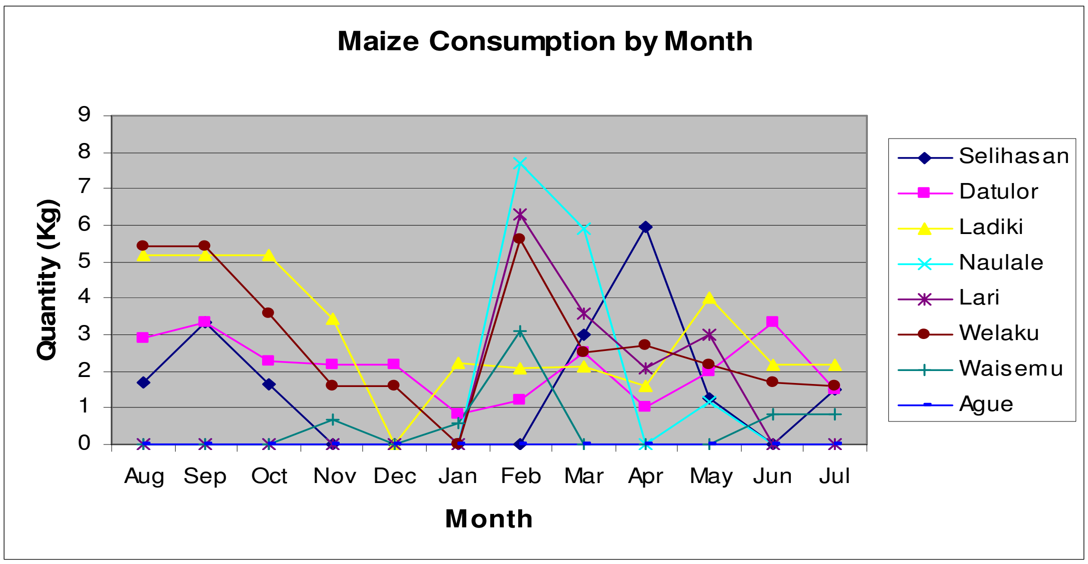


Figure 44. Maize consumption by month

Figure 44 illustrates the differences in maize consumption (and therefore production) between the two districts and in particular, the maize-dominant areas. During the 12-month period from 2007-2008, households in Baucau did not consume as much maize as the households in Manufahi because of their dependency on rice and thus the reverse consumption was reported for the majority of the hamlets. However, the hamlets of Naulale (Vermasse, Baucau) and Ague (Baucau) consumed maize in high quantities in times of harvest from February through to April despite the fact that Ague and Waisemu are rice-dominant locations. All hamlets experienced either maize shortages or complete deficits throughout the year that the study was undertaken. This highlights the severity of deficits experienced by the majority of Timorese farmers in maize-dominant areas.

Figure 44 also illustrates the quantities of maize consumption over a year for the eight households in Baucau and Manufahi. During the wet season, the average daily consumption was 2.7kg. The month of February shows the most radical variation with households consuming maize from very low quantities (0.5kg) to very high quantities (7.8kg). This is due to the possibility of the harvest of short season maize (batar lais) grown specifically for the purpose of sustaining a household for a 3-4 week period until the harvest of the principal maize crop, harvested later in late February and April (and a second season in August). Short season maize is a small, short-cobbed variety grown in sufficient quantities and is a bridging food reportedly grown for children to satisfy their hunger while waiting for the principal maize crop. In 2007

December was categorized as the beginning of the food shortage period because none of the crops were ready for harvesting and reserves were low. During the dry season, an average of 2.7kg per day was consumed, the highest consumption occurring in August (5.5kg) and lowest in June (0.75kg), both in the maize-dominant areas of Same. The following table illustrated the duration of complete maize deficits when farmer households reported zero maize consumption. This relationship can be compared with the data presented in Figure 43 which shows the average time for OFDT farmers to deplete their maize reserves.

Table 207. Duration of maize deficits in Baucau and Manufahi

Location (Suco, Sub-District, District	*Months of maize deficit (months)*
Selihasan,Betano, Manufahi	4
Naulale, Vermasse, Baucau	6
Lari, Vermasse, Baucau	7
Waisemu, Bucoli, Baucau	6

Rice consumption

Figure 45 illustrates rice consumption over a year period for all hamlets in the study. Only two households consumed rice that they planted themselves (including Ague and Waisemu in Baucau) and others bought small quantities of imported rice from the market, or when it was available, local rice. The figure illustrates that January was a serious shortage period of household reserves as farmer households relied on imported bought rice in this month. At that time maize or rice reserves were exhausted and farmers were waiting for their harvest.

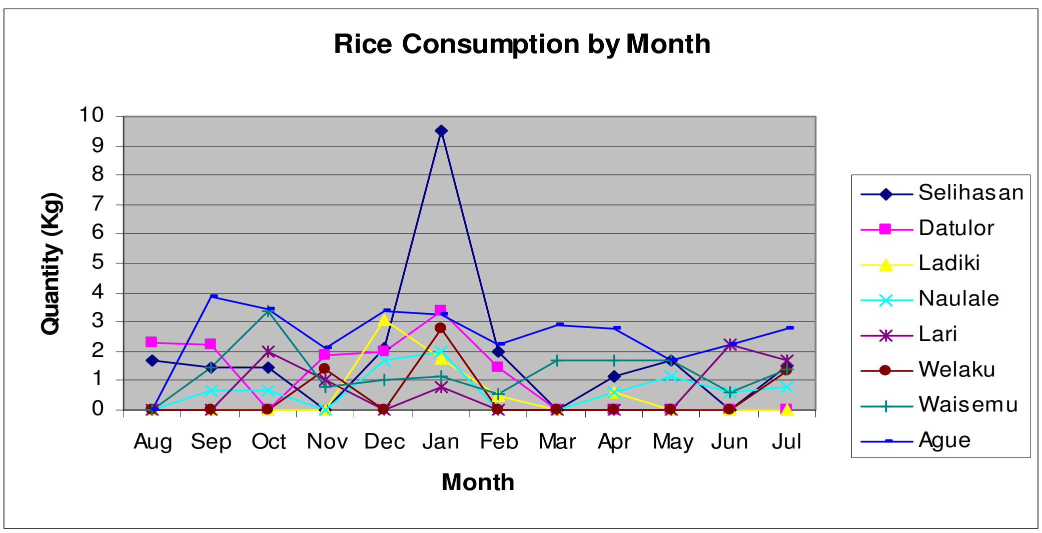


Figure 45. Rice consumption by month

Rice consumption occurred in high quantities when reserves of maize were exhausted. Farmer households were forced to buy imported rice at the market illustrating the importance of rice as a back-up food to maize and the vulnerability of poorer farmer households to fluctuations in market prices. During the dry season, the average consumption of rice was 1.85kg/day. The wet season illustrated an average consumption of 2.0kg/day and an average of 2.3kg/day rice was consumed during the hungry season.

Selihasan hamlet in the Sub-District of Same, Manufahi district had the highest consumption of rice (9.52 kg) from all the hamlets. This was a four-fold increase in the daily average of other households. The reasons the family provided for this high consumption was primarily because of a shortage of other reserves. Maize reserves were finished and no roots or tubers were available.

By comparison, medium and low quantities of rice were consumed in areas where a range of other crops could be grown. This confirms other studies (WFP 2006) that demonstrate high levels of expenditure on food by low income households equaling 61% of income for subsistence farmers compared to about 30% for medium and high socio-economic status farmers. Although subsistence farmers have a much lower income, they must spend a higher percentage on food and they are most vulnerable to changes in their supply or price of food (see Household Stocks and Flows report 2007). In addition, rice farmers are (generally) more likely to specialize in this crop because of the necessary labour inputs and thus highlights vulnerability when the crop fails. Therefore the consumption of rice can be ambiguously interpreted as both a relative marker of wealth and poverty. While on the one hand, rice serves as a status-marker, it also suggests the inability of households to produce a range of other crops which could secure a household's consumption needs without having to resort to buying rice from the market. This highlights the need for MAF to retain a focus on diversifying production other than rice.

Sweet potato consumption

Figure 46 illustrates that sweet potato consumption occurred in four of the households when other stocks of rice and maize began to decline. Consumption occurred mostly during the dry season with a daily average of 2.24kg. However it was consumed in relatively high quantities in two areas of Baucau and Manufahi coinciding with the period when maize stocks were beginning to dwindle. Consumption equaled 4.2kg in Naulale, Vermasse, Baucau in June and 4.46kg in Ladiki, Same, Manufahi in August, suggesting the direct relationship between dwindling grain stocks and the shifting focus to tubers. Households in Selihasan (Same), Waisemu (Baucau) and Welaku (Alas) did not consume any sweet potato over the course of the year. The household in Selihasan (Same) is located near the coast of Betano and had never planted sweet potato. Waisemu planted sweet potato but the harvest failed due to limited rainfall. Welaku (Alas) is located on a slope and had never planted sweet potato.

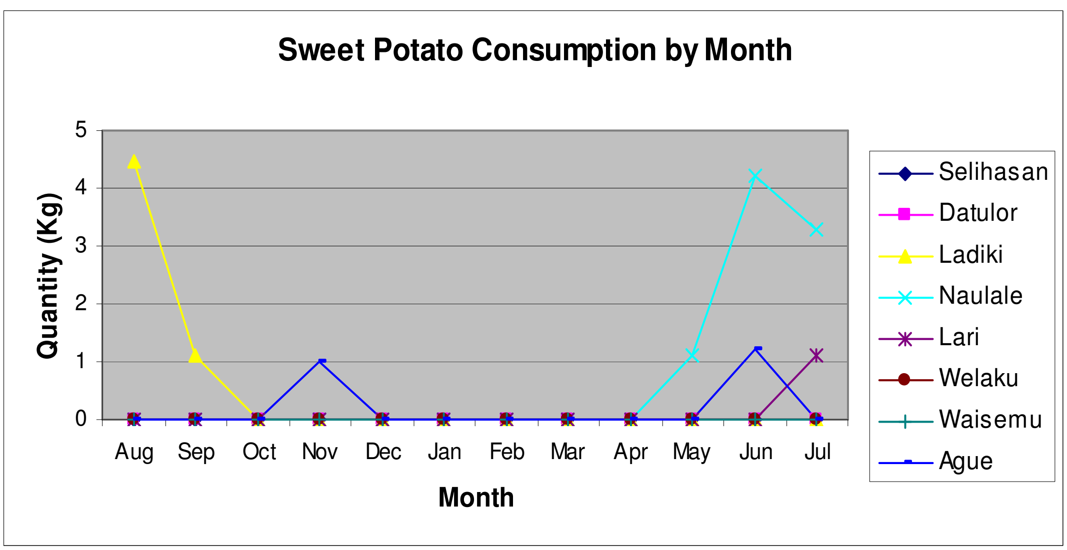


Figure 46. Sweet potato consumption by month

Cassava consumption

The data presented in Figure 47 illustrates cassava consumption on a hamlet basis over a 12 month period. In accordance with the 2007 and 2008 BDL analysis, tuber crops have the distinct advantage of being able to be stored in the ground and only harvested when needed. The daily consumption averages illustrate the highest consumption of cassava coincided with the hungry season peaking in November. The fall in consumption in December may be due to the change in tuber flavour. Many farmer households will not eat cassava at the start of the wet season because it is too watery (pers. comm. Williams 2009). It is significant that no cassava consumption was recorded during the month of January as this was when all food stocks have been depleted and therefore January can be described as the peak of the hungry season. During the dry season (June-October), the average daily consumption was 2.8kg. There was a drop in consumption during the wet season (November-April) to a daily average of 2kg and then a spike in consumption during the hungry season (November-March) to 3kg. The highest monthly consumption occurred in November as stocks of other staple foods dwindled. By the month of February, the short-season maize was able to be harvested bringing some relief to family households. Ague hamlet (Seisal, Baucau) was the only hamlet not to consume cassava over the year period. The household did not plant cassava due to reported inappropriate soil conditions. The prevalence of rice in Ague may also account for this preference.

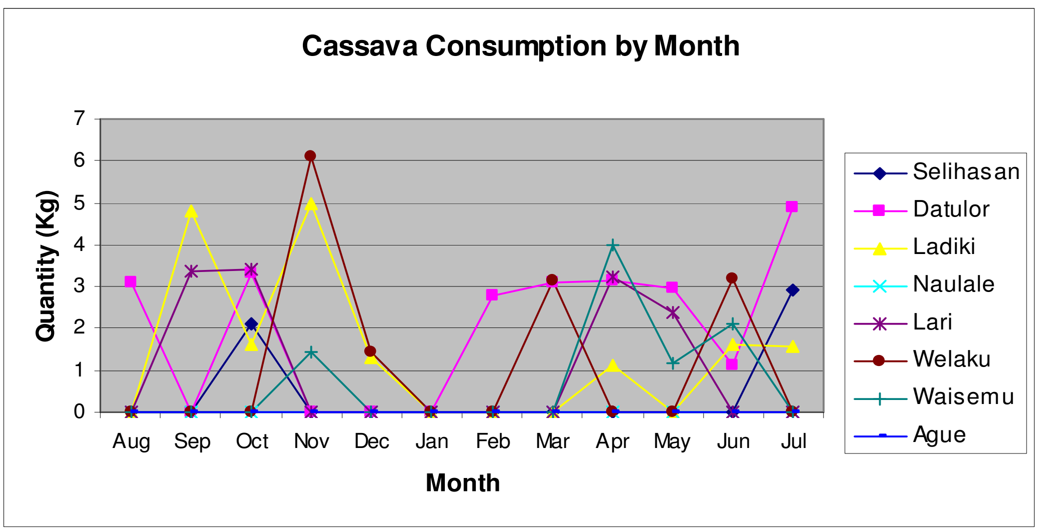


Figure 47. **Cassava consumption by month**

Purchased food crops

The farmers in this study were predominately subsistence farmers and when their supply did not meet demand a variety of other strategies were put in place to fulfill the household's needs. The following graphs illustrate the rice and maize purchases made by farmer households over the course of a year. Figure 48 illustrates the high frequency of rice purchases throughout the year for the majority of the households in the study

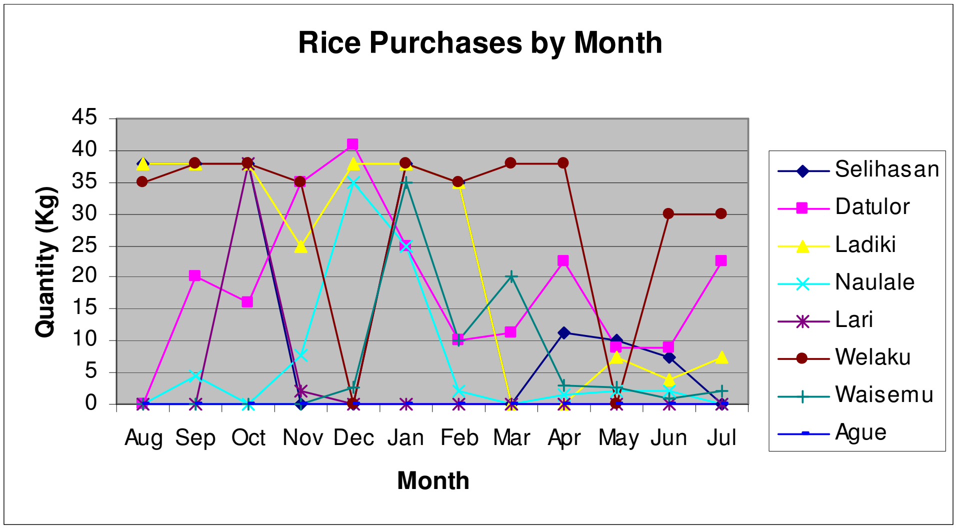


Figure 48. Rice purchases by month

Just one hamlet, Ague (Baucau) did not buy rice during the whole year because the farmer household had sufficient reserves of their own rice harvest. Rice remained the preferred purchase crop primarily because of labour, resources and taste. The Stocks and Flows study (2007) reported the following reasons for rice consumption:

- rice cooks in 5-10 minutes when boiled and therefore requires little fuel (e.g., firewood) compared to maize which takes up to 40 minutes to boil
- cooked rice that is not refrigerated overnight can be readily re-heated and eaten the following day, and maintains good taste
- cooked rice becomes soft and may be consumed by the entire family including the elderly and babies
- imported long rice grains are said to grow more during cooking and are therefore more filling (WFP 2006)
- rice sates the appetite, and where rice is not served among those accustomed to eating rice regularly the meal is considered to be incomplete, causing '*hamlaha'* which may be translated as hunger

Rice was by far the most commonly purchased commodity over the duration of a year. Purchases were significantly higher during the wet season when other food reserves were exhausted. The farmer household of Datulor (Manufahi) hamlet purchased rice in high quantities in December compared to other households principally because of the lack of other food reserves available in the farmer households own house which made them dependent upon the predominately imported rice sold in the local market. This particular farmer household derived the income to purchase the rice from the sale of vegetables and chickens. Ague hamlet purchased maize in small quantities because of the availability of their rice harvest. Seen in district terms per season the table also illustrates significant district patterns. During the wet season, the four Sub-Districts of Manufahi made the majority of rice purchases (65.3%). Baucau made 34.6% of the total number of rice purchases. During the dry season, Baucau made just 18% of rice purchases (80% of these purchases were under 5kg) and Manufahi made 89% of the purchases (all of these purchases were above 5kg and as many as 90% were above 20kg). Interestingly, from the dry season into the hungry season, there was no significant change for both of the districts. During this time, while Baucau made 31% of the rice purchases (66% of these purchases were under 5kg), Manufahi made 68% of the rice purchases (85% were above 20kg).

By comparison, just two hamlets of Datulor and Selihasan purchased maize throughout the year in relatively small quantities when compared to rice purchases (Datulor purchased 3.5kg during February and Selihasan purchased 2.5kg during March) (Figure 49). The under-representation of maize purchases further highlights the dependency of farmer households on rice.

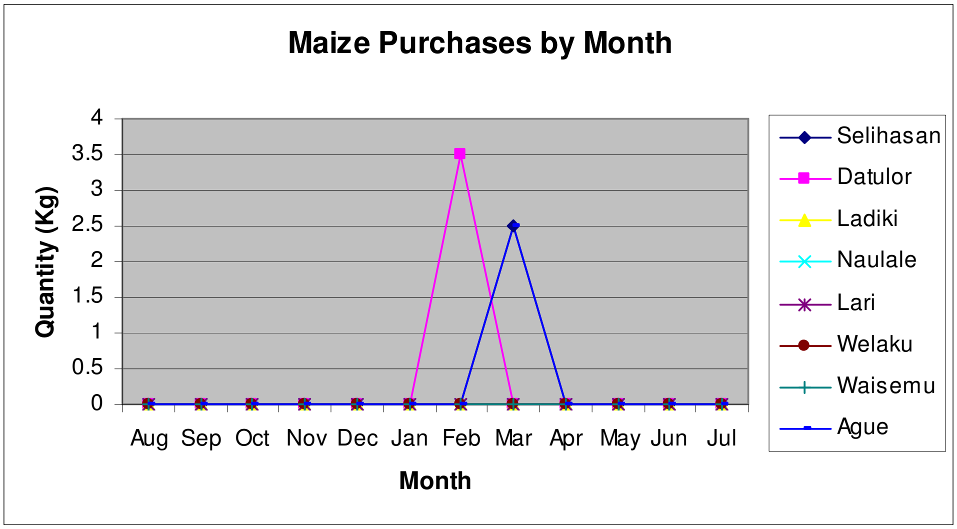


Figure 49. Maize purchases by month

Staple crops sold by farmer households

Surplus yield is often sold in the local market in order to buy other food needs. Selling occurs right at the time of harvest indicating both the lack of storage facilities and the need to buy other staple foods to fulfill household needs. The households in both districts sold maize and cassava – interestingly there was no rice sold (Figure 50). The household in Welaku hamlet (Manufahi) sold their surplus of maize in high quantities in October just after the harvest. Interestingly, the rice-dominant household in Ague (Baucau) hamlet sold a surplus of maize in April; while Waisemu hamlet sold cassava. In general, Manufahi sold more produce (60%) and in larger quantities (up to 64gk in Welaku) than Baucau (40%) (up to 25kg). This reflects the maize-dominant households in Manufahi which could produce a second harvest. Most of these sales also occurred during the dry season, as suggested by the Household Stocks and Flows 2007 study, in order to purchase rice as there was a preference to eat maize and rice alternatively rather than one or the other. During the wet season however, the frequency of selling crops in these two districts was reversed, with Baucau selling 60% of all produce sold and Manufahi selling 40% of all produce sold. During the hungry season, only one food insecure farmer household of Datulor (December) made a sale of cassava – suggesting that rice and maize supplies had diminished. Neither of the two rice-dominant households (Weisemu and Ague, Baucau district) sold any rice suggesting there is either a preference to store produce for household consumption.

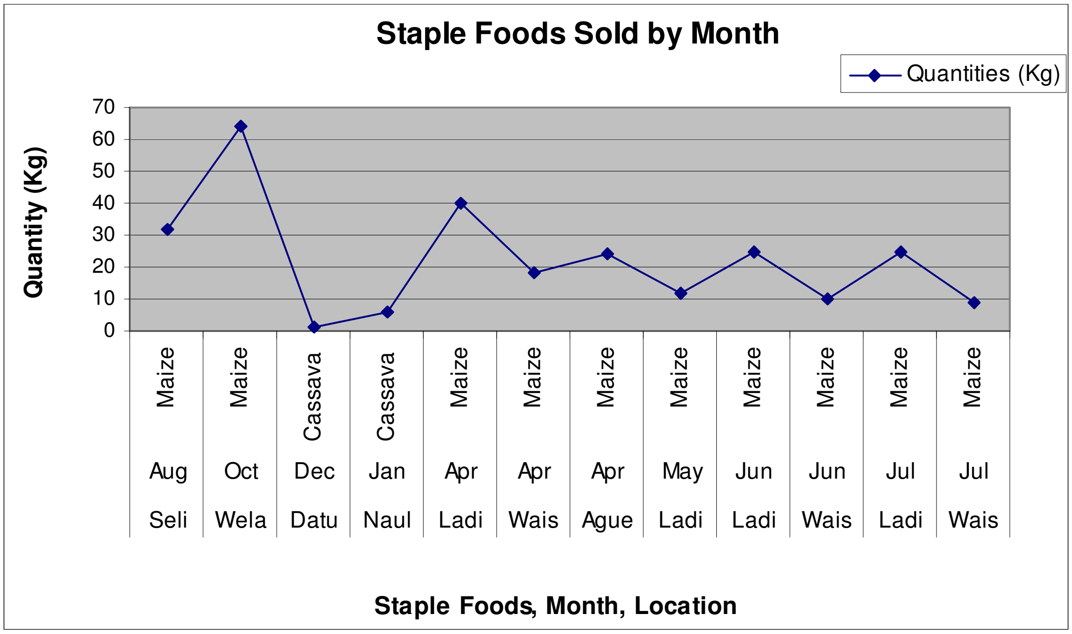


Figure 50. **Staple foods sold by month and location**

Gifted staple crops

Gifts of agricultural produce are very common among subsistence farmers in Baucau and Manufahi with the most common being maize followed by rice Figure 51. The high quantities of maize gifted reflect the predominant maize-growing areas in the study and therefore the households were more likely to give maize rather than receive it. Gifts also function to maintain and strengthen social relations. This gift-giving behavior acts as social capital which can be called upon in times of difficulty. There are two types of gift-giving represented in the graph; one is where farmer households shared foods at harvest time if there was a surplus. This sort of sharing throws up more questions about the rights of certain households in social networks who are eligible for these gifts and what exchange is transacted. In addition, more research on the nature of gift exchanges would also shed light on the significance of social networks and exchange in obtaining food security.

Hamlets experiencing extreme food shortages such as Ladiki (Same, Manufahi) and Waisemu (Bucoli, Baucau) in the months of January and February, continued to gift food, albeit in smaller quantities than other hamlets thus illustrating the importance of gift-giving in Timorese agricultural communities. If the two districts are compared during the dry season, Manufahi has gifted produce; from a total of nine occurrences of gifting, Manufahi provided for 77%. Following this pattern, maize constituted 60% of food gifted. In Baucau, giving only occurred twice and both of these gifts were imported rice which was then re-distributed. These figures are consistent with the frequency of staple crops gifted in the wet season. In Baucau, 33% of gifts constituted rice, while in Manufahi rice constituted just 16.6% while maize constituted 50% of the total gifted food. The hungry season, as could be expected, constituted a period when all farmer households in both regions were less likely to gift food. However, two households in Manufahi district gifted rice and two households in Baucau also gifted rice. Naulale, Venilale, in Baucau district comprised the only farmer household that was unable to gift or receive food throughout the year.

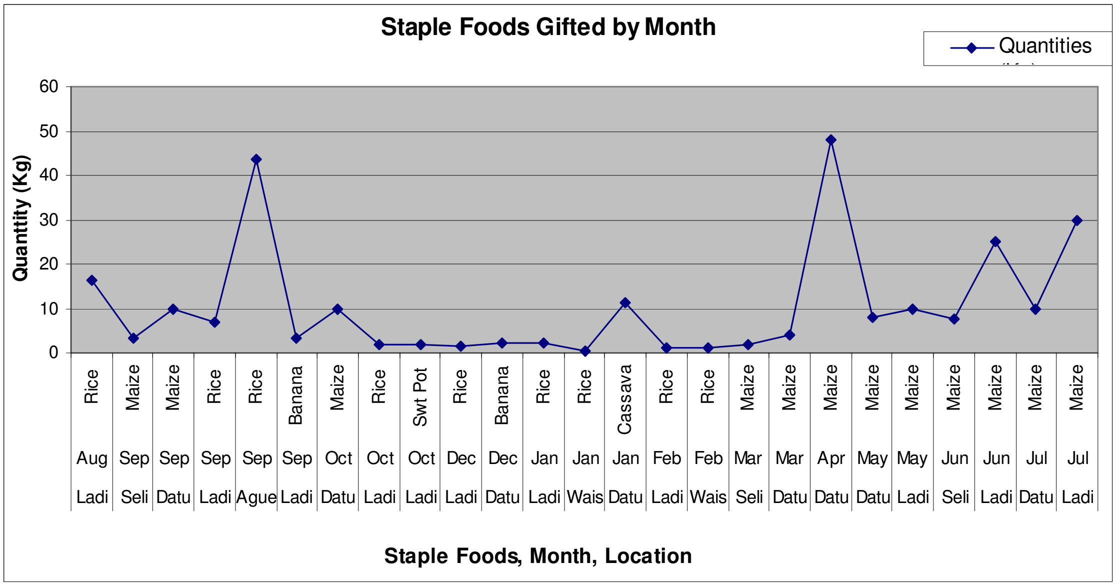


Figure 51. **Gifted staple crops by month and location**

Received staple crops

The study also reinforces earlier findings (see SoL, 2007) of the importance of social relations in securing access to food. Throughout all of the sub-districts, the act of giving food was prevalent no matter the level of household's production. The most commonly received staple commodity was maize (a total of 61kg with the largest quantity of 30kg in Baucau) followed by rice (a total of 38kg and the largest quantity of 12kg in Baucau) and cassava (a total of 23kg and the largest quantity of 10kg in Manufahi) (Figure 52). Banana and sweet potato were also received in moderate amounts.

During the wet season, receiving occurred in equal frequency across the two districts. A total of 40% of the foods received constituted rice in Baucau. In Manufahi, maize constituted 30% of all commodities received and no rice was received during this time. The village of Datulor in Manufahi experienced severe food shortages and this was responded by the high frequency of receiving food (Datulor received 90% of the total food received in this time). Datulor is not located near a forest in which the farmer household was able to forage for local foods. Furthermore, being transmigrants to the region, the farmer's households have the necessary skills to process wild foods such as Sago. Consistent with the other seasons, maize constituted 33% of the total food gifted in Manufahi.

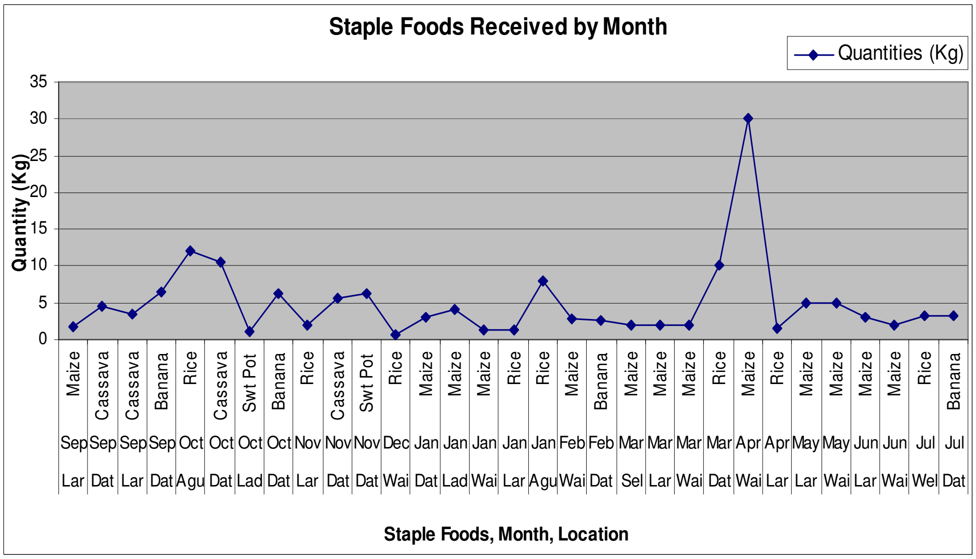


Figure 52. **Received staple crops by month and location**

Wild food consumption

Wild food is an important additional food for households (May-November) located close to mixed forests without a dense canopy that will support a wide variety of wild foods during the dry season. Wild yams were the most commonly consumed wild food over the course of the year (Figure 53). Interestingly, Kumbile, wild yam, was consumed in high quantities (up to 14kg and 80% of the reported wild foods) in Naulale (Baucau) during the dry season (July) because of the proximity to the forest where it could be foraged. The farmer household in Datulor (Manufahi) is not located near a forest with coverage promoting wild foods.

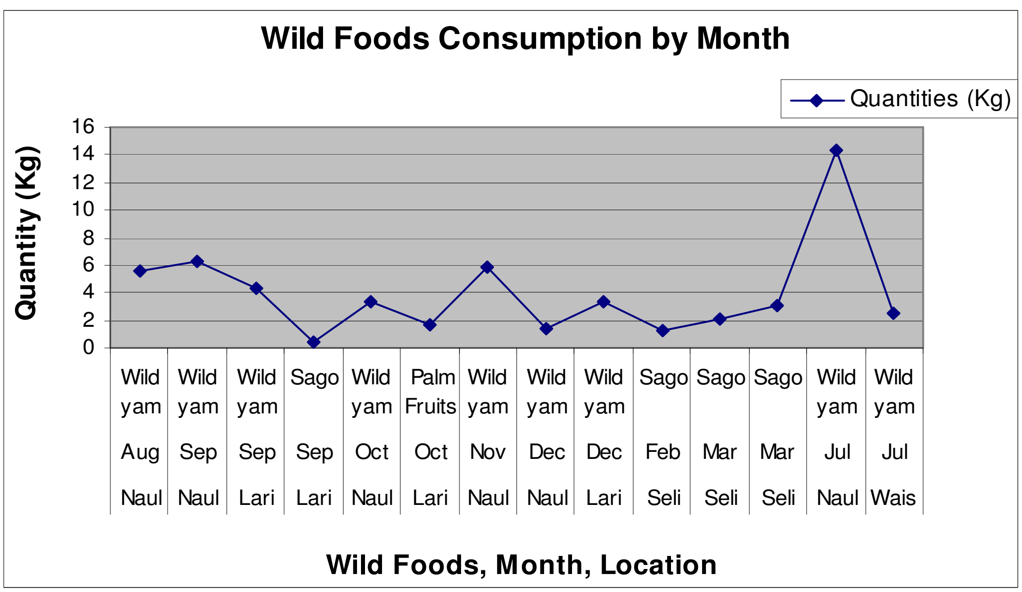


Figure 53. **Wild food consumption by month and location**

Conclusion

This report confirms the conclusions of the Household Stocks report (2007) that suggested that for subsistence farmers, food availability is closely correlated with the harvest cycle of the staple food crops and traditional coping mechanisms involving shifting consumption patterns from rice to maize, to roots and tubers (cassava, sweet potato, kumbile tuber). The extent of food reserves in any household depends on household size (demand) in relation to harvest yield (supply). Maize is an important staple crop and demand exceeds most farmers' reserves even though rationing methods are practiced. When maize reserves are exhausted, farmers are more likely to purchase rice rather than maize due to factors of distribution, cost and labour. This is clearly shown in Manufahi district during the wet season when reserves of maize are depleted and 68% of all rice purchases are made by the four Sub-Districts. The rice growing areas of Baucau are less dependent upon maize (although more reliant in the wet season when they are waiting to harvest their rice). However, as a rice growing area, this does not secure them against food shortages. The common practice of giving and receiving food throughout Timor-Leste functions to strengthen social networks between extended family, and neighbours who are non-kin. Even areas experiencing food shortages (Ladiki in Manufahi and Waisemu in Baucau) continue to gift foods, albeit in smaller amounts. In doing so helps to secure access to food. More research would help to better understand other connections and correlations between giving and receiving foods and the possible role SoL varieties are playing in increasing household food security.

7. Communication and technology dissemination

Information about Seeds of Life activities in 2008-2009 was disseminated though a number of different mediums, as outlined in the table below.

Audience	Communication medium
Farmers	• Direct contact with SoL OFDT research staff • Farmer field days • Research results meetings
MAF district staff	• Ongoing liaison with SoL district staff & leaders • Farmer field fays • Research results meetings
NGO & agency partners	• Ongoing liaison with SoL district staff & leaders • Research results meetings • Website • Publications
Timorese public	• Print, radio and television news stories • Conferences • Tetun-language publications
Australian & international public	• Website • Print and radio news stories • International conferences • English-language publications

SoL's communication with the farming community was primarily through the direct contact of SoL research staff as they designed, installed and monitored OFDTs. RAs decided where to place OFDTs through the RDUs and discussion with MAF staff, village chiefs and farmers.

In addition to SoL staff's direct contact with OFDT farmers, NGOs and MAF extension staff also distributed SoL seed and discussed the attributes of each released variety with farmers.

OFDTs were installed in an increasing number of sucos in the districts where Seeds of Life was working, and in two new districts in 2008-2009: the north-western district of Bobonaro (Maliana and Cailaco sub-districts) and the south-eastern district of Viqueque (Ossu and Uatolari sub-districts)

At the end of the 2008/09 wet season, OFDTs had been installed in 26% of the sucos of Timor Leste. In some districts the coverage is even greater. For example, in the original four districts where Seeds of Life commenced OFDTs in 2005-2006 (Aileu, Liquica, Manufahi and Baucau), more than 70% of the sucos have been exposed to OFDTs. NGOs have also had activities in a number of additional sucos to varying degrees of success. The number of farmers receiving released varieties is expected to increase dramatically in 2009-2010 as the SoL/MAF seed production programs expand their activities.

Farmer field days

OFDT research staff organised field days in all sub-districts where OFDTs were established. Each RA aimed to hold one field day for each crop in the Sub-District where they worked. Between 10 and 30 farmers were invited to each field day at harvest time. MAF district office staff and extension staff were also invited to attend. The RAs engaged farmers in discussion about the trial lots, and farmers assisted in harvesting the plots. The harvest from each plot was then weighed, cooked and eaten. The attributes of each variety were discussed. SoL staff used this opportunity to disseminate technological information to neighbouring communities.

Research station staff also organised field days, designed to enable farmers and other consumers to evaluate technologies under examination prior to advancing them to the on-farm stage. These field days also provided the opportunity for farmers to taste-test some of the varieties under investigation. Such evaluations helped the researchers 'short list' accessions for further measurement.

Research results meetings

Research results meetings were held in each of the seven SoL districts in early September 2009, to present the results from the period September 2008-August 2009. The day-long meetings were well organised and well attended, and provided a valuable opportunity for SoL to engage with local farmers, district administration, MAF district staff and NGO staff.

Publications

SoL produced a range of publications during the year, including:

2009 Calendar

2500 copies of the 2009 Seeds of Life calendar were designed and printed in November 2008, and distributed to farmers and officials in December 2008. The colourful calendars are often prominently displayed in farmers' homes, providing a visible promotion of the Seeds of Life program throughout the year.

2008 Annual Research Report

The 2008 Annual Research Report was published in August 2009 in English and Tetun. 500 copies were printed in English and 1,500 in Tetun, and were distributed to MAF divisions, AusAID, NGOs etc. The research report is also available to download from the Seeds of Life website as a PDF file, together with reports from previous years.

Seeds of Life Brief

Based on a recommendation from the TAG Mid-Term Review, a four-page brochure summarising the activities and outcomes of Seeds of Life was published in May 2009. 500 copies were printed in English and 1,250 in Tetun, and distributed to MAF divisions, AusAID, NGOs etc. The brochure provides a concise introduction to the SoL program for new audiences.

Reaping the Benefits

A 20-page booklet presenting a SOSEK economic impact study from 2007-2008 was published in May 2009. 500 copies were printed in English and 1,250 in Tetun, and distributed to MAF divisions, AusAID, NGOs etc. The booklet quantifies the economic benefits that a sample of farmers have enjoyed since participating in OFDTs and continuing to replant SoL varieties over larger areas of land, and is a useful reference to have on hand when visitors and stakeholders visit the SoL office. The booklet is also available to download from the Seeds of Life website as a PDF file.

Variety Release Brochures

Information brochures produced in the previous year continued to be distributed to farmers. These brochures highlight the attributes of recently released MAF varieties and explain other technologies including the GrainPro grainbags for seed storage. New brochures for Ai-luka 2 and Ai-luka 4 cassava varieties were designed in late August 2009.

Publications to the end of 2009

At the end of August, 2009, 55,500 brochures describing the 9 released varieties and use of the grain pro bags had been printed and most distributed. Brochures for maize, rice, sweet potatoes and peanuts were on their fourth re-printing. 3,500 general descriptions of the program had also been printed along with 4,250 Annual Research Reports (2005-2008). 4,500 Calendars had also been produced along with 30,000 seed labels for use on the distributed seed.

Website

Seeds of Life maintained a website hosted by the University of Western Australia server at: http://sponsored.uwa.edu.au/sol/index. The website provided an overview of the Seeds of Life mission, research and staff.

In order to better promote and profile the program, and to have greater flexibility in updating the site and expanding the content, a new website was designed in mid-2009. The site is hosted at: www.seedsoflifetimor.org, a domain which SoL already owned but had not previously developed. The site design and content were written in June and July, and a web designer was contracted in August to develop the backend of the site. The site went live in early October 2009.

Communications volunteer

A Communications officer was recruited to SoL through the Australian Youth Ambassadors for Development (AYAD) program in the second half of 2008. Sally Bolton started with SoL in late March 2009, working on a range of communications activities including farmer benefit stories, the website redesign, design of new publications, a photography database and training, and media releases.

Local media coverage

SoL activities were publicised within Timor-Leste on a number of occasions through local newspaper, local radio and TVTL news broadcasts. Activities which the Minister or Secretary of State of the Ministry of Agriculture and Fisheries participated in and received significant attention at ceremonies, include the Nakroma field day in Tequinomata, Baucau on 31 March 2009 and the Ai-luka cassava variety release in Dili on 27 August 2009.

A copy of the story below is on file in the SoL Dili office:

FBM Halo Treinamento Konaba Hamoos Fini Hare (SoL Conducts Training on Rice Seed Training). Suara Timor Lorosae. 16 July 2009

Australian media coverage

Links to websites and online media which reference SoL are included below.
Food Security in East Timor. ABC Rural 26 September 2008
http://www.abc.net.au/rural/sa/content/2006/s2375427.htm
Drums for East Timor. ABC Rural 24 October 2008
http://www.abc.net.au/rural/sa/content/2006/s2400754.htm
Champion Farmer and Champion Runner. CLIMA Beanstalk December 2008
http://www.clima.uwa.edu.au/news/newsletter/December_2008.pdf
Seeds of Life Review. ACIAR January 2009
http://www.aciar.gov.au/node/10457
Learning Aussie Farming Methods. Warwick Daily News 2 April 2009
http://www.warwickdailynews.com.au/story/2009/04/02/learning-aussie-farming-methods/

Improving food security in East Timor. Asian Currents July 2009
http://asaa.asn.au/publications/ac/asian-currents-09-07.html#3c

Asia-Pacific Journalism Centre Visit

SoL met with eight young Australian journalists who visited the Loes Research Station in June 2009 as part of a familiarisation tour of Indonesia and East Timor organised by the Asia-Pacific Journalism Centre in Melbourne. The journalists represented news organizations including BRW, AFP, AAP, SBS, The Age, ABC TV and ABC Radio.

Conference presentations

Seeds of Life staff presented at a number of national and international conferences, as detailed below:

Participatory variety selection increases adoption of modern varieties by subsistence farmers in East Timor. Robert Williams, Lorenco Fontes, Deolindo da Silva, Alex Dalley and Brian Monaghan. *14th Australian Society of Agronomy Conference,* 21-25 September 2008, Adelaide, South Australia, Australia
http://www.regional.org.au/au/asa/2008/poster/farmer_focussed_research/5885_williamsr.htm#Top

The socio-economic study comprehension of food security towards food sovereignty in East Timor. Modesto Lopes, Anita Ximenes and Angie Bexley. *The role of agriculture technology in food sovereignty and bio-energy towards sustainable agro-industry*. 17-19 November 2008. Gadjah Mada University, Yogyakarta, Indonesia

The importance of agricultural social research in the East Timor Ministry of Agriculture and Fisheries. Modesto Lopes, Anita Ximenes, Marcelino de Jesus and Angie Bexley. *Understanding Timor Leste: A research conference.* 2-3 July 2009. Universidade Nacional de Timor Leste, Dili, East Timor

Alternatives in Agriculture. Luis Almeida. *Transforming Timor Leste for sustainable development, human rights and peace: an opportunity for dialogue.* 6-7 July 2009. East Timor Ministry of Foreign Affairs, Dili, East Timor

Refereed international journal publications

Lourenco Fontes Borges, Adalfredo do Rosario Ferreira, Deolindo Da Silva, Robert Williams, Rebecca Andersen, Alex Dalley, Brian Monaghan, Harry Nesbitt and William Erskine (2009). *Improving food security through agricultural research and development in Timor-Leste: a country emerging from conflict. Springer. Published on-line October, 2009.* *http://www.springerlink.com/content/050t8r7584553435/*

Erskine, W., and Nesbitt H., (2009). *How can agriculture research make a difference in countries emerging from conflict?* Expl Agric. (2009), volume 45, pp. 313–321

8. Capacity building

A training needs assessment conducted in 2006 (Shires and Balasubramanian, 2006) identified the need to assist with improving the capacity of personnel within the Timor-Leste MAF to conduct research on research stations and to implement an on-farm technology evaluation plus technology delivery program.

The strategy proposed was for the program to possess elements of (1) post graduate courses, (2) on-the-job training (OJT) and (3) short courses with the long term aim of having sufficient trained researchers at the national research institutes and trained extension staff in the districts to satisfactorily handle the research and development needs of Timor-Leste. In order to be fully successful, the training program also involves farmers and other technology adopters for evaluating the technologies and for developing a program suited to the country's needs.

The long term goal is for Government personnel formal qualifications to reach the levels presented in Table 208.

Table 208. Long term goal for qualifications of personnel working in MAF

- National research institutes: 40% M.Sc., 30% B.Sc., and 30% diploma holders.
- District level: One M.Sc. level crops extension specialist trained in general agronomy and crop management, one B.Sc. level plant protection extension specialist trained in entomology and pathology, and one extension specialist with diploma in livestock extension.
- Sub-District level: Three to four extension staff at diploma level for each district.
- Suco level: A suco extension officer and 2-3 locally trained lead farmers as para-extension staff to promote technologies in their respective target areas.

At end of August, 2009, the Directorate of Research and Special Services was manned by two MSc graduates, the remainder possessing either a Diploma or undergraduate degrees. There were no MAF personnel with MSc qualifications residing in the districts. MAF staff numbers by National Directorate are presented in Table 209. There was also an extra 409 extra staff members in the Districts making a total of 1793 staff members in the MAF. Approximately 10% of Headquarters staff was considered to be Professionals and 6% of District staff classified as Professionals (MAF, 2009) as opposed to Technical or Non Technical. These statistics emphasize the need for a wide ranging human capacity building program within MAF if international levels of education are to be equaled.

Table 209. Staff and budget of MAF Directorates

National Directorate	*Permanent staff*		*Temporary staff*		*Total*	*Budget ('000 USD)*
	HQ	*District*	*HQ*	*District*		
Research and Special Services	8	3	39	45	95	523
Agriculture and Horticulture	22	13	136	51	222	16,363
Agricultural Community Devel.	2	0	56	398	456	412
Total research and ext'n	32	16	231	494	773	
Total in National Directorates	161	10	521	692	1384	
TOTAL in MAF					1793	29,802

Source: MAF Overview on Policies and National Directorates: Their Resources, Activities and Plans for 2009

The MAF allocates approximately 1.75% ($523/$29,802) of its budget to agricultural research. Little of this is spent on training compared with salaries and operational costs. SoL contributes to the training program directly and indirectly through facilitating MAF personnel gaining access to opportunities with other agencies.

In 2009, six Timor Leste researchers were assisted with their post graduate training. Two were directly sponsored by SoL to attend Bogor Agricultural University in Indonesia (commencing July, 2009) and two further students were assisted with applying for John Allwright scholarships to attend courses at the University of Western Australia (UWA). The John Allwright scholars will commence in January, 2010. A fifth student received support from SoL to complete the last two units of his Master Degree of Geographical Information Science (MGISc) at the University of New England (completed in 2009). In addition one student is being partially supervised by the SoL Australian Program Coordinator to complete his PhD candidature (will complete studies late 2010).

On-the-job training was limited in the SoL program to the end of 2009, mainly because of poor English language skills. Places were identified in both Australia and at IRRI headquarters in the Philippines but English language was a limitation.

For short term courses, SoL invested considerable resources and time to the training of national professional staff and farmers in a wide range of topics. The number of 'staff training days' (total of the number of days conducted for each trainee, per year) increased considerably year by year (see Figure 54). The total number of training days in 2005-2006 was 280 days, which had increased significantly to a total number of 2078 days in 2008-2009 (mirroring the increase in the size of the project and increase in number of staff). This total number of training days means that on average, 9 people attended training each work day. The extensive training effort allowed staff development to become confident researchers and agronomists, taking on more responsibility every year. Competencies in various fields, such as agronomic, computer and management skills, are recorded and monitored to enable more tailored training programs for future phases of the program.

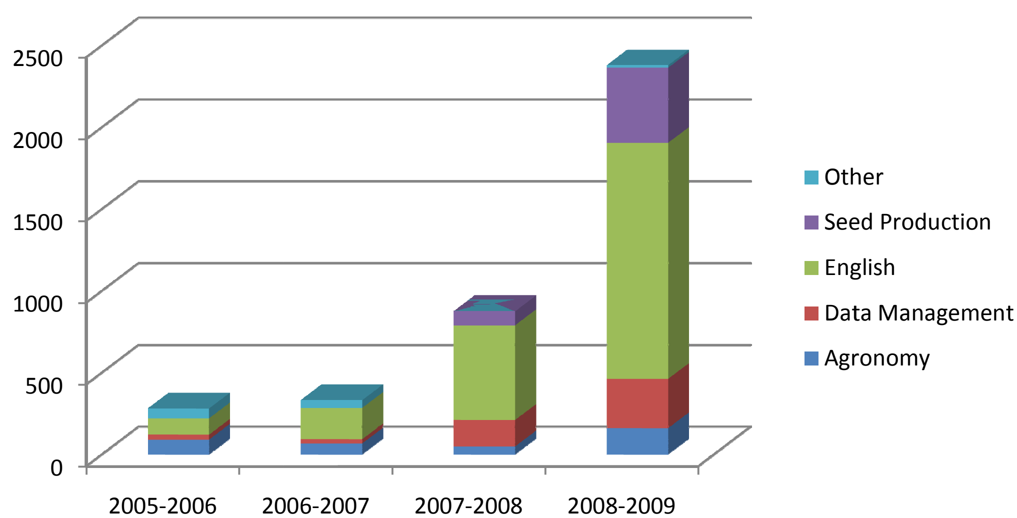


Figure 54. Annual total training days, 2005 - 2009

Apart from English language training, training courses were presented in either Tetun or Bahasa Indonesian. Training material was often translated from English or Indonesian into Tetun. Indonesian professors from Bogor University of Agriculture visited SoL and presented 6 courses over a two year period (2007-2009) in Bahasa. Seed production training was presented by the Indonesian SoL advisor in Bahasa, a language which is often the medium of instruction in Timor Leste universities. English language training remains important in the SoL training program to improve the potential for MAF personnel to work with computer programs and attend training courses abroad.

English language capacity within MAF research staff improved significantly over the period from 2005-2009. During this time, the average staff English level has increased from 1.9 to 2.2 on a scale of 1-4.

Following consultancy with Therese Curran in 2007-2008, self-evaluations have been conducted to monitor staff skills. Each staff member is asked to grade themselves on their personal skill levels, which is then revised by an advisor. Self-evaluations are conducted by SoL research staff as a way to monitor the best direction for training focus. Evaluations were conducted in July, 2008, December 2008, and again in May, 2009. Staff were asked to score their skills on a scale of 1-4:

1: Have not yet had the opportunity to learn
2: Progressing (can conduct the activity when assisted)
3: Good (can do the activity alone)
4: Very Good (can teach others how to do it)

The competency ratings were reviewed by advisors and categorized into groups. Figure 55 shows the increase in staff skill sets for data management, maths, agricultural knowledge and computer skills, comparing their competencies at the commencement of their employment, and after a period of 2-3 years.

Figure 55. OFDT staff skill competencies per category

The assessment of staff competencies over time shows that there has been a steady increase in the staff skill sets over time, with some categories advancing faster than others. OFDT staff considered their planning and communication skills have improved significantly, whereas they indicate a further need for training in some categories.

Being a part of the MAF and the broader agricultural and food security community in Timor Leste, when SoL conduct in-country training activities, members of MAF and the local and international NGO community were frequently invited. MAF staff from the research and crops divisions (external to SoL staff), were also often invited to training activities overseas. Figure 56 shows the percentages of participants.

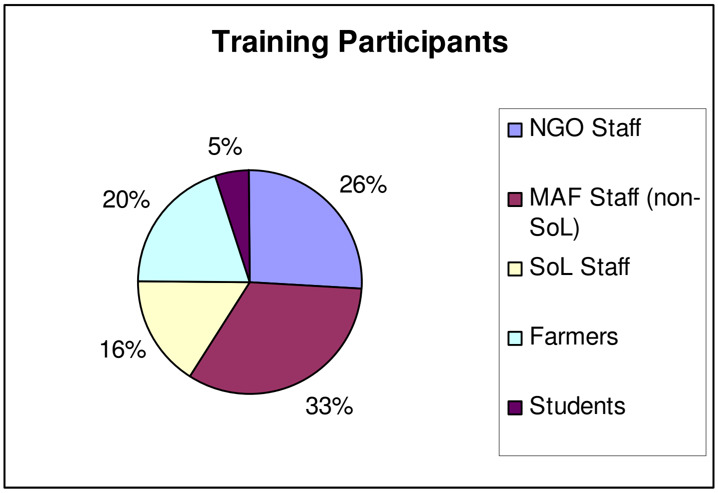


Figure 56. Percentage of training participants from various organizations

9. Technology recommendations

9.1 Released and potential variety evaluations

Nine new crop varieties identified by SoL had been released by the MAF at the end of August, 2009. The first seven varieties were recommended to the MAF by the varietal recommendation committee (VRC) at its first meeting on 8 March 2007. This committee was chaired by the Minister of Agriculture and Fisheries. Two of the seven varieties were 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. In the 2005/06 wet season, both replicated trials and non replicated on-farm trials were established, the results of which are presented in the Annual Research Report for 2006 (SoL, 2006). A similar program of installing replicated and on-farm trials continued during the dry season of 2006 and wet season of 2006/07, the dry season of 2007 and wet season of 2007/08. These trials were described in the Annual Research Reports for 2007 and 2008 (SoL, 2007, 2008). Some of these varieties were further evaluated in 2008-2009 in comparison with local varieties and some potential new releases.

Two cassava varieties were selected for release by the variety release committee on 26 August, 2009. Both varieties were bred at the Indonesian Legumes and Tuber Crops Research Institute (ILETRI) (sometimes referred to as RILET) or selected by the Center Research Institute of Food Crops (CRIFC). The responsible breeders from ILETRI attended the VRC meeting chaired by the Minister of Agriculture and Fisheries and were present when the varieties were officially released on 27 August, 2009. Both varieties were evaluated over at least 13 sites (13 sites for Ca26 and 16 sites for Ca15), were high yielding and considered by farmers to be either sweet or very sweet. A description of the newly released cassava varieties is presented below. A detailed description of the results leading to the release and productivity information after release is presented in the 2008 SoL Annual Research Report (SoL, 2008). An update on the variety selection results for each crop is presented below.

9.1.1 Maize

Seed of the two (Sele and Suwan 5) open pollinated maize varieties introduced by CIMMYT in 2000 and released in March 2007 were multiplied and distributed in 2008-2009. Details of their performance over the period from 2001 to 2008 are detailed in SoL, 2008.

Both Sele and Suwan 5 are yellow grained and, for yellow maize, possess characteristics preferred by most of the population. They are both high yielding, possess good pounding characteristics and are sweet to eat. Descriptions of these characteristics and farmers reactions to the varieties are summarized in SoL, 2008.

Both Sele and Suwan 5 continued to perform extremely well in the replicated trials during 2008-2009 (see Chapter 2.1.1). Yield advantages over a combination of local varieties for both of the SoL releases were over 80% (Table 210). Since its release, Sele has become by far the most popular variety of the two and continued to be an entry in the OFDTs (Table 211), while Suwan 5 was discontinued. Sele is preferred for its sweet flavor, high yield particularly in drought conditions and its superior storage characteristics.

Sele grain yields in the field improve from year to year compared with local varieties averaging a yield advantage of 57% over 235 sites in 2009 (Table 211). Twenty five tons of Sele seed were multiplied by SoL during 2008-2009 for distribution compared with 1 ton of Suwan 5.

Some farmers prefer to taste of white varieties and replicated trials in 2006-2009 included a range of improved white maize composites sourced from the Philippines (P series) and CYMMIT in Zimbabwe (Har series). One potential release (Har12) was examined more closely in 2007-2008 and 2008-2009 after performing extremely well in replicated trials during 2006-2007 (Table 210). Har12 continued its good performance compared with controls in 2008 and

2009 and was included in OFDTs in 2007-2008 and 2008-2009. On farmer's fields, this white variety did not perform as well as the higher yielding Sele but outperformed a mixture of controls (some white and some yellow) by an average of 24% over a two year period (Table 211). Har12 also performed consistently over years by multi year, multi location analysis (Figure 15). This variety is liked by farmers and will be included in further evaluations.

Table 210. Select maize yields and yield advantages, research stations, 2001-2009

	Yield (t/ha)						*Yield advantage (%)*				
Year	*Suwan 5*	*Sele*	*Har12*	*Har05*	*P07*	*Local*	*Suwan 5*	*Sele*	*Har12*	*Har05*	*P07*
2001-2005	3.5	3.1	na	na	na	1.7	106	82	na	na	na
2006 (Four sites)	1.6	1.5	na	na	na	1.1	41	39	na	na	na
2007 (Six sites)	1.9	2.6	2.7	2.0	2.6	1.5	27	73	80	33	73
2008 (Four sites)	1.5	1.5	1.3	1.2	1.3	1.0	53	53	33	22	33
2009 (Five sites)	1.9	1.8	1.6	1.6	1.6	1.0	87	81	53	58	58
Mean (2006-2009)	1.7	1.9	1.9	1.6	1.8	1.1	52	62	55	38	55

Two additional white maize varieties in Har05 and P07 were included in OFDTs in 2008-2009 and will be included in OFDTs during 2009-2010. P07 has highly regarded grain compared with Har12 and other white varieties by farmers even though it is not as high yielding and will be examined closely for its eating qualities.

Table 211. Select maize yields and yield advantages, OFDTs, 2006-2009

Year	*Yield (t/ha)*						*Yield advantage (%)*				
	Suwan 5	*Sele*	*Har12*	*Har05*	*P07*	*Local*	*Suwan 5*	*Sele*	*Har12*	*Har05*	*P07*
2006 (170 sites)	2.6	2.3	na	na	na	1.7	53	35	na	na	na
2007 (278 sites)	2.5	2.4	na	na	na	1.7	47	41	na	na	na
2008 (220 sites)	na	2.5	1.8	na	na	1.6	na	56	13	na	na
2009 (235 sites)	na	2.2	1.9	1.6	1.7	1.4	na	57	36	14	21
Mean (2006-2009)	2.6	2.4	1.8	1.6	1.7	1.7	50	47	24	14	21

9.1.2 Peanuts

Utamua

The peanut variety Utamua was selected and released based on six years of replicated trials (see Sol, 2008). Farmers were attracted to the large seed size, good eating quality and good yield. In 2008-2009, replicated trial data demonstrated this was a good choice with the variety returning a yield advantage over six sites of 32% (Table 212).

Table 212. Utamua peanut yields and yield advantages, research stations, 2001-2009

	Yield (t/ha)				*Yield advantage (%)*		
Year	*Utamua*	*Pt14*	*Pt15*	*Local*	*Utamua*	*Pt14*	*Pt15*
2001-2005	2.1	na	na	2.0	7	na	na
2006 (Two sites)	1.1	1.8	1.3	1.2	-9	50	8
2007 (Five sites)	2.0	2.4	2.3	1.7	17	40	34
2008 (Four sites)	1.3	1.1	1.1	0.9	43	26	23
2009 (Six sites)	1.5	1.2	1.5	1.1	32	5	32
Mean (2006-2009)	1.5	1.6	1.5	1.2	21	30	24

In the on-farm trials conducted on 166 sites, Utamua performed exceedingly well (Table 213) returning a yield advantage of 80%. The average size of the seed measured was 103g/100 seeds which are 60-100% greater than most local peanuts. This large seeded variety does take longer to mature and an optional variety is needed.

Pt14 and Pt15 both performed as equally well in replicated trials (Table 212) and were included in the OFDTs in 2008-2009 (Table 213). Unfortunately, Pt14 did not perform well in the field and some sites were affected by rust. This variety will be deleted from the list of potential releases. Pt 15 continues to look promising and will be included in OFDTs in 2009-2010.

Table 213. Utamua peanut yields and yield advantages, OFDTs, 2006-2009

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

9.1.3 Sweet potato

Sweet potato is an extremely important crop in Timor-Leste for both food security and nutritional purposes. It grows well in a range of soils where it is generally cultivated with little or no fertilizer. Traditional sweet potato varieties are low yielding. Higher yielding sweet potato varieties have been evaluated by the Seeds of Life program since 2000 with exceptional results. Between 2000 and 2005 trials were designed by the CIP Regional Office for East, South East Asia and the Pacific. The best of the evaluated clones to date are CIP–1 (released as Hohrae 1), CIP-6 (released as Hohrae 2) and CIP-7 (released as Hohrae 3) all of which were released in Timor Leste in March 2007.

Sweet potato yields

All 14 varieties from CIP initially imported for evaluation by SoL performed well compared with local varieties over the period from 2001 to 2009. Hohrae 1-3 were the best performing of these. Root yields varied considerably across the trials sites with yields being high at the higher altitude in Aileu compared with Betano. The results of the successful replicated sites are presented for each year from 2001 to 2009 in Table 214**.** Yield advantages of Hohrae 1-3 compared with local varieties were very significant in these trials, with more than a doubling of root yield.

Table 214. Sweet potato yields and yield advantages, research stations, 2001-2009

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
Mean (2006-2009)	*15.9*	*14.6*	*17.3*	*7.1*	*180.2*	*244.4*	*138.4*

It has proved very difficult to gain meaningful yield data from on-farm trials. The varieties are extremely popular with farmers who tend to harvest the roots on a needs basis and do not wait for the researchers to harvest the whole plot. Many of the OFDTs were grown close to the house and were harvested prior to the agreed harvest date (SoL, 2007). Comparative yields increased significantly in 2008 as the researchers become aware of the problem. In the 2008/09 season, yields were compared by sub plot harvest where five or more plants were harvested from each plot to reduce the variability in yield data.

The yield advantage of growing Hohrae varieties compared with the local varieties was also very significant in the OFDTs. The mean yield advantage of Hohrae 1 and 2 for two years was 66%, 80% respectively on 198 on-farm trials. (Table 215). In 2009, three alternative varieties were evaluated compared with a local and Hohrae 3. All three new test varieties yielded significantly more than the locals but not more than Hohrae 3. Hohrae 3 performed extremely well compared with the control over 76 sites (Table 215)

Table 215. Sweet potato yields and yield advantages, OFDTs, 2001-2009

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	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
Mean (2006-2009)	5.1	5.5	8.9	3.3	66	80	169

9.1.4 Rice

Yield and grain quality

Nakroma, the SoL/MAF variety released in 2007 continued to perform well in replicated trials during 2008-2009 (Table 216). It also outperformed local varieties in a major number of the OFDTs averaging 18% more yield on 71 sites (Table 217). 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 (Sol, 2008) and seed will be multiplied for the farming community in the future.

PSB RC 80 is another variety which has performed extremely well in replicated trials leading up to 2007 when it produced 5.3t/ha compared with the lowest yielding entry of 2.2t/ha. In 2008 and 2009 it averaged a yield of 39% above the local varieties. This variety was included in OFDTs in 2009 but did not perform as well as Nakroma (Table 217). It will be included in the OFDT program for 2010 as will Nakroma.

Table 216. Rice yields and yield advantages, research stations, 2008-2009

	Yield (t/ha)			*Yield advantage (%)*	
Year	*Nakroma*	*PSB RC80*	*Local*	*Nakroma*	*PSB RC80*
2008 (Three sites)	1.8	1.9	1.7	5	13
2009 (One site)	1.2	1.7	1.0	12	64
Mean (2008-2009)	*1.5*	*1.8*	*1.3*	*9*	*39*

Table 217. Rice yields of OFDT, all districts, 2005 to 2009

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*
Total (246 sites)	3.2	3.9		22		

*significant for a pairwise comparison between mean yields of Nakroma and local only

9.1.5 Cassava

Selection criteria for cassava varieties to be released in Timor Leste are similar to those for other food crops. Cassava is not grown purely for tapioca or starch production as in Thailand and other countries and the selection criteria for new varieties are similar to those of other food crops. New varieties need to taste good and have other outstanding eating qualities in addition to possess good yield characteristics.

Yield trials of cassava conducted between 2001 and 2005 identified a number of potential new clones for release in Timor Leste (Table 218) (also presented as Table 18 in SoL, 2006). These clones were imported by CIAT as part of a wider evaluation program. Five were initially identified as being potential for release (Table 218 in italics). After further taste tests, the recommended cassava clones for evaluation on-farm were refined to those presented in Table 219 (Table 23 in SoL, 2006).

Table 218. Average yields (t/ha) and yield advantage across all locations (2001-2005)

Rank	*Pedigree*	*Yield* (t/ha)	*Yield advantage over Mantega* (%)
1	*OMM 90-03-100 (Ca 15)*	*38.83*	*61*
2	*CMM 96-36-224 (Ca 7)*	*35.94*	*49*
3	*OMM 96-01-93 (Ca 14)*	*35.47*	*47*
4	CMM 96-36-269 (Ca 9)	34.55	43
5	CMM 90-36-224	33.73	40
6	CMM 96-27-76	33.03	37
7	*Gading (Ca 26)*	*32.87*	*36*
8	*CMM 96-25-25 (Ca 13)*	*32.64*	*35*
9	Sulawesi (Ca 19)	32.62	35
10	SM 2361-1	32.30	34
12	SM477-2	31.83	32
17	CMM 96-08-44	31.27	30
19	CMM 97-02-36 (Ca 36)	30.94	28
46	CMM 96-36-255	27.46	14
54	Mantega	24.10	0
	Total of 55 genotypes evaluated over 5 years		

Table 219. Recommended cassava clones for on farm trials, 2004/05

Code	*No of trials*	*Taste*	*Yield advantage over local*	*Location*
Ca13	10	Very sweet	20%	All
Ca15	9	Sweet	43%	All
Ca26 (Gadang)	6	Very sweet	27%	All
Ca36	3	Very sweet	28%	All
Ca 14	9	Very Sweet	65% (In Betano)	Betano Only

Cassava yield trials across six years (Table 220, and Table 53 in SoL, 2007) provided strong indications that Ca15 and Ca26 were both high yielding and considered to be sweet by farmers. They were both evaluated over a long period both in agronomic trials and palatability testing. Both varieties were released in 2009 as Ai-luka 2 and Ai-luka 4 respectively.

Table 220. Cassava yield advantages across all test locations, 2001 - 2006.

Code	*Variety*	*Number of experiments*	*Percent above local check (%)*	*StDev*	*% of farmers saying sweet at Maliana, 2006*	*Starch content (%)*
Ca15	OMM 90-03-100	12	54.4%	0.51	70	25
Ca 34	CMM 97-11-155	5	39.0%	0.49	-	-
Ca 42	CMM 97-02-181	5	38.2%	0.58	-	-
Ca25	Gembol	9	35.7%	0.76	55	24
Ca14	OMM 96-01-93	12	34.4%	0.71	66	22
Ca26	Gading	9	34.3%	0.57	27	26
Ca40	CMM 97-07-145	5	32.0%	0.58	-	-
Ca19	local Sulawesi	7	31.1%	0.51	-	
Ca36	CMM 97-02-36	5	30.9%	0.19	67	26
Ca45	CMM 97-15-255	5	27.3%	0.48	-	-
Ca03	CMM 96-08-19	6	25.5%	0.30	35	23
Ca21	Bogor-1	6	25.2%	0.39	-	-
Ca02	SM 2361-1	3	21.8%	0.19	-	-
Ca13	CMM 96-25-25	13	20.1%	0.16	53	21
Ca09	CMM 96-36-269	8	19.7%	0.25	56	22
Ca07	CMM 96-36-224	6	19.2%	0.32	33	17
Ca05	CMM 96-36-255	13	16.5%	0.48	68	27
Ca35	CMM 97-11-191	6	16.0%	0.64	-	-
Ca38	CMM 97-11-157	5	14.9%	0.47	-	-
Ca12	CMM 95-42-3	13	13.5%	0.72	24	22
Ca33	CMM 97-02-183	5	12.3%	0.64	-	-
Ca04	CMM 96-08-44	7	9.3%	0.22	16	22
Ca08	OMM 96-02-113	6	2.1%	0.17	63	23
Ca18	local Putih	9	1.5%	0.69	44	22
Ca11	CMM 95-14-13	6	-0.4%	0.29	38	21
Ca37	CMM 97-06-48	2	-3.0%	0.22	-	-
Ca32	CMM 97-01-158	5	-3.8%	0.46	-	-
Ca01	CMM 96-27-76	6	-6.3%	0.32	21	21
Ca16	local Mentega	12	-11.4%	0.37	78	27
Ca10	OMM 96-01-69	6	-13.4%	0.39	-	-
Ca17	local Merah	7	-19.9%	0.65	19	21
Ca31	CMM 94-04-87	5	-23.6%	0.41	-	-
Ca22	Ranti	2	-23.8%	0.34	-	-
Ca24	Klenteng	2	-24.2%	0.08	-	-
Ca23	Enak	9	-24.3%	0.28	19	27
Ca43	CMM 97-14-54	4	-25.7%	0.41	-	-
Ca39	CMM 97-15-241	5	-26.1%	0.40	-	-
Ca06	CMM 96-37-275	7	-29.7%	0.26	--	-
Ca20	Daeng Mere	2	-39.7%	0.23	-	-
Ca41	CMM 97-01-22	1	-42.0%		-	
Ca47	local Lesu	3	-49.2%	0.34	-	-

Nine new cassava clones imported from Thailand were included in the trials for the first time in 2006-2007. Some of these (Ca 100+) performed extremely well compared with earlier varieties (Table 221 and Table 48 in SoL, 2008).

Table 221. Cassava variety comparisons 2001-2007.

Code	*Variety*	*Origin*	*Aileu Taste*	*Maliana 05 taste*	*No. sites*	*% yield above mean*	*StDev*
Ca 107	Rayong 72	Thailand			4	119.4	1.03
Ca 109	KU 50	Thailand KU*			4	88.9	0.50
Ca 104	Rayong 3	Thailand			4	74.9	1.29
Ca 102	Rayong 1	Thailand			4	72.7	0.74
Ca 42	CMM 97-02-181	RILET*, Indonesia	Sweet		9	71.3	0.85
Ca 15	OMM 90-03-100	RILET, Indonesia	Sweet	Sweet	16	64.7	0.58
Ca 105	Rayong 5	Thailand			4	52.7	1.12
Ca 26	Gading	CRIFC*, Indonesia	Mixed	Vsweet	13	50.9	0.56
Ca 13	CMM 96-25-25	RILET, Indonesia	Sweet	Vsweet	17	49.1	0.63
Ca 25	Gembol	CRIFC, Indonesia	Sweet	Vsweet	13	47.4	0.73
Ca 36	CMM 97-02-36	CRIFC	VSweet	Vsweet	9	45.0	0.49
Ca 07	CMM 96-36-224	RILET, Indonesia		Sweet	10	44.7	0.44
Ca 40	CMM 97-07-145	RILET Indonesia	VSweet	VSweet		39.3	0.75
Ca 34	CMM 97-11-155	RILET Indonesia	Sweet		5	38.9	0.49
Ca 09	CMM 96-36-269	RILET, Indonesia	Bitter	Mixed	10	35.0	0.39
Ca 19	local Sulawesi	CRIFC, Indonesia	Mixed		7	31.1	0.51
Ca 14	OMM 96-01-93	RILET, Indonesia	VSweet	Vsweet	16	29.0	0.68
Ca 106	Rayong 60	Thailand			4	27.5	0.91
Ca 45	CMM 97-15-255	RILET Indonesia	VSweet	VSweet	5	27.3	0.47
Ca 03	CMM 96-08-19	RILET, Indonesia		Bitter	6	25.5	0.30
Ca 21	Bogor-1	CRIFC, Indonesia	Sweet		8	24.3	0.33
Ca 05	CMM 96-36-255	RILET, Indonesia	Bitter	Sweet	13	16.4	0.47
Ca 35	CMM 97-11-191	RILET Indonesia	Sweet		6	15.9	0.64
Ca 38	CMM 97-11-157	RILET Indonesia	Sweet		5	14.8	0.47
Ca 12	CMM 95-42-3	RILET, Indonesia	Bitter	Bitter	13	13.5	0.72
Ca 33	CMM 97-02-183	RILET Indonesia	Vsweet	VSweet	5	12.3	0.64
Ca 04	CMM 96-08-44	RILET, Indonesia		Mixed	7	9.2	0.22
Ca 32	CMM 97-01-158	RILET Indonesia	VSweet	VSweet	8	7.3	0.44
Ca 101	Hanatee	Thailand			4	2.6	0.59
Ca 08	OMM 96-02-113	RILET, Indonesia		Bitter	6	2.0	0.17
Ca 18	local Putih	Timor Leste	VSweet	VSweet	9	1.4	0.68
Ca 11	CMM 95-14-13	RILET, Indonesia		Bitter	6	-0.4	0.28
Ca 108	Rayong 90	Thailand			4	-2.4	0.63
Ca 01	CMM 96-27-76	RILET, Indonesia		Bitter	6	-6.3	0.32
Ca 16	local Mentega	Timor Leste	Sweet	Sweet	16	-10.5	0.42
Ca 103	Rayong 2	Thailand			4	-10.5	0.72
Ca 10	OMM 96-01-69	RILET, Indonesia			7	-18.3	0.37
Ca 060	Local Etuhare	Timor Leste			4	-19.7	0.58
Ca 31	CMM 94-04-87	RILET Indonesia	Sweet		5	-23.5	0.40
Ca 23	Enak	CRIFC, Indonesia	Mixed	Sweet	9	-24.3	0.27
Ca 43	CMM 97-14-54	RILET Indonesia	Sweet		4	-25.7	0.40
Ca 39	CMM 97-15-241	RILET Indonesia	Sweet		5	-26.1	0.39
Ca 06	CMM 96-37-275	RILET, Indonesia		Sweet	7	-29.6	0.25
Ca 17	local Merah	Timor Leste	Sweet		11	-29.9	0.59

*RILET=Research Institute of Legumes and Tuber Crops (Indonesia)
*CRIFC=Center Research Institute of Food Crop (Indonesia)
*KU =Kasetsart University, Thailand

Ca107 performed extremely well two years in a row (Table 221, Table 222 [This report, Table 59]) and this clone plus Ca25, Ca36 and Ca42 were included in the OFDTs in 2008-2009 (Table 223)(Table 65 this report)

Table 222. 2008 predicted mean yields and long term yield advantage

Code	*Variety*	*All trial (2001-2008) yield advantage (%)*	*2008 mean yield (t/ha)*	*2008 Aileu Taste test**	*Percentage of Farmers who selected this variety (Aileu yield in brackets)*
Ca 107	Rayong 72	107	25.3	Bitter	0 (18.1)
Ca 015	Ai-luka 4	82	24.3	Mixed	10 (25.7)
Ca 104	Rayong 3	77	25.7	Mixed	0 (12.1)
Ca 013	CMM 96-25-25	69	25.6	Sweet	23 (15.1)
Ca 109	KU 50	68	20.6	Mixed	0 (13.5)
Ca 105	Rayong 5	67	24.0	Mixed	3 (20.1)
Ca 040	CMM 97-07-145	63	15.0	Mixed	16 (12.8)
Ca 007	CMM 96-36-224	63	24.5	Mixed	3 (20.0)
Ca 042	CMM 97-02-181	63	22.0	Sweet	10 (24.6)
Ca 102	Rayong 1	60	23.1	Sweet	3 (12.1)
Ca 036	CMM 97-02-36	55	22.3	Sweet	10 (24.9)
Ca 026	Ai-luka 2	42	19.0	Sweet	16 (16.5)
Ca 108	Rayong 90	36	19.1	Sweet	7 (18.4)
Ca 025	Gempol	33	17.1	Sweet	10 (12.8)
Ca 014	OMM 96-01-93	33	15.2	Mixed	0 (12.0)
Ca 106	Rayong 60	24	19.6	Bitter	0 (6.6)
Ca 101	Hanatee	19	21.2	Sweet	0 (13.3)
Ca 032	CMM 97-01-158	16	13.5	Sweet	0 (15.1)
Ca 021	Bogor 1	10	12.5	Sweet	13 (11.9)
Ca 103	Rayong 2	3	11.6	Sweet	3 (18.1)
Ca 016	Local Mantega	*	15.6	Sweet	0 (9.4)
Ca 017	Local Merah	*	13.7	Sweet	0 (7.8)
Ca 060	Local Etu Hare	*	9.7	Mixed	0 (14.9)
F prob			0.001		
LSD			5.1		

*Conducted on freshly harvested uncooked tubers

OFDT entries were selected before the release of two very sweet varieties in Ca15 and Ca26 (Ai-luka 2 and Ai-luka 4 respectively). Ai-luka 4 continued to perform extremely well in 2008-2009 (Table 223) as did Ai-luka 2, the other sweet variety preferred by farmers. A description of these two newly released varieties is presented in the variety release documents in Table 224.

Table 223. Yield components for cassava OFDTs 2008/09

Variety	*Yield (t/ha)*	*Tubers per plant*	*Weight per tuber (g)*	*Mean yield from replicated trials (2002-2008)**
Ca107	15.9	6.6	358	28.2
Ca25	13.9	5.5	223	21.2
Ca36	12.2	4.9	259	22.2
Ca42	10.5	4.6	233	24.6
Local	8.7	4.9	212	14.7
LSD	*4.3*	*ns*	*ns*	

* Ca107 from 2005-2008

Table 224. Variety release documents for Ca 15 (Ai-luka 2) and Ca26 (Ai-luka 4)

BOTANICAL NAME	*Manihot esculenta* Crantz	
SUITABLE ENVIRONMENT	Well drained areas in the uplands or lowlands.	
EVALUATION NAME	Ca 15 (Ai-luka 2)	Ca 26 (Ai-luka 4)
BREEDING NUMBER	OMM 90-03-100	MLG 10169
PARENTS	Ambon local as female (open pollination)	Gading Local (Sooka, Punung, Pacitan, E Java)
BREEDER	Sholihin and Yudi Widodo	Sholihin and Yudi Widodo
RELEASED NAME	Unreleased	Unreleased
PROPOSED TIMOR LESTE NAMES	Ai-luka 2	Ai-luka 4
BACKGROUND	Cassava is an extremely important crop for household food security in Timor Leste. It grows well in a range of soils where it is generally cultivated with no fertilizer. Traditional cassava varieties a low yielding. Higher cassava varieties have been evaluated by the Seeds of Life Program since 2000 with exceptional results particularly in the lowland sites such as Betano. Between 2000 and 2008 trials using extensive material (more than 60 clones) obtained from a number of sources via the Asia Office of the International Centre for Tropical Agriculture (CIAT). However many of the very high yielding clones had poor eating quality and high HCN contents and are suitable only for commercial production of cassava starch products. Over a long period of time the two clones Ca 15 and Ca 26 consistently displayed relatively high yields combined with the good eating characteristics that farmers in Timor Leste desire. However they still have reasonable starch contents which means they will also be suitable for commercial production as the market for cassava develops over time. In terms of yield data obtained in trials to date, Timor Leste appears to have a significant comparative advantage over other countries in which there is a flourishing cassava industry.	
DESCRIPTION		
Plant type	Absence of branching	Absence of branching
Type of main stem	Monochotomus	Monochotomus
Plant height	Medium (187 cm)	Medium (141 cm)
Stalk diameter	Medium	Medium
Internode length	Medium	Medium
Colour of mature stem	Greenish grey	Orange brown
Colour of young stem	Green 135 B	Green 138 D
Shape of lobe	Obovate-lanceolate	Obovate-lanceolate
Number of lobes	7 lobes	7 lobes
Shoot colour	Green	Purplish
Leaf vein color on upper part	Green 134D	Green 134D
Leaf shape	Normal	Normal
Leaf colour	Green	Green

Colour of petiole	Green /red	Red
Petiole length	Intermediate	Intermediate
Tuber: shape	Cylindrical-conical	Cylindrical-conical
The color of periderm	Slight brown	Grey brown N199 B
Tuber color	White	White
Taste of cooked tuber	Sweet	Sweet
YIELD AND QUALITY		
Yield (t/ha) (mean 2001-2008 across 20 replicated trials and 5 locations)	32.5	26.0
Yield advantage over local (%) (mean across 20 replicated trials and 5 locations in years 2001-2008)	65	51
Starch content (%) (mean 2006-2008 across 9 replicated trials across 4 locations)	26	24
HCN content (ppm)	86	38
General	Both these cassava varieties have always been rated as sweet in a number of taste tests conducted with participating farmers during the evaluation period 2001-2008 and tests have also indicated low to medium HCN contents	
AGRONOMIC ADAPTABILITY	Both Ca 15 and Ca 26 are better adapted to warmer conditions in lower altitudes (where their average yields over the testing period were 42 and 31 t/ha respectively), but still yield relatively well (55% of lowland yields) in upland sites up to an altitude of 1000m. Cuttings of app. 20cm in length should be planted at the beginning of the rainy season at spacings of no closer than 1m x 1m. Cassava should be weeded regularly during the early growth period, but generally weeding is unnecessary after canopy closure. If cassava is planted on sloping land in larger commercial plantations, soil erosion control measures such as contour planting of hedgerows should be practiced. These cassava varieties can produce economic yields after 8-10 months.	
STORAGE	Unlike sweet potato, cassava tubers can be stored in ground for longer periods but this can reduce the eating qualities of the tubers. For commercial production, tubers should be processed or sold as soon as possible after harvest. For longer term storage for home consumption and animal feeding, tubers should be sliced, sun-dried and stored in cool, dry conditions.	
DISEASE AND INSECT PEST REACTION	Disease and insect pest resistance are yet to be evaluated for each of the four selected clones.	
HERBICIDE REACTION	Herbicides are not used on sweet potato in Timor Leste	
ECONOMIC BENEFITS	Other than some small scale selling in local markets, there is currently no commercial market for cassava in Timor Leste. Neighboring countries in South-East Asia such as Indonesia and Thailand have well developed industries based on cassava, ranging from small-scale village level processing of cassava food products and for animal feeding, and to large scale starch factories. There is currently a significant world demand for cassava for ethanol production and it is hoped that releasing these higher yielding varieties will help establish the necessary production base to allow Timor Leste to begin supplying this export market in the future. In the short-term, higher yielding cassava varieties with good eating qualities will help maintain household food security but using less land area. This will potentially allow this land to be planted where possible to higher	

	value crops with immediate economic benefits
SOCIAL BENEFITS	The very high yielding test clones will bring significant improvements to food security in Timor Leste. Yields will be doubled by planting the new varieties and improved health benefits will be gained by the higher volumes available for consumption. The risk level of growing improved clones is similar to that of growing traditional varieties
ENVIRONMENTAL IMPACT	The introduction of the two new varieties will improve the genetic diversity within Timor Leste. None of the new clones are genetically modified organisms (GMO) using recombinant DNA technology and will not introduce any undesirable traits to the environment. Cassava tends to be environmentally friendly because of the low inputs required, especially nitrogen. However because they drastically suppress weed growth after canopy closure, leaving the soil surface relatively bare underneath the canopy, extensive plantings of commercial cassava on sloping land have been known to lead to soil erosion problems. However this risk can be minimized by strategic contour planting of other hedgerow crops. It is *not* considered a risk in the small-scale mixed cropping farming systems prevalent in Timor Leste.
SEED PRODUCTION	Seed producers are currently multiplying cuttings of both new varieties for extension to farmers.

9.2 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 Suwan 5 are well adapted over all testing regions. There is no indication that Sele or Suwan 5 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 hole. 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 during the 2006/07 wet season indicated that velvet bean will need to be planted after maize to avoid smothering the crop during the wet season. These results were supported by trials conducted in 2007/08. 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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