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prepared by	Harry Nesbitt, Australian Program Coordinator, and Luc Spyckerelle, Monitoring and Evaluation Advisor Seeds of Life – Timor-Leste program University of Western Australia
co-authors/ contributors/ collaborators	Seeds of Life 3 team members Ministry of Agriculture and Fisheries, Timor-Leste Centre for Plant Genetics and Breeding, University of Western Australia
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Contents

1 Acknowledgments

Seeds of Life (Fini ba Moris) was a program within the Timor-Leste Ministry of Agriculture and Fisheries (MAF), and this Final Report covers the third and final phase of the program, Seeds of Life 3 (SoL3), which ran from 1 February 2011 to 30 June 2016. The Governments of Timor-Leste and Australia collaboratively funded the Seeds of Life program. Australian funding was through the Department of Foreign Affairs and Trade (DFAT) and the Australian Centre for International Agricultural Research (ACIAR). The program was managed by ACIAR. The Centre for Legumes in Mediterranean Agriculture (CLIMA) and subsequently the Centre for Plant Genetics and Breeding (PGB) within The University of Western Australia (UWA) coordinated the Australian funded activities. The assistance of all partners is gratefully acknowledged.

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From ACIAR, the Research Program Managers for Crop Improvement Management, Paul Fox and Eric Huttner provided tireless leadership and management over the years.

At UWA, William Erskine steadily steered the program and encouraged the completion of practice-based scientific papers.

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Finally, it must be acknowledged that the success of the program is directly attributed to the dedication and hard work of the SoL3 Australian Team Leader, John Dalton, his team of advisors, and the almost 100 Timorese staff, from national coordinators, local research and seed production personnel, and various program support staff. Over the years, the following long-term advisors provided support: Robert Williams, Nick Molyneux, Samuel Bacon, Asep Setiawan, Buddhi Kunwar, Joseph Freach, Wayan Tambun, Luis Aguilar, Brian Monaghan, Martin Browne, Buenafe Abdon, Carla da Silva and Luc Spyckerelle. The almost 100 MAF and non-MAF staff were based in Dili and in the municipalities. They in turn received valuable guidance from the farming community.

Financial support from the Australian Government through ACIAR and DFAT is greatly appreciated.

2 Executive summary

The objective of the Seeds of Life 3 (SoL3) program was to improve food security through increased productivity of major foodcrops. The foodcrops SoL3 targeted were in first instance the staple foodcrops of the Timorese menu, i.e. maize, rice, peanut, cassava and sweet potato. The program also expanded into research on legumes (e.g. kidney beans, mung beans and winged beans) and temperate crops (e.g. wheat, barley, potatoes).

SoL3 started on 1 February 2011 as a five-year program, but was extended until 30 June 2016 to capture the full 2015-2016 growing season. SoL3 was jointly funded by ACIAR, AusAID (predecessor of DFAT) and the Timor-Leste Ministry of Agriculture and Fisheries (MAF). The Australian contribution amounted to $26,730,478. MAF funding to SoL was mainly in-kind but budget contributions included an increasing proportion of operational costs over the 5.5 year period. SoL3's activities were partly a continuation of those started in the earlier program phases.

SoL1 (2001-2005) was initiated as a result of an ACIAR mission in 2000. The mission identified the lack of improved germplasm of major foodcrops as a most serious constraint on foodcrop production, and SoL1 – an AU$1.2 million ACIAR project – was designed to improve farmers' access to a range of higher yielding crop varieties adapted to the varied environments in Timor-Leste. The improved varieties were sourced from the international CGIAR crop improvement centres network, and agronomy trials were conducted on two research stations. SoL1 also built capacity of the staff of the newly established Ministry of Agriculture to evaluate, produce and distribute improved germplasm.

SoL2 (2005-2011) was jointly financed by AusAID and ACIAR with a total budget of AU$10.4 million. SoL2 continued the variety identification and testing from SoL1, but also engaged in rehabilitation/establishment of agricultural research stations, and the procurement of equipment for field trials, and for seed production and testing. SoL2 expanded into participatory variety selection with subsistence farmers in the different agro-ecological zones of the country, and by the end of SoL2, the ministry had released nine improved foodcrop varieties. In the second half of SoL2, the program expanded into seed production of the released varieties, and their distribution to farmers throughout the country.

The SoL3 design was structured around four program components:

(1) Crop identification and development, which focused on agricultural research on research stations and on farmer's fields. This component also included research related to the impact of climate change on agriculture in Timor-Leste, and crop modelling.

(2) Source seed and quality control, which had a twofold focus. First, to grow breeder and foundation class seed of the released varieties to enable the production of sufficient quantities of certified seed so that Commercial Seed Producers and Community Seed Production Groups could multiply seed and increasingly meet the country's demand for improved seed. Second, to execute quality control on the certified and the commercial seed, to safeguard the quality of the improved seed which was distributed through various channels.

(3) Community and commercial seed development, which initially focused on establishing Community Seed Production Groups throughout the country, and later on facilitated the transition of the more successful of these groups into Commercial Seed Producers.

(4) Seed system management, which covered a range of project activities and support functions to help establish the emerging seed system at national and sub-national (i.e. municipal) levels.

SoL3's vision was to have the foundations of a national seed system established and operational by the end of the program. By June 2016 an estimated 65,000 crop growing households (50% of the total) was expected to have access to and routinely use improved seed and planting materials of the major staple food crops.

SoL3 has by-and-large achieved, and in several aspects exceeded its targets. The list below highlights some of the major achievements.

- A national seed system, endorsed by the Minister of Agriculture and Fisheries in 2013, has been established and is operational. The National Seed Council, which acts as the advisory body to the Minister of Agriculture for the national seed policy, conducts regular meetings (on average twice a year), and the three Committees that have been established under the Council also perform satisfactorily. The national seed policy is expected to be endorsed by the Council of Ministers.
- A successful program of human resource development reached more than 2,700 individuals (Ministry staff, NGO staff, farmers and SoL3 staff). The program also supported 10 program staff to pursue master degree courses.
- By mid-2016, MAF had released 19 improved varieties, of which 18 had been tested and trialled with SoL support.
- Timor-Leste has a well-established seed system infrastructure which in mid-2016 comprises:
  - Six functional agricultural research centres/stations.
  - Six seed warehouses that can store 28.2 Mt of maize, 15.4 Mt of rice and 8.8 Mt of peanut.
  - Three seed laboratories, in Dili, Betano and Triloca.
  - One soil laboratory.
  - Sixty-five community seed houses, operated by Commercial Seed Producers to store their seed and conduct group meetings.
- During SoL3 more than 140 Mt of certified rice seed was produced; 150 Mt of certified maize seed, and more than 38 Mt of certified peanut seed.
- More than 1,200 Community Seed Production Groups were formed. From these, and from some contract seed grower groups, 69 Commercial Seed Producers were established. Between 2011-2015 the Community Seed Production Groups produced 215 Mt of rice seed, 268 Mt of maize seed and 40 Mt of peanut seed. In 2014 and 2015, the Commercial Seed Producers produced 143 Mt of rice, 234 Mt of maize and 11 Mt of peanut seed.
- The end-of-program survey indicated that 48% of the 700 households interviewed throughout the 13 municipalities were growing one or more of the improved varieties. In 2011, at the start of SoL3, the adoption rate of improved varieties was 18%.
- The program published extensively (i.e. annual research reports; survey and study reports; peer reviewed papers in international journals; suco information sheets for all 442 sucos and 13 municipal climate posters; etc.). These and other materials were made generally accessible through the program website.

The end-of-program survey indicated that food security overall seemed to have improved: the percentage of households experiencing hunger in the 12 months prior to being interviewed came down from 82% in 2013 to 65% in 2016. The reduction in hunger was even more pronounced for households that were growing improved varieties: it fell from 77% in 2013 to 54% in 2016. More than 80% of farmers growing improved varieties agreed that growing these varieties had helped them produce more food; e.g. improved maize growing households were on average able to consume self-grown maize for 8.3 months, whereas it was only 7.6 months for households that did not grow improved maize.

Households growing improved varieties also had to take less often recourse to one or more coping strategies to secure food than households that did not grow improved varieties. Longer-term adopters were better able to earn money from selling foodcrops: 56% of improved varieties growers versus 43% among other households were selling part of their crops.

The end-of-program survey also indicated that most of the improved varieties planted in the 2015-2016 growing season were from own seed or cuttings which the farmers had kept themselves from the previous harvest; it ranged from 42% for Hohrae sweet potato cuttings to 69% for Ai-luka cassava cuttings. In 2013 the percentages of self-saved seed or cuttings ranged from 5% for Nakroma rice to 15% for maize and sweet potato, with a high of 32% for peanut. This increased percentage of self-provisioning in seeds and planting material bodes well for the continued use of improved varieties in the coming years.

Keeping the national seed system going with little or no extra funding will be a challenge for Timor-Leste. While it is clearly demonstrated that growing and distributing in-country grown seed of improved maize, rice and peanut is much cheaper and more effective than importing and distributing seeds from abroad, the seed system can only operate adequately and effectively if operational funds and other inputs or services are available at crucial times linked to the growing calendar.

The long-term issue is not whether Timor-Leste can afford to operate a national seed system; it is rather that, given resource constraints it may have to face in coming years, and taking into account the importance of agriculture for the livelihood of the majority of its rural population, as well as the need to keep on growing a fair amount of it foodstocks in-country, it cannot afford not to operate a national seed system.

3 Background

SoL3 (2011-2016) was a continuation from SoL1 (2001-2005) and SoL2 (2005-2011). The focus of SoL1 was to start a program of variety testing on two agricultural research centres of improved varieties that had been sourced from various CGIAR centres. The nation's agricultural research stations had seen most of their infrastructure destroyed in the aftermath of the Indonesian withdrawal in 1999, and one focus of SoL2 was the rehabilitation of these stations.

SoL2 expanded the program scope with identification of more productive foodcrop varieties through participatory testing of crops with farmers, and – from late 2008 onwards – with the production of formal seed of released varieties for distribution to farmers.

In August 2009, an Australian concept mission visited East Timor to consider the potential for further Australian support to the Seeds of Life program. As a country emerging from conflicts, Timor-Leste faced a range of rural development constraints that were common to such situations: poor rural infrastructure; lack of crop and livestock production inputs, including seed of improved varieties; a rapidly increasing population; weak rural development capacity; limited on- and off-farm employment opportunities; limited farmer production skills; etc. Also, a majority of farmers experienced food insecurity between November-February because of low yields of staple crops, lack of income to purchase crops, and food storage losses.

The experience of SoL2 indicated that the approach that had been followed so far worked well:

- Nine varieties of staple food had been released, and these had the potential to increase yields with between 23-80%, depending on the variety.
- Participatory variety selection through on-farm demonstration trials (OFDTs) worked well, and could be managed by MAF.
- Rapid multiplication and distribution of seeds and planting material had been piloted successfully, reaching 2,500 households in 2007-2008, 10,979 households in 2008-2009, 21,190 households in 2009-2010, and 11,124 households in 2010-2011.
- Partnerships with other organisations – such as CARE and other international and Timorese NGOs – could substantially increase on-farm production and storage.

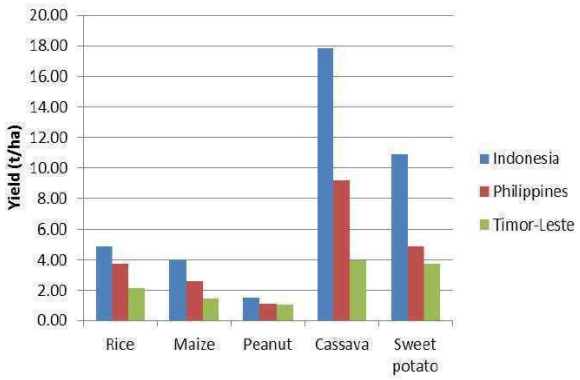
The rationale for the SoL3 program was to continue and expand on the activities of SoL2, and in doing so establish a basis for a sustainable national seed system for Timor-Leste.

The justification for SoL3 was clearly spelled out in the Program Design Document (SoL3 2010). These are listed below, in italics, with short elaborations for each of these points.

- *The program is an excellent fit with the current policy settings and development objectives of both the Government of Timor-Leste and the Government of Australia*.
  The Timor-Leste Strategic Development Plan 2011-2013 mentions specifically in the section on food security that "To achieve our goal of food security by 2020, we will: (…) Use high yield Seeds of Life varieties" (GoTL 2011:119). One of the Australia – Timor-Leste 2009-2014 development program focuses was to increase employment by increasing agricultural productivity (AusAID 2009), matching the "National objective 2: increasing employment".
- *There is a demonstrated high level of need, evidenced by widespread household-level food insecurity and reliance on grain imports.*
  In Timor-Leste three-quarters of those living below the poverty line reside in rural areas. Agriculture is the most important sector for poor Timorese, with 80% of the poor dependent on agriculture for their livelihood. Much of this is subsistence

agriculture characterised by low productivity. Food insecurity affects up to 80% of households in some municipalities.
Timor-Leste is a big importer of foodgrain (mostly rice), usually from Vietnam and Thailand. In 2011, Timor-Leste Customs reported the importation of 97,177 Mt of rice by local traders and 520 Mt by the Ministry of Trade, Commerce and Industry. For 2012, a local trader estimated the total rice import requirements to be in the order of 70,000 Mt (Young 2013).

- *There is significant potential to improve food security through the introduction of higher yielding food crop varieties, already demonstrated under SoL2.*
  The productivity of the major foodcrops in Timor-Leste lies well below that of some neighbouring countries (Figure 1). Crops in Timor-Leste are often intercropped, which reduces yields, but farming systems in Timor-Leste are generally low input with little or no fertiliser use.
  The improved varieties released under SoL2 had higher yields than common local varieties, e.g. Sele maize (50%), Nakroma rice (24%), Utamua peanut (47%), Ai-luka 2 cassava (46%), and Hohrae 3 sweet potato (131%) (SoL3 2016).



(Source: Fargher and Edmeades 2011)

Figure 1. Target crop yields in Timor-Leste vs. Indonesia and the Philippines

- *Previous Phases of SoL have laid a solid foundation on which to build a national seed system, but the task is far from finished.*
  At the start of SoL3, the national seed system was still in an embryonic phase. The ministry had released nine improved varieties, and the formal seed component was multiplying seed for distribution in the country, but less than 20% of the foodcrop farmers had access to seed of the improved varieties. Also seed system management was barely established and there was not yet a documented policy nor an institutional setup for the national seed system.

- *There is sufficient baseline institutional capacity within MAF for the program to be successfully implemented. Further building this capacity will be an important focus of Phase 3.*
  At the end of SoL2 there were 47 MAF staff assigned to the program, and in the program design document it was anticipated that around 30 additional full-time MAF staff would be required to scale up to a national program. Even though in the transition from SoL2 to SoL3 the increase of MAF staff assigned to the program was not as high as anticipated in the design document, the fact that MAF had substantially increased the number of staff to the program, and the high quality of the assigned staff was positively mentioned in the Technical Advisory Group report. Capacity building of the MAF staff assigned to the program, and other program participants (primarily farmers) was indeed an important focus of the program.

- *There is strong support for the program from GoTL.*
  The Seeds of Life program was strongly supported by the Government – as evidenced by its specific mentioning in the Strategic Development Plan 2011-2030. The strong support by the Ministry of Agriculture and Fisheries continued throughout the whole program period, from February 2011 to June 2016.

4 Objectives

The main objective of SoL3 was to work “towards a sustainable national seed system for Timor-Leste”. To achieve this, the program continued and expanded on the range of activities of SoL2.

The project goal, as stated in the Program Design Document was to: “Improve food security through increased productivity of major foodcrops”. In the first two years of the program there were discussions on the objective, the number of farmers / crop-growing households to be reached, and it was proposed that the end-of-program target became: “50% (est. 65,000) of crop producing households have access to and are routinely using improved food crop varieties” (Spyckerelle 2012).

The SoL3 program was structured around four components with specific objectives, with an additional set of program management activities. Over the life of the program the titles of some components changed to better reflect their actual purpose. So, e.g. the terms “formal” and “informal” seed production were dropped as the focus of the activities in the two components developed beyond their original scope. In this Final Report, the terms as used in the final years of the program are used.

Component 1. Crop identification and development

Component outcome**:** Improved varieties of foodcrops evaluated and released.

The outputs of this component were:

- Establishment of Agricultural Research Centres and Stations completed.
- Genetic material of potential improved varieties identified and sourced.
- Potential new varieties evaluated on-station.
- Potential new varieties evaluated on-farm.
- Selected new varieties officially released.
- Capacity of MAF research staff to manage the identification and release of new varieties strengthened.

Component 2. Source seed and quality control

Component outcome**:** Sufficient high quality seed produced by contract growers to maintain the genetic quality of released varieties.

The outputs of this component were:

- Sufficient foundation seed produced for national seed system.
- Certified seed produced by contract growers.
- Quality assurance systems established.
- Technical extension support provided to contract growers.
- Seed grading, packing and storage facilities established.
- Certified seed distributed through preferred distribution channels.
- Capacity of MAF Seed Department staff to manage the production and distribution of certified seed strengthened.

Component 3. Community and commercial seed development

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

The outputs of this component were:

- Community Seed Production Groups established.
- Commercial Seed Producers supported.
- Focal seed merchants in local markets established.
- Improved access to seed for vulnerable groups.
- Systems linking registered commercial seed producers with potential buyers developed.
- Capacity of MAF extension staff to establish CSPGs strengthened.

Component 4. Seed system management

Component outcome**:** MAF capacity to manage the national seed system strengthened.

The outputs of this component were:

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

5. Program management

Objective**:** SoL 3 effectively and efficiently managed in a manner that is responsive to stakeholder needs.

The outputs of this component were:

- Program governance arrangements established and operating effectively .
- Program management arrangements established and operating effectively.
- Program effectively coordinated with other relevant donor programs.
- Lessons learned systematically reviewed and shared with Government and other donors.

5 Methodology

The National Seed System can be presented schematically as shown in Figure 2. There are the three core components (i.e. crop and variety identification and development; source seed cultivation and quality control; community and commercial seed development) with a range of seed system support functions (e.g. training; monitoring and evaluation; communications; etc.) and overall seed system management to provide the guidance and ensure the proper interaction between all the components.

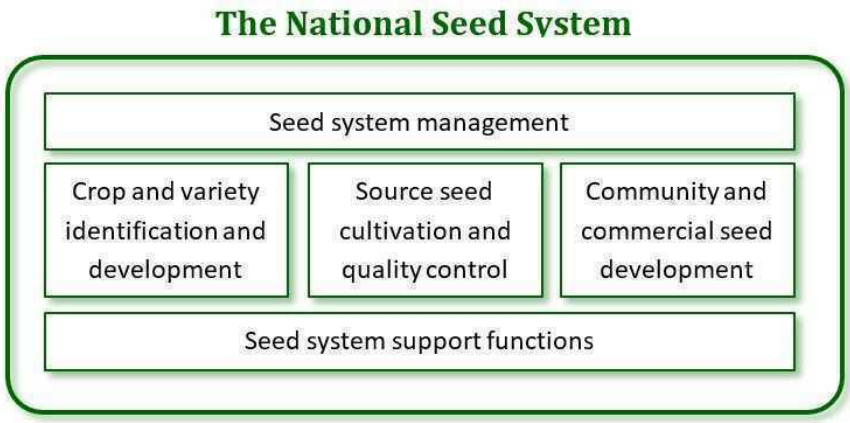


Figure 2. Schematic overview of the National Seed System

This section provides an overview of the methodologies applied in the Seeds of Life program. The methodologies will only be described in general terms, without specific details on implementation and results. For more specific details, please refer to the **Annual Research Reports** (2006-2015).

As the program components differed in scope and focus, the information is provided for each component separately, with an additional sub-section for program activities that were either operating across components, or were additional to these.

5.1 Component 1: Crop identification and development

“Crop identification and development” is sometimes described as the “engine room” of the seed system: its outputs generate the momentum for further expansion and growth of the seed system.

The process of selecting crop varieties for general release in Timor-Leste to broaden the choice of crops for Timorese farmers follows a rigorous process. In this way the farmers are assured that the released varieties are of superior quality and that they are suited to growing conditions in Timor-Leste.

The starting point of the process is the **identification of potential varieties**, of foodcrops and legumes, which address one or more deficiencies in the current choice of varieties in Timor-Leste. This can e.g. be a yield deficiency (i.e. the locally available varieties have substantially lower yields than varieties grown elsewhere), a higher propensity for pests or diseases, or a re-introduction of a crop or a variety which was grown in country before but which had been lost. The sources for the potential improved varieties are the CGIAR centres, but also crop development centres in neighbouring countries, such as Indonesia and the Philippines.

The second step is for **the potential varieties to be tested out in first instance in replicated trials on one or more of MAF’s research centres and stations**. As an example, in 2010-2011 there were 36 white maize varieties from CIMMYT Zimbabwe and the Central Mindanao University, the Philippines, trialled; 12 clones of sweet potato, ten of

which came from the CIP office in Indonesia and two were local checks; 33 irrigated rice varieties that were part of the International Finegrain Aromatic Rice Observational Nursery (IRFAON), and 100 upland rice varieties, all sourced from IRRI; 30 varieties of peanut were trialled, 27 of which were obtained from ICRISAT in India, and three were local Timorese varieties. There were in that year also replicated trials for 12 wheat varieties, 15 barley varieties and 12 winged bean varieties, the latter being sourced from the Australian Tropical Crop and Forages Collection (ATCFC), but originating from several countries.

During SoL3, there were two research centres and four research stations where agronomy trials were conducted. Table 1 shows the main characteristics of the research stations and centres, and which crops were trialled in 2013.

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

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

The imported potential varieties are grown for at least three years on one, but preferably on several research stations. Based on how the varieties perform in the on-station trials, they remain in the test program (when they show promise, in terms of yield and suitability to Timorese growing conditions), or they are dropped from it (e.g. rather low yields or high susceptibility to pests).

The research activities on the research stations and centres were handled by 11 researchers (ten men, one woman), assisted by permanent labourers and other staff.

When the trialled crops are harvested on the research stations, there are also food preparation and taste tests, to assess how the varieties score on these points. These tests involve the workers on the research stations and local population living in the neighbourhood. The varieties are thus assessed against a broad number of criteria, not only for superior yield and agronomic adaptability, but also for their social, environment and gender impacts.

Figure 3. Cassava and sweet potato taste tests, Loes research station, November 2011

The next step is then that **the promising varieties are selected for on-farm demonstrations and trials** (OFDTs) so that they can be tested in various locations throughout the country, in different agro-ecological zones (Figure 4). In several locations, farmers are asked if they are willing to voluntarily participate in trying out some new varieties. This involves that they allow one of more small sections (5m by 5m) of their normal foodcrop plots to be planted with seeds or cuttings that are provided by the program. The farmers cultivate the trial crops in the same way as they cultivate their other crops – i.e. no special treatment in terms of land preparation, weeding or fertilising – and a program field researcher will from time to time drop by to observe how the trial is proceeding (on average six times during the trial). At harvest, staff recorded the fresh weight of cobs from the whole plot (25 m^2). A subsample of five cobs was taken from the fresh cobs at harvest time, and only grain from these cobs were threshed and dried. The ratio of dried grain to the cob fresh weight was used to convert the total fresh weight of cobs to amount of grain weight per plot, and then converted to tons per hectare. Farmers kept the produce from each OFDT, except for the small sample taken for analysis.

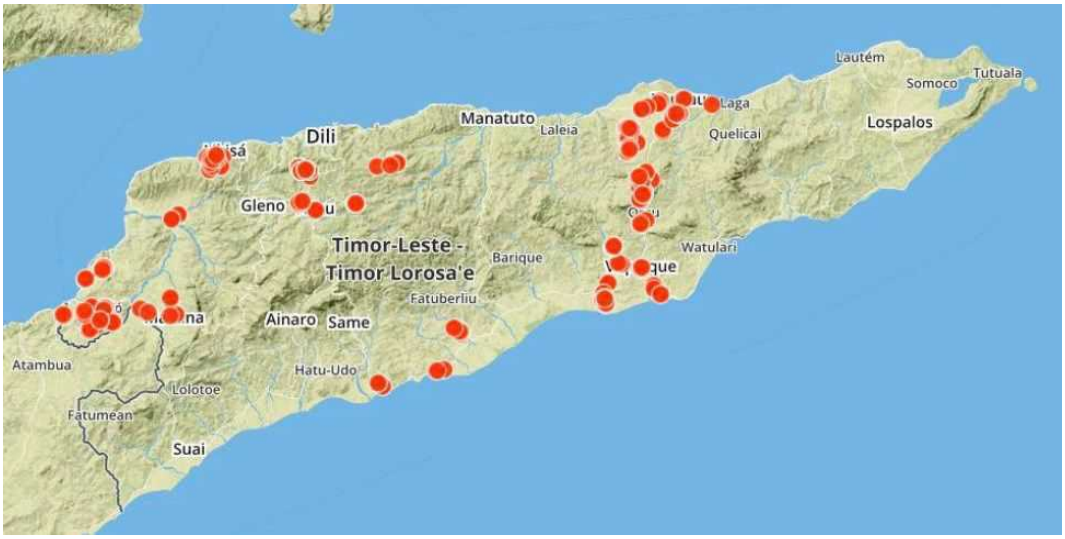


Figure 4. Map of 371 locations where OFDTs were conducted in 2013-2014

Such OFDTs have to be conducted for at least two years, and the **results of the OFDTs are then analysed.** Ultimately only a small group of tested varieties seem suited for general release by the ministry.

The recommendation to the minister on whether or not to release a variety is taken by a **Variety Release Committee**. Until 2014, Variety Release Committees were *ad hoc* committees which became operational if there were potential varieties ready for release. After the establishment of the National Seed Council, the "Variety Approval, Release and Registration Committee" was established as a committee residing under the National Seed Council. The committee is composed of key researchers, academics, members of civil society and farmers. For example, the committee which met in February 2016 had to formulate a recommendation for the possible release of eight varieties. The 17-person committee was headed by the MAF National Director of Research, Statistics and Geographical Information, and the other 16 members were from outside MAF. They represented: academics (six persons, one of them a woman), civil society (four representatives, including two women), and seven farmers (three of whom were women).

The committee met for two days. The first day was for presentations and discussions in Dili; the second day was spent at the Loes research station, to observe the varieties in growth. The committee meetings are open meetings; the discussions in Dili had 66 people in attendance, and during the field trip to Loes there were 65 participants.

On this occasion, the committee recommended that seven of the eight proposed varieties, i.e. two mung beans, two sweet potatoes (one of which was a local, purple variety), one rice, and two kidney beans of the climbing variety, be proposed to the minister for release. The eighth variety, a local red rice, was considered not yet ready for release; farmers on the Release Committee reported that the rice was a mixture of at least two varieties, and was not pure. Researchers will therefore make an effort to produce pure seed in the coming season.

Figure 5. Engr. Estanislau Aleixo da Silva, the Minister of Agriculture and Fisheries, launches the new improved varieties on 7 April 2016

Based on the recommendation of the Variety Approval, Release and Registration Committee, **the Minister of Agriculture and Fisheries launches the new improved varieties**.

All the varieties have been released with new Timorese names. In the April 2016 event, the two mung beans were named after Timorese birds, and two varieties were named after research locations, while a kidney bean variety was named after a major bean producing area in the country. The local sweet potato was named "Sia", which means "sweet potato" in the local Makasa'e language.

The variety release on 7 April 2016 was the first for local Timorese varieties. More local Timorese varieties are expected to be released in the coming years – and several are already in the process of on-station testing and/or on-farm testing. It is also the intention that the National Seed System will acknowledge and register local varieties, without going through a rigorous agronomic testing process. The purpose of such registration is to help ensure that varieties which are currently in the public domain in Timor-Leste remain so, and to prevent individuals or companies claiming intellectual property on them through some simple modification.

As part of SoL3, several other types of research were conducted, e.g. farming systems research, climate change research and crop modeling and social science research (the latter will be discussed in the sub-section on component 4 below).

One type of farming systems research conducted under SoL3 was focused on soil fertility improvement through the use of cover crops, in particular the **use of velvet bean in combination with maize**. The research was started in 2008 as a long-term rotation experiment in Betano, and continued during SoL3. In the 2010-2011 growing season, trials were conducted at the Betano and Loes Research centres with randomized block designs. In Betano, five treatments were applied in three replicates to compare mechanical ploughing as opposed to the farmers' practice of no tillage, with or without Round-Up (a herbicide) and velvet bean. When velvet bean was included in a treatment, it was sown 30 days after the maize crop. In Loes the methods of land preparation were: 1) mechanical tillage, 2) weeding by hand, and 3) application of roundup with no soil tillage.

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

The conclusion of the experiments was that velvet bean intercropping significantly reduces the weed burden on maize. The effect was often sufficient to completely eliminate weeds at harvest time. As weeds represent the limiting factor for Timorese farmer's ability to produce more food, use of velvet bean may become an important method of weed management in Timor-Leste. In fact, there is a long history of velvet bean intercropping among Timorese farmers, with evidence that it was used in several parts of the country. Reports from farmers indicate that velvet bean was common in some areas approximately 40 to 50 years ago, but that seed stores were lost and no new sources could be identified for several decades. The Seeds of Life program has been the only known source of velvet bean seed in the country since independence and small amounts of seed have been recognized and readily accepted by farmers.

Other farming system research has been conducted as part of the SoL3 program. The titles of the research topics are listed below, with reference to the Annual Research Reports (ARRs) in which more detailed information on each research is provided.

- Effectiveness of metal grain bins for maize storage. [ARR 2012].
- Sweet potato nutrient-addition pot trial for sweet potato growers in Baucau. [ARR 2012].
- Rice agronomy trials to test the recommendations of the System of Rice Intensification (RSI). [ARR 2012].
- Effect of weeding and plant spacing on maize yields. [ARR 2013].
- Effect of inorganic fertilizers on rice production. [ARR 2013].
- Effects of macro- and micro-nutrients on maize. [ARR 2013, ARR 2014].
- Effects of herbicides and cultivation on nutgrass. [ARR 2013].
- Long-term maize and velvet bean trial soils. [ARR 2014].
- Effect of hilling up on sweet potato varieties. [ARR 2014].

The **climate change and cropping systems research** has been a prominent part of the SoL3 program. A major focus has been to generate new information, and to make such information as widely available as possible. Climate and climate change posters were prepared for each municipality, as well as Suco Information Sheets for each of the 442 sucos, and information materials on the effects of El Niño and La Niña events on

agriculture in Timor-Leste. All of these, and many more were placed on the Seeds of Life website (www.seedsoflifetimor.org) and these were generally considered as the best available internet resource with maps of Timor-Leste.

From 2014 aflatoxin testing has been conducted on maize and peanuts. The purpose was to assess what levels of aflatoxin were encountered in maize and peanuts which were stored and available in markets, and to try out methods for quick measurement of aflatoxin levels.

5.2 Component 2: Source seed and quality control

The roles of Component 2 in Timor-Leste's national seed system are: 1) to provide source seed for the system, and 2) to provide necessary quality control so that only quality seed is moving through the system. In order to perform these roles, the program works closely with the Department of Seed Production and Seed Certification (hereafter referred to as "Seed Department") in the National Directorate of Agriculture and Horticulture.

The core activity of SoL3, as envisaged at the start of program, was as shown in Figure 6. Foundation seed would be grown on the research stations, which would then be passed on to specialist growers under contract to MAF, who would grow formal seed. The formal seed would be distributed to the Community Seed Production Groups that were being set up, to grow informal seed, as well as – as had been done in SoL2 – to be distributed to individual farmers through the free seed distribution program which MAF organized each year.

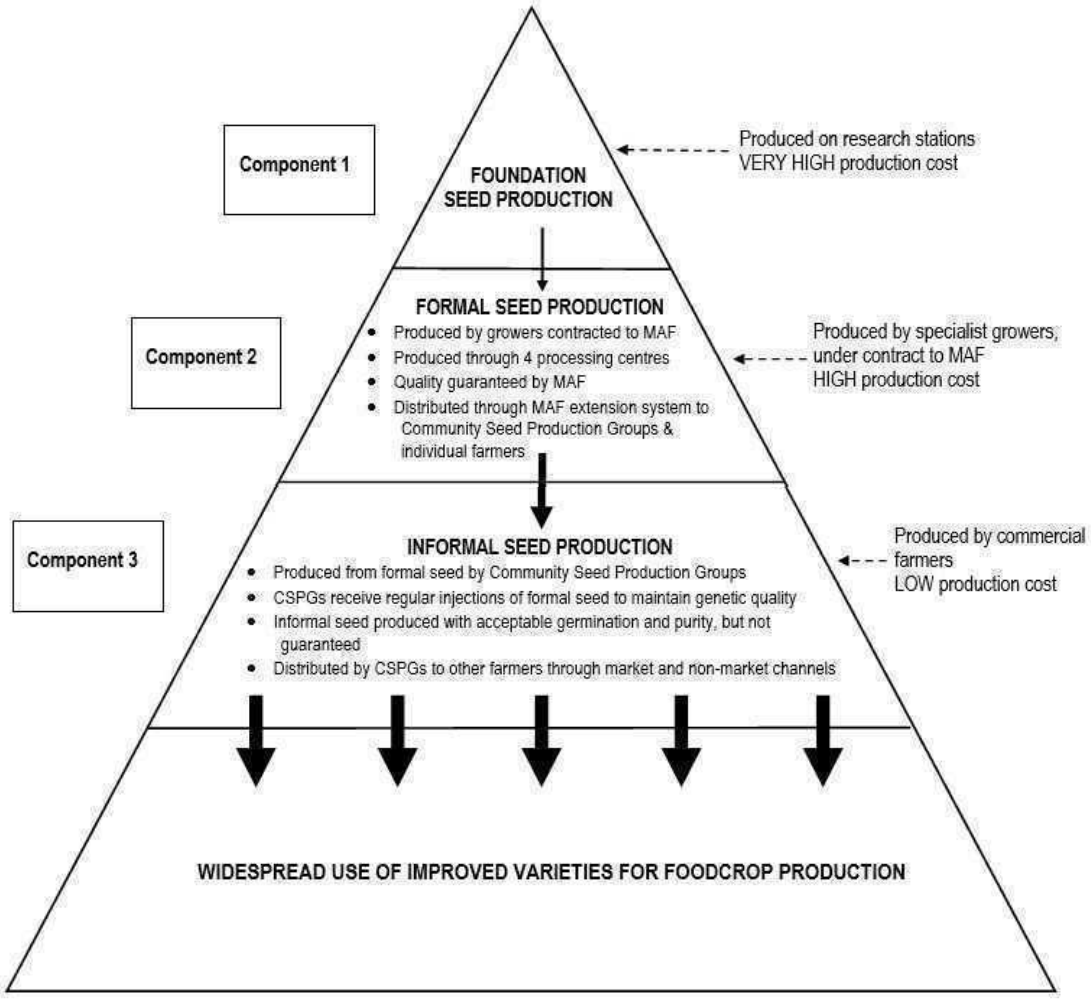


Figure 6. Seed industry structure as envisaged at the start of SoL3

The intention of the component “Formal seed production and distribution”, which was the initial name of component 2, was to produce each year large quantities of high quality seed – some 175 Mt of maize, rice and peanut seed combined, plus 600,000 sweet potato cuttings and 600,000 cassava canes – and to distribute these to CSPGs and to East Timorese farmers in general.

As the program developed, and considering that an increasing group of suco-based Community Seed Production Groups would also become sources of good quality seed for local farmers, it became clear that continuing formal seed production along these lines would use a lot of program resources, and result in a system which MAF would not be able to sustain after the end of the program. It would also have meant that the storage capacity of the MAF warehouses would have to be vastly increased, or that alternative solutions would have to be found for the storage of seed (e.g. by contracting privately owned storage facilities).

In October 2012, it was therefore decided to use different production targets for the formal seed component, and that these would be based on what was needed as amounts to keep the research going, to provide planting seed to the contract growers and the CSPGs, and to have a buffer stock in case of very poor production or some natural disaster.

The performance indicator for the outcome of component 2 was therefore changed to:

> Seed Processing Centres capacity sufficient to process high quality seed to service the certified seed needs of all Community Seed Production Groups, research and formal seed production (MAF and MAF-SoL). Approximately 20 Mt of maize seed, 20 Mt of rice seed, 10 Mt of peanut seed, 600,000 sweet potato cuttings and 600,000 cassava canes each year.

As the CSPGs started to develop and harvest their seed crops, it became clear that this was not a homogenous group: some CSPGs were quite successful, and produced good quality seed well in excess of the amounts which the group members needed for growing crops on their own plots; other groups produced only small amounts, and/or did not come across as a strong and vibrant group. The idea quickly rose that the more successful CSPGs – and especially so if there were a few of them in the same or in neighbouring sucos – had the potential to evolve into commercial groups.

Because of that, the terminology “formal/informal” became less suited as some so-called informal seed producers would be growing commercial seed. As the seed system thinking developed, a new categorisation of seed classes emerged (Figure 7).

- **Breeder Seed** and **Foundation Seed** are grown on the research stations by MAF itself. The crops are under continuous supervision by MAF staff and corrective measures can be taken immediately if there is risk of seed quality loss or crop failure.
- The Foundation Seed is provided as input to contract seed growers who produce **Certified Seed**. Municipal Seed Officers assess the capacity of the contract seed growers to produce high quality seed and early in the year – usually in the first quarter – contracts are signed so that the contract growers know what prices they will get for their seed (e.g., in February 2015, the seed prices mentioned in the contracts were: 1.25 US $/kg of maize, 1.25 US$/kg of rice, 2 US $/kg of peanut, and 0.05 US$/stem of cassava). MAF staff carry out inspections throughout the growing process to ensure that the produced seed will be high quality. After the harvest, the seed quality is also tested before the actual purchase of the seed by MAF. All post-harvest handling of the seed is done by MAF in the regional seed warehouses.
  The Certified Seed goes to MAF for the research program, to Commercial Seed Producers as input for the growing of Commercial Seed, and for the buffer stock. Certified Seed is in principle no longer distributed directly to farmers (although it could happen for small amounts of surplus Certified Seed).

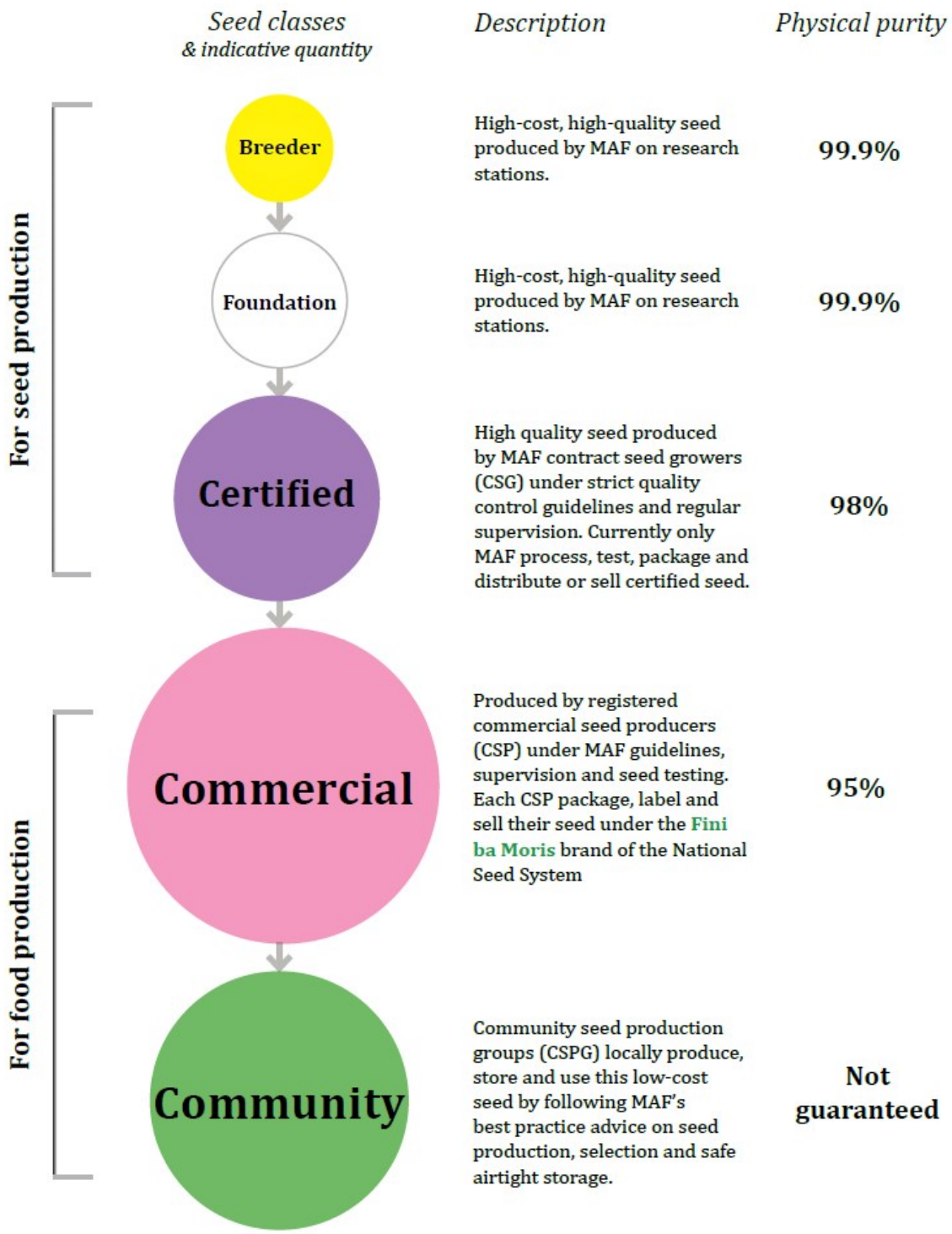


Figure 7. The seed classes of the National Seed System

- The **Commercial Seed** is grown by MAF-registered Commercial Seed Producers, starting from Certified Seed (with new Certified Seed each year). Supervision of the seed growing, and testing of the seed after harvest is done by MAF staff, but under a less stringent system of quality control than applies to the production of Certified Seed. The Commercial Seed is also tested after harvest in the MAF seed laboratories.
- **Community Seed** is the seed that is produced by the CSPGs. The CSPGs receive on a regular interval (every third year for maize; every fifth year for rice and peanuts) a new amount of Commercial Seed so that the genetic quality of the

Community Seed does not degenerate too quickly. The CSPGs receive advice from the Suco Extension Officers on good practices in seed growing and post-harvest handling, but there are no guarantees regarding the quality of the produced seed.

The seed production, supervision and quality control are handled by MAF's Seed Department, with a team of 26 persons, among whom seven women. There are two Pure Seed Officers (in Betano and Loes) who manage the production of Breeder Seed and Foundation Seed. In the municipalities Aileu, Baucau, Maliana, Liquiça, Manufahi and Viqueque there are Municipal Seed Officer Coordinators and Municipal Seed Officers. They supervise the contract seed growers and carry out inspections of the Commercial Seed Producers. For the seed quality testing in the seed laboratories, there is a Seed Analyst Coordinator, two Seed Analysts and an administrative staff.

Seed grading, packing and storage of the Certified Seed is done at six warehouses, in Aileu, Manufahi, Liquiça, Bobonaro, Baucau and Viqueque. There are in total 12 silos for maize with a total storage capacity of 21.6 Mt, 12 silos for rice with a total capacity of 16.8 Mt, and 16 silos for peanut with a total capacity of 12.8 Mt. As for seed processing equipment, there are dryers and drying pads, threshers, seed cleaners (rice cleaners, air screen cleaners and manual sieves), packaging and plastic sealers, seed germinators, moisture testers, scales/balances, and compressors and generators. The seed processing centres and warehouses are staffed by 15 people, including one woman.

5.3 Component 3: Community and commercial seed development

The role of community and commercial seed production in Timor-Leste's seed system is to contribute to widespread and timely availability of improved seed and planting materials for at least 50% of the food crop farmers throughout the country. To achieve this, the focus is primarily on establishing and supporting CSPGs for different crops in the sucos, and on providing assistance to the registered Commercial Seed Producers (CSPs) in the municipalities to produce and market good quality commercial seed.

Establishing and developing CSPGs was based on a model successfully implemented by CARE in the municipalities Bobonaro and Liquiça. The CARE-supported seed production groups had been established as new groups, and one of the problems that has surfaced at the end of the activity was the "handover" of the groups from CARE to MAF, so that the groups could continue to receive support in future.

For the SoL3 supported CSPGs it was decided to follow another approach. Instead of establishing new groups, in discussion with national and municipal MAF extension staff already existing MAF farmer groups which had potential to become CSPGs would be identified, and the groups would be selected from these. Only if there were not sufficient farmer groups in a suco, or if the existing groups were not considered suitable to engage in seed production, a new farmer group could be established.

The advantage for MAF of working with existing farmer groups was that a substantial part of their farmer groups – of which there are probably in the order four

Figure 8. Orientation on community seed production to a farmer group

thousand – would become involved in, and receive support for seed production activities. Also, at the end of SoL3, MAF would not "inherit" an additional 1,000 plus farmer groups with the expectation of providing continued support for these groups. The disadvantage of the approach was that the "social capital" of these groups was a given, and that some were perhaps less-than-adequately prepared to engage in seed production as a group. In the past some farmers declared themselves to be a "group" because membership of a farmer group was a precondition to gain access to certain farming inputs (like tools and seed). Some such groups were e.g. not very broad based; they may have had the expected 10-15 members, but they belonged to just three or four households.

The CSPG activities started in late 2011 in the seven municipalities where SoL2 had been active, with 10 sucos being selected in each of the seven municipalities, and four CSPGs being established in each suco[1]. Each CSPG received a package of inputs and training, including seed, seed storage, production and processing advice, tarpaulins, basic hand-tools and equipment including labour-saving devices such as maize shellers. The CSPG activities were to be implemented on a common plot (often around 0.2 ha). The CSPGs were also provided with a "Group Book" to record such information as: group membership, minutes of meetings, receipt and distribution of seeds/tools, production and distribution of seeds, etc. Unfortunately, not many groups used such Group Books as intended.

The CSPGs were supported by the Suco Extension Officers (SEOs), who in turn were supported by the sub-district coordinators and the district/municipal extension officers. To increase the mobility of the SEOs, those who already had a motorbike received a monthly fuel allowance of $25, and the SEOs who did not yet have a motorbike were provided with one by the program. The CSPGs received two training sessions in their first year: the first training session focused on agronomic practices for production operations, and discussed, among others: differences between seed and food grain and the need for good seed; land preparation and isolation techniques; weeding, rogueing and pest control.

Figure 9. Members of a CSPG in Tequinaumata (Baucau) selecting good cobs and seeds for maize seed

The second training, closer to the harvest, discussed agronomic practices for harvest and post-harvest operations, and discussed, among others: harvesting; separating cobs for

[1] Details on CSPG expansion will be provided in Section 7, "Key results and discussion". Apart from the 280 MAF-SoL supported CSPGs, there were an additional 446 NGO-supported farmer groups that used improved seed for multiplication as part of their rural development programs.

seed and grain; drying, shelling and cleaning; local techniques for moisture testing; and storage of seed and grain.

In 2012, there were successful CSPGs in the sucos Fahilebo in Liquiça, and Tequinaumata in Baucau. They expressed an interest to work more closely together, as associations of CSPGs, and produce seed on a larger scale, for sale. The idea caught on, and the next year more CSPGs in other sucos applied to establish similar associations, and some of the contract grower farmer groups also wanted to engage in commercial seed production. To make this more formal, it was decided that such groups had to register with MAF as “Commercial Seed Producers” and obtain an annual permit for seed production.

In June 2013 guidelines for commercial seed production under truthful label scheme were issued by MAF (MAF 2013). It required that groups that were interested to be registered as CSPs had to meet certain criteria (such as: having at least one year experience in growing seed of improved varieties; having received training on seed production and quality control; have basic seed processing equipment and storage facilities). The interested groups had to submit a request to MAF to be registered as a Commercial Seed Producer, and to be issued an annual commercial seed production permit. The Municipal Seed Officer would then do a field inspection to assess if the conditions were met for the group to be registered and obtain a permit, and how much seed, and of what crop and variety the group wanted to grow. If the field assessment was satisfactory and the other conditions were met, the group was registered as a Commercial Seed Producer (for a period of five years), and issued an Annual Commercial Seed Production Permit, which stated the crop and variety, and what size of seed plot were approved for seed production.

In March 2015, additional requirements for commercial seed production were issued in relation to four points, based on the difficulties encountered in previous years to properly inspect the seed plots:

- **Access**: The base of operations of any group wanting to register as a CSP must be accessible by an all-weather road so that the staff of the MAF Seed Department (including the Municipal Seed Officer) are able to conduct all the quality control procedures necessary to assure any buyer that the commercial seed produced and offered for sale by the CSP is good quality.
- **Plot size**: For commercial maize or rice seed production the area (size) of any commercial seed production plot must be a minimum of one hectare and a maximum of five hectares. For peanut production the minimum and maximum sizes can be reduced by 50% (i.e. 0.5 and 2.5 hectares, respectively).
- **Plot number**: for all types of commercial seed production a maximum of two separate commercial seed production plots is allowed under any one permit to produce. Any two plots are considered “separate” if distance between them is a minimum of 50 metres and a maximum of two kilometres.
- **Plot location**: Any commercial seed production plot must be located within a maximum of two kilometres of the commercial seed warehouse (aka “community seed house”).

MAF had released improved varieties for maize, rice, peanut, cassava and sweet potato. One of the findings of the 2011 baseline survey, the 2013 mid-term survey, and also from general observations was that adoption of maize, rice and peanut seed went reasonably well (between 11-16% of the crop farmers), but the **uptake of sweet potato and cassava** was much lower; respectively 7% and 3% only. One problem with cassava and sweet potato is that the cuttings and canes are much more perishable in transport than seeds.

To address this, a decentralized network of cassava and sweet production centres was established, so that such production centres were closer to the farmers. This did however not result in a substantial increase of adoption of cassava and sweet potato by the end of the program; the 2016 end-of-program adoption rates for cassava was 5% and for sweet potato it was 10%.

The SoL3 program design included the activity of **improving access to seed for vulnerable groups** through seed fairs. This activity was implemented in a different manner as it was thought that MAF would not be able to continue implementing seed fairs after the end of the program. In February 2013, a pilot was conducted where sweet potato cuttings sourced from four CSPGs in suco Maumeta, Liquiça, were distributed as a farmer-to-farmer exchange to 120 vulnerable households in the same suco. The list of vulnerable households in the aldeias (hamlets) had been put together by the Chiefs of the Aldeias, together with the Chief of the Suco and the SEO, and 30 households in each of the four aldeias had been identified as target beneficiaries (SoL3 2014). Each of the households received an average of 200 sweet potato cuttings. The pilot went reasonably well, and the approach was repeated on a larger scale, and with a broader range of crops, in preparation of the 2013-2014 planting season.

Prior to the 2014-2015 growing season, seeds and cuttings were distributed to close to 6,000 households (32% of them headed by women) in 145 aldeias of 51 sucos. An assessment in early 2015 indicated that there had been some problems with the distribution, in the sense that more remote sucos and aldeias had received little assistance, and that households that were close to the SEOs had received more aid, and received it more frequently.

The 2015-2016 seed distribution to vulnerable groups was therefore organised differently. The intention was to basically reach all rural aldeias, and the amounts of seed or cuttings to be distributed to each of these would be determined at municipal level, based on the total amount of seed available to be distributed. The SEO and the aldeia chief would then select the recipients for this year's distribution, with the understanding that they would not be targeted as recipients for at least another two years.

5.4 Component 4: Seed system management

The overall goal of SoL3 was to help Timor-Leste to establish a national seed system. In 2008 a draft Seed Law had been proposed by MAF to parliament, but not much progress had been made in its deliberation. In discussion with counterparts in MAF at the start of SoL3 it was decided that it would be better and more effective to develop a seed policy first, gain several years' experience with implementing the policy, and only later to formalize it in legislation and regulations.

This approach gained more support after a study visit to Nepal in early 2012 by national and municipal MAF directors. One specific recommendation from the Nepali counterparts was to avoid making the same mistake as they had made; they had started with a Seed Law, and in hindsight had encountered many difficulties in implementing the emerging seed system as some of the developments went counter to what had initially been envisaged, and what had been enshrined in the law. They recommended to keep the Seed Law for last.

The development of the national seed system – which was initially referred to as the National Seed System for Released Varieties – was conducted in a very participatory way. With the assistance of a Nepali seed system expert, a draft seed policy was prepared. This was first consulted and discussed with a broad-based central-level working group, and then, in December 2012, in municipal discussion meetings conducted in all municipalities. The recommendations and suggestions from these municipal consultations were then discussed by the national working group, and a revised draft policy document was prepared. The Timor-Leste National Seed Policy was endorsed by the Minister of

Agriculture and Fisheries on 11 March 2013. Implementation of the seed policy, such as the establishment of the National Seed Council, started soon afterwards.

The national seed policy document was updated in early 2016, to take into account the reorganization of MAF which took place in 2015, and the developments that had taken place since 2013 on seed policy institutions (such as the membership of the National Seed Council and of the three Committees that are part of it), and on the operating procedures. It was also the intention that the updated National Seed Policy would be submitted to the Council of Ministers for general Government endorsement.

In the logical framework of SoL3, some cross-component support activities were listed under Component 4.

A first of these was **gender**. The program developed and implemented a gender strategy which specified what activities each program component had to promote gender equality and create more opportunities for a stronger participation of women in the program. In the community and commercial seed production women participation stood at 30% or more, and it was even higher for the involvement of women in the three main positions (i.e. leader, secretary or treasurer) of either the CSPGs or CSPs.

The program's **monitoring and evaluation** setup also closely followed the component structure. The day-to-day monitoring of activity implementation in the components 1, 2 and 3 fell to the main advisors supporting these components. The M&E advisor focused more on bringing the results of activities together at the higher levels of the logical framework, and on assessing program impacts through a series of case studies and country-wide adoption surveys.

Training and capacity development was a key element of all program components. The assessment of its effectiveness was conducted at two levels. First, for each specific training activity – but more so for the formal training events than for the on-the-job training and mentoring – there were "before" and "after" assessments, to measure what benefit each participant had obtained from the activity. Second, each year there was also a competency assessment, which was a moderated self-assessment, in which each MAF staff assigned to the SoL program, as well as the SoL staff, assessed to what extent they were capable and confident to implement the core activities linked to their positions in the program. Figure 10 shows the 1-4 rates which were used by the staff to assess to what extent they were able to perform listed tasks, and to assess progress over the years of the program's capacity building efforts.

Rate and meaning	
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)

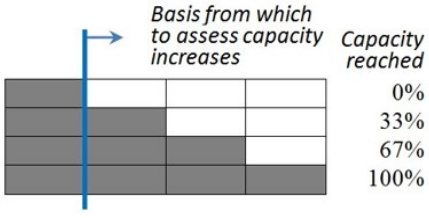


Figure 10. Rating scale for the capability/ability of MAF and SoL staff to perform position-specific tasks

The SoL3 program design document hardly mentioned **communications**, but it was clear from the start that this had to be an integral part of operations to achieve the program goal, i.e. that half of all foodcrop growers in Timor-Leste would be using one or more improved varieties on a regular basis. The program developed a communication strategy which helped to spread the word on the program's activities, the improved varieties and the emerging national seed system in many forms and through many channels (ranging from traditional print publications, electronic communications through internet and social media, radio, TV, film and drama.

5.5 Program management and other

The Seeds of Life program operated at national but also at regional levels. There were **three Regional Offices** which, between them, provided support for program activities in 12 municipalities (support activities for Dili were supported out of Dili).

- Western Region, with Maliana as basis, and providing support for the municipalities Bobnaro, Liquiça, Ermera and Oecussi.
- Central Region, with Same as basis, and providing support for the municipalities Aileu, Ainaro, Covalima and Manufahi.
- Eastern Region, with Baucau as basis, and providing support for the municipalities Baucau, Manatuto, Viqueque and Lautem.

The Regional Offices provided general, cross-component support for the program activities, and ensured follow-up with the MAF offices in their respective municipalities. From 2013 onwards, an important aspect of the regional work was the support for the respective municipal seed systems.

As for the **management** of the Seeds of Life program, it is the opinion of the program team that several factors have contributed to its success:

- The Seeds of Life program was firmly embedded in MAF. The program office was located in the MAF compound, assuring easy access to and interaction with the ministry counterparts (even to the point that the Team Leader basically had daily meetings with the Director-General or Secretary-General). The program was also very much implemented by Timorese nationals; of the 95 program positions that were filled by Timorese staff in 2012, 56 were filled by seconded MAF staff.
- There were 11 international positions on the Seeds of Life advisor team, and the Executing Agency, the University of Western Australia, was given the freedom to hire internationally to select the most suited persons for these positions. Over the 5.5 years of the program, the composition of the advisor team was remarkably stable; only for three positions was there a change in person who filled the position.
- The University of Western Australia, as a not-for-profit organisation, had a very different attitude to program implementation, and in relation to the cost of providing services to the program team in Timor-Leste, than could be expected from a commercial international development contractor. The much lower management overhead meant that more program resources remained available in support of program activities, or to secure short- or long-term personnel support to assist with their implementation.
- The program team practiced a very “open data” and document sharing policy, both within the team, and with other development partners in- and outside the ministry. Program implementation through a commercial company might well have operated a much more controlled and restricted data and document sharing policy.
- The program also collaborated intensively with a broad group of stakeholders and development partners. With some the interaction was limited to sharing of information and coordination of complementary activities, but with some a more intense collaboration was pursued. One example is the collaboration between the Seeds of Life program and the IFAD-supported Timor-Leste Maize Storage Project. SoL provided improved maize seed to be distributed together with the 200 litre storage drums. A total of 41,790 drums and 33,753 improved maize seed packages (of around 1.3 kg) were distributed to 23,468 households. Figure 11 shows what the benefits are for farmers if they use both improved maize seed and better methods of storing their harvests.

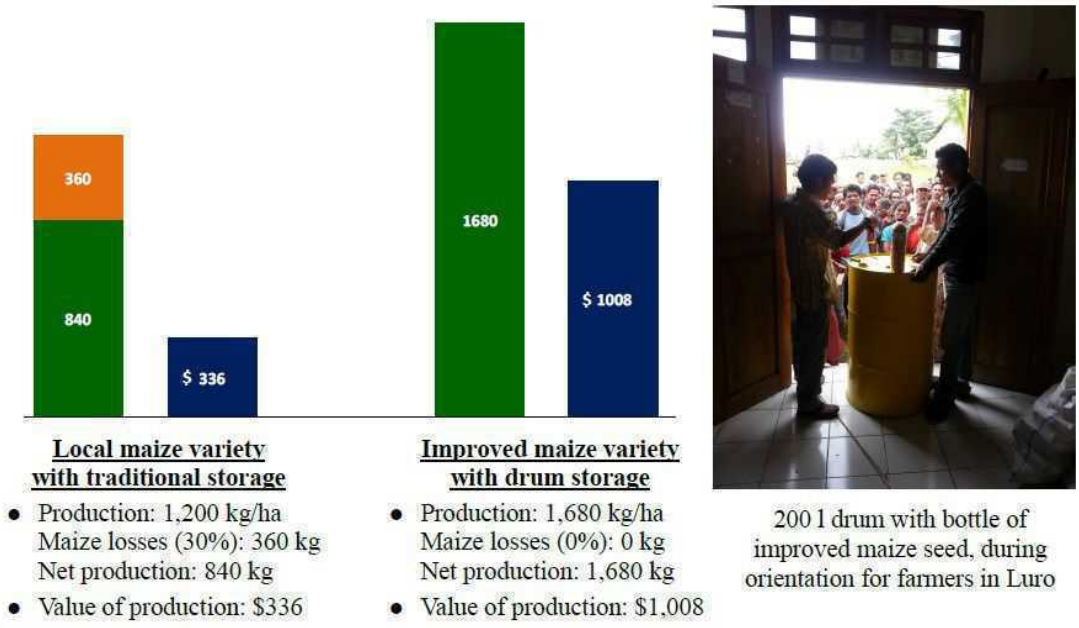


Figure 11. Benefits for maize farmers of the combined effect of using improved seed and storing the harvested maize in drums

Another example of effective collaboration was between SoL3 and the conservation agriculture project supported by FAO. SoL's experience in using velvet bean to suppress weed growth in maize, and to improve soil fertility was taken up by the FAO project as a recommended practice for wider application in its project areas.

- The program leadership showed a remarkable degree of flexibility, and allowed to adjust the scope and magnitude of planned and unplanned program activities to take advantage of emerging opportunities, and to deal with implementation constraints. The program did not stick to a rigorous, "cast in stone" workplan, but continuously assessed what approaches were likely to give the best long-term results.

6 Achievements against activities and outputs/milestones

In this section the achievement against the activities and outputs/milestones for each program component are listed.

Objective 1: Improved varieties of foodcrops identified and released

no.	activity	outputs/ milestones	completion date	comments
1.1	Establishment of agricultural research centres and stations completed	• Research Centres and Stations established and/or upgraded. • Professional staff deployed at research centres and stations. • Operational budget allocated.	All major construction at two research centres (Loes and Betano) and four research stations (Quintal Portugal, Ululefa, Darasula and Raimaten) was completed by the end of 2013. Some repairs and refurbishments were done in the first half of 2014.	The sites are operating on a MAF budget and manned by MAF professional staff.
1.2	Genetic material of potential improved varieties identified and sourced	Number and type of improved varieties introduced.	Between 2011-2016, genetic material of several potential varieties was identified and sourced from different centres such as: white maize from CIMMYT Zimbabwe, the Philippines and yellow maize from IITA Nigeria; sweet potato from CIP Indonesia; rice from IRRI; peanut from ICRISAT India.	In 2016 MAF intends to introduce 30 large seeded bean varieties and a range of potato varieties for testing
1.3	Potential new varieties evaluated on-station	• Number of varieties trialled on-station. • Number of varieties selected for OFDTs.	The varieties sourced from the CGIAR centres and other sources evaluated on-station.	
1.4	Potential new varieties evaluated on-farm	• Number of varieties trialled on-farm. • Number of OFDTs conducted. • Number of OFDT coordinators and OFDT officers deployed. • # OFDT farmers selected by gender.	Between 2011-2015, OFDTs were conducted for the following number of varieties: 4 maize, 7 sweet potato, 3 cassava, 4 rice, 4 mung beans, 3 winged beans and 4 climbing beans. In total some 1,095 OFDT were conducted, supervised by 14 OFDT officers and 2 coordinators. There were 1,087 OFDT farmers of whom 308 were women.	The number of OFDTs conducted in 2015-2016 is not included. The research program is now fully MAF funded and managed, and no data was provided on the number of OFDTs.
1.5	Selected new varieties officially released	• Number of new varieties officially released. • Number of women in variety release committee and observers during release committee sessions. • Variety release documents include a section on gender impact.	In total 19 new varieties released, of which 18 from MAF-SoL research. In SoL2, 10 varieties were released. During SoL3, a white maize was released in 2012, one bitter cassava in 2014, and one rice, two sweet potatoes, two kidney beans and two mung beans in 2016.	One local red rice variety and three winged beans are in the final stages of variety testing. A program for soy bean testing has also been started.

no.	activity	outputs/ milestones	completion date	comments
1.6	Capacity of MAF research staff to manage the identification and release of new varieties strengthened	Number of people trained, by position, subject, type of training provided and gender.	Between 2006-2015, some 2,627 training opportunities (36% of the total) were provided to researchers. Of the 10 MSc graduates, 5 were research staff.	

Objective 2: Sufficient high quality seed produced by contract growers to maintain the genetic quality of released varieties

no.	activity	outputs/ milestones	completion date	comments
2.1	Sufficient foundation seed produced for national seed system	Quantity of foundation seed produced.	In December 2015, the stocks of foundation seed of some crops were: Sele 360 kg; Noi Mutin 100 kg; Nakroma 657 kg.	Only small amounts of foundation seed required for the national seed system.
2.2	Certified seed produced by contract growers	• Quantity of certified seed produced. • Number of contract growers. • Value of certified seed produced. • Number and area of sweet potato and cassava nurseries established. • Number of sweet potato cuttings and cassava canes produced.	Amounts of certified seed produced during SoL3: rice, more than 140 Mt; maize 150 Mt; peanut, more than 38 Mt. The number of contract growers varied between 117 in 2011 and 38 in 2016 In 2015, nearly 2.5 million sweet potato cuttings were produced.	Sweet potato and cassava cuttings were first multiplied through contract farmers, but in later years most cuttings came from 4.3 ha in 11 cassava cuttings production centres and 28,300 m^2 in 23 sweet potato cuttings centres.
2.3	Quality assurance systems established	• % of certified seed produced that meets minimum standards, by type. • % rejected.	Seed produced by contract growers and CSPs tested. Most samples do well on moisture content and purity, but some have low germination results.	
2.4	Technical extension support provided to contract growers and Commercial Seed Producers	• Number extension staff providing direct support to contract seed growers. • Number Seed Department staff deployed. • Number of contract growers trained.	There are in total 15 Municipal Seed Officers (11 M, 4 F) who provide support to contract seed growers and CSPs. The Seed Department has a total staffing of 26 (19 M, 7 F). Between 2006-2015 a total of 949 farmers were trained in seed production.	
2.5	Seed grading, packing and storage facilities established	• Number, capacity and location of Seed Processing Centres established. • Number of professional staff deployed. • Quantity of seed processed by SPCs.	Six seed processing centres in six Municipalities were established by the end of 2013 and fully equipped. Each warehouse is capable of storing 30t of seed and cleaning/ grading rice at 1t/hr and corn seed at 0.2 -0.3 t/hr. 15 persons (including one woman) were assigned by MAF to the seed production program.	

no.	activity	outputs/ milestones	completion date	comments
2.6	Certified seed distributed through preferred distribution channels	• Quantity of seed distributed by distribution channel. • $ generated from cost recovery on seed distributed.	The change in thinking on the purpose of Component 2 in 2012 made the first indicator irrelevant. Cost recovery from seed distribution was not done because of difficulties on how to handle this in bookkeeping between SoL and MAF.	
2.7	Capacity of MAF Seed Department staff to manage the production and distribution of certified seed strengthened	# of Seed Department staff trained, by position, subject, type of training provided and gender.	Between 2006-2015, some 1,263 training opportunities (17% of the total) were provided to seed production staff. Of the 10 MSc graduates, two were seed production staff.	

Objective 3: Mechanisms for the production and distribution of seed through community and market channels strengthened

no.	activity	outputs/ milestones	completion date	comments
3.1	Community Seed Production Groups established	• Number and location of CSPGs established, by crop type. • Total membership, by gender. • Number of women holding top-three positions in CSPGs. • Total production of CSPGs, by variety. • Quantity and value of sales, by variety. • Number of SEOs directly involved in supporting establishment of CSPGs. • Number of farmers joining suco level training for CSPG, by gender.	By 2015, there were 1,191 CSPGs. 481 Sele, 220 Noi Mutin, 188 rice, 294 peanut, 18 cassava and 64 sweet potato. They had 14,670 members of which 31% were women. In 2014−2015, 10% of CSPGs had a woman as Chief, 23% had a woman Secretary, and 39% had a woman Treasurer. In 2014-2015, CSPGs produced 75 Mt rice, 117 Mt maize and 13 Mt peanut. Hardly any of this was sold; most was meant for CSPG members, and for local, in-suco barter, sale or gifting. Between 2006-2015, 949 farmers received training on seed production, and 365 on business planning. Most of these would have been CSPG members.	

no.	activity	outputs/ milestones	completion date	comments
3.2	Commercial Seed Producers supported	• Number and location of Commercial Seed Producers (CSPs) established and accredited • Total number of members in the CSPs. • Number of women holding top-three positions in CSPs. • Total production, by variety. • Quantity and value of sales, by variety.	In 2015-2016 there were 69 CSPs. They had 1,845 members of which 35% were women. In 2014-2015, 16% of the CSPs were led by women, 21% had a woman secretary, and 81% had a woman treasurer. In 2014-2015, the CSPs produced 110 Mt rice, 185 Mt maize and 10 Mt peanut. Most of this was bought by contractors, on behalf of MAF, for distribution to farmers.	
3.3	Focal seed merchants in local markets established	• Number of focal seed merchants supported, by gender. • Quantity and value of sales, by variety.	The focal seed merchants' activity was not implemented as such. It was partly replaced by CSPs and Anaprofiko, the umbrella organisation of CSPs, and partly by the Agriculture Shops	
3.4	Improved access to seed for vulnerable groups	• Number of sucos/aldeias with distribution of improved varieties to vulnerable households. • Number of vulnerable households, by type (male and female headed. • Quantity and value of improved varieties, by variety and location.	In 2014-2015, 5,830 vulnerable households in 51 sucos / 145 aldeias received 7.3 Mt of maize seed, 819 kg of rice seed, 191 kg of peanut seed, and close to 750,000 sweet potato cuttings. Of the receiving households, 1,838 were headed by women, and 3,992 headed by men.	In 2015-2016 the intention was to reach all the rural aldeias for such vulnerable households seed distribution.
3.5	Systems linking registered Commercial Seed Producers with potential buyers developed	• Number of commercial seed producers per municipality. • Number of buyers purchasing seeds from registered commercial seed producers. • Quantity and value of sales, by variety and municipality.	In 2015-2016, there were 69 CSPs. The smallest number was 1 CSP in Dili, and the highest 12 in Baucau. Seed buying in 2015 was done by three contracted companies, on behalf of MAF. The majority of the CSP seed was sold. Some that was not bought by the MAF-contracted companies was later bought by other buyers.	
3.6	Capacity of MAF extension staff to establish CSPGs strengthened	Number of people trained, by position, subject, type of training provided and gender.	Between 2006-2015, some 2,271 training opportunities (31% of the total) were provided to extension staff. Of the 10 MSc graduates, one was extension staff.	

Objective 4: MAF capacity to manage the national seed system strengthened

no.	activity	outputs/ milestones	completion date	comments
4.1	Seed planning and management systems established	• Forward planning systems developed and operational. • Allocation procedures developed and operational. • National inventory management system established and operational.	Support provided at central and municipal level for the planning and operationalisation of the seed system	The national seed system established at central and municipal levels.
4.2	Monitoring and evaluation processes strengthened	• M&E staff competently implement field evaluation activities and systematic monitoring of the national seed system to inform management by MAF leaders. • Number and nature of studies conducted and reported. • Assistance provided to DP&P M&E Unit to develop MAF-wide M&E system.	Information on the performance of the national seed system provided through country-wide adoption surveys, and through smaller case studies. Four nation-wide adoption surveys were conducted and 10 case studies.	Assistance to the DP&P M&E Unit was hampered by the two reorganisations of MAF, and the time it took for these to be implemented, and the assigned staff to be nominated.
4.3	GoTL seed policy being informed by SoL experience	• Number of seed system-related policy issues identified. • Number of advisory documents related to seed system governance, central and municipal based planning, strategy development and financial budgeting, prepared and submitted.	SoL experience continuously informed the GoTL seed policy, but such feedback was most often not through the formal submission of documents that discussed the issues. Most of the influencing was through regular day-to-day contacts, and gradually working through changes as issues arose.	
4.4	Seed system gender strategy implemented	Targets of gender sensitive indicators achieved.	Each of the program components had its specific gender targets. Most of these were achieved.	
4.5	Improved-variety technical and promotional materials developed	• Number and type of technical and promotional materials prepared. • Extent of distribution.	SoL communications were provided as banners, booklets, calendars, labels, leaflets, posters and reports. The numbers varied from year to year, but much of it had nation-wide coverage.	
4.6	Awareness of improved varieties increased through use of mass media	• Number of mass media campaigns conducted, by channel and cost. • Number of mentionings of SoL and/or improved varieties in local and international media.	Increasing awareness of improved varieties was done through banners, booklets, calendars, labels, leaflets, posters and reports, newspaper articles, web postings, social media (Facebook and Twitter), videos, and radio and TV programs. Most of this had nation-wide coverage.	

no.	activity	outputs/ milestones	completion date	comments
4.7	Environmental and climate change impacts addressed	• Number of climate impacts on crop production reports released. • Number of agro-ecological zone adaptation reports released. • Number of administrative post level information sheets produced.	There were Suco Information Sheets for each of the 442 sucos; municipal climate posters for each municipality; a series of two-weekly reports on the impact of El Niño in the 2015-2016 season; and multiple other downloadable maps on various agro-ecological-meteorological aspects.	
4.8	Capacity of MAF staff to manage the national seed system enhanced	Number of people trained, by position.	Between 2006-2015, a total of 7,338 training opportunities were provided to MAF staff. Of the 10 MSc graduates, two were Sosek staff.	

7 Key results and discussion

7.1 Introduction

This section will discuss the results of SoL3 activities over the life of the program. The key results for the overall program objective, the establishment of a national seed system are discussed first, followed by the discussion of the key results of the program components.

7.2 National seed system

During SoL2 a draft Seed Law had been submitted by MAF to parliament, but this had made little progress. In 2012, SoL3 organised a visit for senior MAF staff to Nepal to study how the seed system had developed there, and what lessons could be drawn from this for Timor-Leste. One strong message was **not to rush through a Seed Law, but rather to start with developing and gaining support for a seed policy**, and putting the structures and procedures in place. As the ministry and other stakeholders gain experience with the evolving seed system, the deficiencies and shortcomings of current arrangements will become clear, and corrections and adjustments can more easily be implemented than if it has already been enshrined in law and regulations.

MAF and the Seeds of Life program were also well aware that establishing a seed policy would not be universally supported by all development stakeholders in Timor-Leste. From previous experience, it was clear that some development observer groups and NGOs had a negative view of the program's involvement in establishing a seed system in Timor-Leste; SoL was accused that the improved seeds that were being tested were hybrids or Genetically Modified Organisms (GMOs) – a completely false accusation – and that the focus should not be to bring in seeds from overseas, test them and release the most promising and suitable ones, but rather that a program should be developed to take local East-Timorese seeds, and see what improvements could be made for these.

MAF and SoL therefore decided that the **seed policy should be developed in a very participatory manner**. A draft policy was developed with a broad-based working group, and this draft was then discussed in a series of municipal workshops which involved all 13 municipalities. The recommendations for changes from the municipal workshops were discussed by the working group, which prepared the final draft. The resulting national seed policy document was submitted to the Minister of Agriculture and Fisheries for approval, and signed by him on 11 March 2013.

In June 2014, a stakeholder consultation was conducted on the formation of the **National Seed Council** (NSC), to discuss the proposed membership, and the roles and responsibilities of the three proposed committees:

- The Variety Approval, Release and Registration Committee, with the primary purpose of coordinating the process and implementing legal provisions associated with approval, release and registration of new and local plant varieties.
- The Seed Planning and Production Coordination Committee, with the primary purpose of planning and coordinating production and distribution of source seeds (such as foundation seeds) and certified seeds based on an assessment of municipal and national seed demand.
- The Seed Quality Regulation and Monitoring Committee, with the primary purpose of setting quality standards and establishing mechanisms for quality regulation and monitoring as appropriate for Timor-Leste.

The first meeting of the NSC took place in September 2014, and meetings have been held regularly, with the fifth and most recent NCS meeting taking place on 21 June 2016. NSC meetings are scheduled to be held three times each year (preferably in March, June and September) with the committees meeting at least one month before the NCS meeting.

Figure 12. The National Director of Agriculture and Horticulture addresses the second meeting of the National Seed Council, March 2015

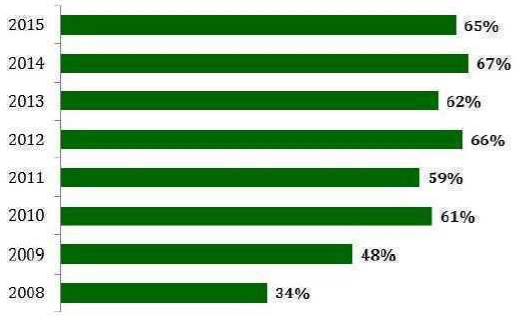
One decision of the fifth NSC meeting was the agreement on the need to create a **National Register** that not only lists those varieties of seeds formally released by MAF, but also varieties already released in similar counties that could contribute to improved farm production in Timor-Leste. These too could possibly be permitted to be imported providing the National Directorate of Quarantine can control all seed importations so that only registered varieties can be imported (i.e. assuming all phytosanitary and other import requirements are also met).

One concern regarding the seed policy is that so far it has only been approved by the Minister of Agriculture and Fisheries, but that this does not necessarily bind the other ministries and state agencies to act in accordance with the stipulations of the policy. The Ministry of Finance could e.g. approve the issuance of contracts for seed imports, even though the seed policy states that import of seeds should only be a measure of last resort, if in-country supplies are insufficient to meet the demand. It has therefore be proposed to the Minister, and the Minister has agreed, that the **national seed policy should be submitted to the Council of Ministers** for broader government acknowledgement and endorsement.

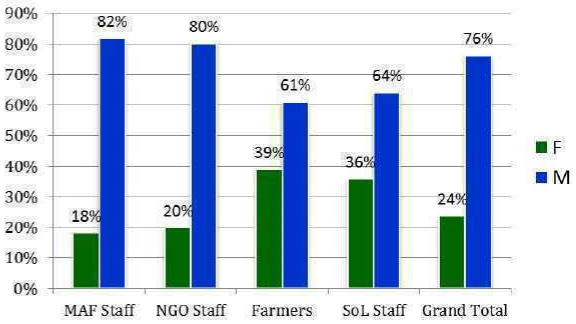
One key result of the Seeds of Life program which has enabled to establish the national seed system and support its implementation, as well as achieving the key results for the program components, is the success of the program's **capacity building and human resource development**. Table 1 shows that between 2006-2015 a total of 2,653 individuals received 37,195 days of training, and most of this training went to MAF staff (Raab 2016). Figure 13 shows the evolution of the self-assessment capacity scores, and the percentages of male/female participants by training category.

Table 2. Number of opportunities and total training days offered to various target groups and count of unique individuals trained in each group 2006-2015

Trainee Category	No. individuals	No. opportunities	No. days
MAF staff	955	7,338	32,169
NGO staff	195	260	517
Farmers	1,454	2,247	2,797
Sol staff	49	518	1,713
Totals	2,653	10,363	37,196



Capacity self-assessment scores 2008-2015



Percent of male and female participation in SoL training events by target group (2006-2015).

Figure 13. Capacity self-assessment scores, 2008-2015, and male/female participation in training events

In the long term, it may turn out that it will be this support for human resource development and capacity building which gives the most lasting and valuable contribution for seed system development, and agriculture development in general in Timor-Leste.

7.3 Component 1: Crop identification and development

The rehabilitation of the **research centres at Loes and Betano** was mostly done under SoL2, but during SoL3 some further infrastructure development was done at the two centres and at **the four research stations**, so that these were better equipped for the agronomic research, and for the production of the breeder seed and the foundation seed.

Figure 14. The Research Station Quintal Portugal in Aileu

During the first three years of SoL3, the operational cost of Component 1 was fully borne by the program. In 2014, MAF paid 50% of the operational costs, and as of 2015, all research costs were fully paid from the MAF budget.

On the research stations and centres, potentially promising varieties sourced from various CGIAR crop centres were subjected to a series of rigorous **on-station trials** to determine their suitability to Timorese conditions. Table 3, on the next page, shows the number of wet season germplasm evaluation trials that were conducted on the research stations and centres between 2011 and 2014.

The on-station trials did not always work out successfully for all varieties, and there were a number of setbacks. For example, one white maize variety from CIMMYT Zimbabwe gave a high yield and was easy to pound and good to eat, but it was extremely vulnerable to weevil attack. Other high yielding white maize varieties, also sourced from Africa, did better for resistance against weevils, but they were susceptible to downy mildew, a disease which is not very common in Africa but quite common in Timor-Leste. These varieties were therefore dropped from the testing program.

Table 3. Wet season germplasm evaluation trials, 2011-2014

Species	Number of trials		
	2011-2012	2012-2013	2013-2014
Cassava	4	4	4
Maize	5	5	5
Peanut	4	4	4
Potato	2	1	2
Rice-irrigated	6	7	6
Rice-irrigated + fertiliser			1
Rice-upland	2	2	2
Sweet potato	5	5	6
Velvet bean	4	3	2
Wing bean	1	3	4
Barley	2		
Climbing beans	1	4	4
Wheat	2		
Nutrient trial (maize)		1	
Liming agronomy pot trial		1	
TOTAL	38	40	40

The varieties which did well for several years in the on-station trials were then selected for the **On-Farm Demonstrations and Trials** (OFDTs), together with some local varieties as references. Table 4 shows the number of OFDTs which were conducted for the different crops and varieties, how many households were involved in these, and the number of households headed by men and women. The varieties which did well in the on-station and on-farm trials were then brought to the Variety Release Committee for its consideration as a variety to be recommended to the Minister for general release

Table 4. On-Farm Demonstrations and Trials (OFDTs), 2010-2015

Growing season	Number of OFDTs	Number of households	Male headed	Female headed
2010-2011	277	277	182	95
2011-2012	225	219	166	53
2012-2013	143	143	109	34
2013-2014	438	273	188	85
2014-2015	176	175	134	41

Between 2007 and mid-2016, **MAF released in total 19 improved varieties**; 18 of these were tested on-station and on-farm as part of the Seeds of Life program, and one yellow maize variety, Nai, had been developed by Dr. Claudino Nabais, as part of is PhD research. Figure 15 shows the improved varieties which have been released, what their yield advantage is over commonly grown local or traditional varieties, and the main characteristics of the improved variety.

Utamua
peanut
47%
Large peanuts, stable growing capabilities, tolerant to late leaf blight

Nakroma
rice
24%
Excellent eating rice, semi-fragrant

Hohrae 1
sweet potato
102%
White flesh, moist texture, can be grown at all elevations, sells for a good price

Hohrae 2
sweet potato
91%
Cream flesh, crumbly texture, a good breakfast sweet potato, tasty young leaves

Hohrae 3
sweet potato
131%
Orange flesh, moist texture, very high in vitamin A, sells for a good price

Ai-Luka 1
cassava
43%
Non-fibrous tasty roots, bitter variety, good for industrial use

Ai-Luka 2
cassava
46%
Non-fibrous tasty roots, excellent eating variety

Ai-Luka 4
cassava
15%
Non-fibrous tasty roots, slightly bitter

Sele
maize
50%
Yellow maize, sweet when picked early, resistant to strong winds and drought, requires airtight storage

Noi Mutin
maize
46%
White maize, suitable for all areas, good cooking & eating qualities, requires airtight storage

Suwan 5
maize
54%
Yellow maize, requires airtight storage

Nai
maize
50%
Yellow maize, requires airtight storage

Fleixa - RW
kidney bean
54%
Purple seed, adds good colour to rice when cooked together

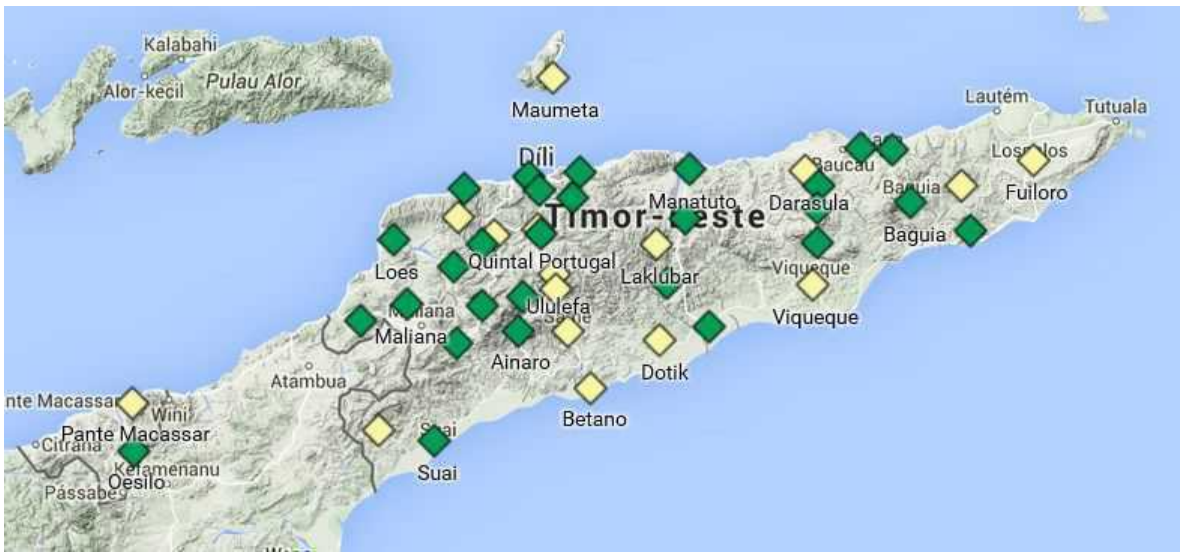
Ululefa - RW
kidney bean
73%
Pink seed, can harvest more than three times

Darasula - CIP
sweet potato
119%
Red skin, orange flesh, very high in Vitamin A, four months to harvest

Sia - LT
sweet potato
110%
Purple skin, purple flesh, contains antioxidants, four months to harvest

Figure 15. The improved varieties released by MAF, with their yield advantage over local/traditional varieties, and their main characteristics

The SoL3 program has also made a major contribution to the **development of the weather station network in Timor-Leste**, and in making agro-meteorological data more publicly accessible. Figure 16 shows the network of 44 weather stations operated by MAF's Agricultural and Land Use Geographical Information Systems (ALGIS) unit. The primary network of weather stations provides data on rainfall, air temperature, relative humidity, solar radiation, wind speed, gust speed, wind direction, soil moisture and soil temperature. The secondary network includes rainfall, air temperature, relative humidity, solar radiation and wind speed. Of the 44 weather stations, 28 are traditional and have to be visited regularly to download on site the collected data; the other 16 stations can be consulted online, via http://seedsoflifetimor.org/climatechange/climate-data/.



Note: The "yellow" weather stations have live data

Figure 16. The network of weather stations in Timor-Leste

7.4 Component 2: Source seed and quality control

One important achievement of Component 2 is that it resulted in the establishment, in June 2011, of the **Department of Seed Production and Seed Certification** (or "Seed Department") in the National Directorate of Agriculture and Horticulture. By creating the Seed Department, MAF established a "home" for the management of the seed system, and made it much more likely that the seed system would continue to operate after the end of SoL 3. At the end of the SoL program, there were 18 people assigned to seed production (2 Pure Seed Officers, and 16 Municipal Seed Officers and their Coordinators in the six municipalities where there were seed warehouses), three Seed Analysts supported by an Administration Officer, a National Coordinator, and a Head of the Seed Department.

SoL3 assisted MAF in establishing the **infrastructure for seed quality control** (in Dili, Betano and Triloka), and for post-harvest handling and storage of the certified seed in the six warehouses. Table 5 shows the seed processing equipment installed at the seed warehouses.

Table 5. Seed processing functionality at the seed warehouses

Location	Drying [a]	Thresher	Seed Cleaner [b]	Silo	Packaging / plastic sealer	Seed germinator	Moisture tester	Scale/ Balance	Compressor	Generator
Aileu	0 (0)	2	1/0/4	10	1	0	1	1	1	1
Baucau	1 (0)	1	1/1/4	29	1	2	1	1	1	1
Bobonaro	0 (1)	1	1/1/4	23	1	2	1	1	1	1
Liquiça	0 (1)	1	0/0/4	16	1	2	1	1	1	
Manufahi	1 (1)	1	0/1/4	16	1	2	1	1	1	
Viqueque	0 (1)	1	1/0/4	10	1	2	1	1	1	1

[a] The first number is an artificial drying; the number in bracket is a drying pad.
[b] The first number is a rice cleaner; the second number is an air screen cleaner; the third number are manual sieves.

The **amounts of certified seed produced** for rice, maize and peanut are given in Table 6. These were produced by contract growers.

Table 6. Production of certified seed (kg) during 2010-2015

Growing season	Rice	Maize		Peanut
		Sele	Noi Mutin	
2010-2011	98,696	32,224		8,212
2011-2012	2,389	36,321	5,537	4,329
2012-2013	26,615	32,409	9,679	8,052
2013-2014	7,872	7,392	10,104	7,556
2014-2015	5,000	8,300	6,900	10,584

Up to 2013, the certified seed was provided as input to other program components – agronomic research on-station and on-farms; for the CSPGs and CSPs – and distributed by MAF as free seed to farmers. The latter was largely curtailed – at least as concerns the distribution of high-quality and high-cost certified seed – from 2014 onwards.

Figure 17. Seed sampling of commercial seed, June 2015

Figure 18. The Minister of Agriculture and Fisheries visits to the Corluli seed warehouse in Maliana in 2015

7.5 Component 3: Community and commercial seed development

The program design for the establishment of **Community Seed Production Groups** (CSPGs) was that by the end of the program, around one thousand CSPGs would have been established. Table 7 shows that this target was reached by late 2013.

Table 7. CSPGs by crop variety and municipality, 2015-2016

No	Municipality	Cropping Season 2015-2016						Total # of groups*				
		Maize - Sele	Maize - Noi Mutin	Rice	Peanuts	Cassava	Sw. Potato	2015-2016	2014-2015	2013-2014	2012-2013	2011-2012
1	Aileu	48	16	4	33		5	84	81	99	79	40
2	Ainaro	57	1	3	11	4	5	71	71	73	84	40
3	Baucau	66		52	18	1	4	127	127	121	80	40
4	Bobonaro	25	36	24	22	1	4	108	113	75	80	40
5	Covalima	12	65	31	35			143	148	58		
6	Dili	17				1	9	26	26	31		
7	Ermera	21	22	7	13	3	4	70	72	67	24	
8	Lautem	56	12	15	48	3	3	133	137	74	24	
9	Liquiça	32	12	3	10		10	62	62	73	77	40
10	Manatuto	27		28	18			72	73	77	24	
11	Manufahi	28	10	6	20	1	5	67	67	65	80	40
12	Oecussi	27	26		34	4	14	96	99	101	49	
13	Viqueque	65	20	15	32		1	132	132	104	80	40
Total (2015-2016)		481	220	188	294	18	64	1,191				
Total (2014-2015)		483	224	193	299	21	71		1,208			
Total (2013-2014)		397	154	182	247	17	84			1,018		
Total (2012-2013)		239	109	114	173	10	36				681	
Total (2011-2012)		105	0	59	52	25	39					280

* As several CSPGs grow more than one crop, the sum of the CSPGs by crop is often larger than the number of CSPGs in a municipality.

The peak number of CSPGs established was 1,208 in 2014. This dropped to 1,191 the next year because some of the CSPGs transformed themselves into Commercial Seed Producers – and they were therefore no longer counted as CSPGs, to avoid double counting – and because some CSPGs were no longer active. The total membership of the CSPGs at the end of 2015 was 14,670 persons, of whom 31% were women.

Figure 19 shows the year in which a first CSPG was established in a suco. There are CSPGs in 364 of the 442 sucos (82%), and in 62 of the 65 subdistricts of the country. Some sucos do not have CSPGs because they are urban sucos, or because there is no SEO providing extension services to farmers in that suco.

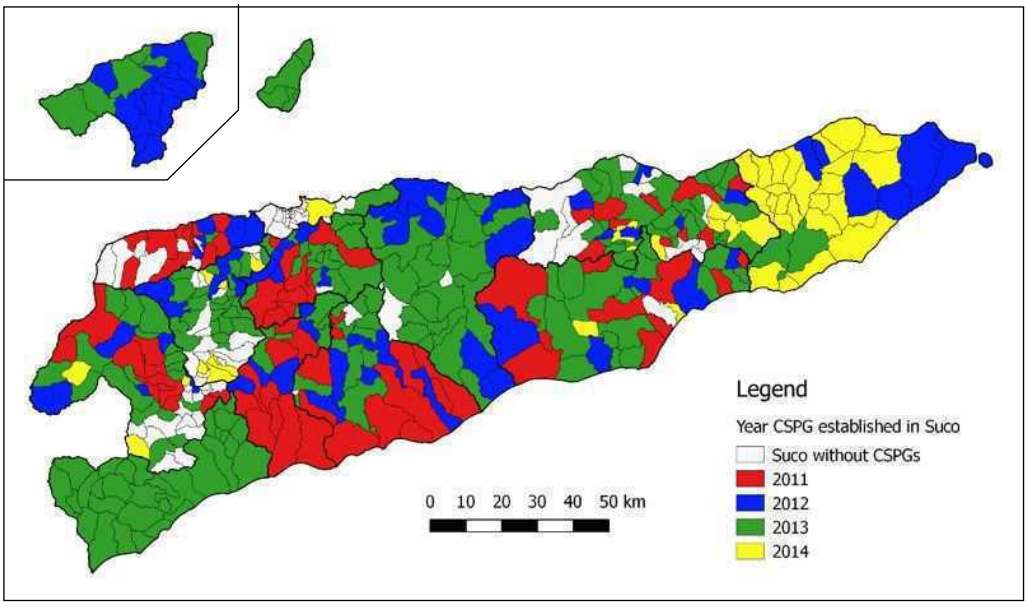


Figure 19. Establishment of CSPGs in the sucos of Timor-Leste

Starting from 2012, in some sucos the more successful CSPGs saw an opportunity to go commercial by collaborating with one another. They established what became the first **Commercial Seed Producers** (CSPs). Also some groups of contract growers – who had previously been growing certified seed for MAF – decided that they would rather become CSPs than remain contract growers. Table **8**, on the next page, shows the spread of the 69 CSPs, by municipality and by crop/variety. Several CSPs grow seed for more than one crop; growing more than one variety of a crop is however not permitted, this to avoid contamination of the seed.

To assist with their commercial activities, one of the first CSPs – Naroman in suco Fahilebo, Liquiça –decided that it wanted to build a Community Seed House. The Community Seed House was built on a piece of land donated by one of the group leaders, and SoL3 supported the construction with the contribution of cement, reinforcement bars for concrete, and roofing. All other materials and labour were contributed by the CSP. The program subsequently also supported other CSPs with similar assistance for their Community Seed Houses (Figure 20).

Figure 20. The Community Seed House from CSP Motaain Furak in suco Haupu, Ermera

The CSP's Community Seed Houses serve the following purposes:

- To serve as the CSP office;
- To safely store clean seeds produced by the CSP;
- To store agriculture tools and records of the CSP;
- To be used as a meeting place and learning centre for the CSP members;
- To use the space for drying and processing seeds for marketing.

Table 8. CSPs by crop variety and municipality, December 2015

Municipality	No. of CSPs	Maize		Rice	Peanut
		Sele	Noi Mutin	Nakroma	Utamua
Aileu	5	2	1	2	1
Ainaro	3	2		1	
Baucau	12	4	2	7	5
Bobonaro	7	2	2	3	2
Covalima	4		2	1	1
Dili	1				1
Ermera	3	2		1	
Lautem	6	3	1	1	2
Liquiça	4	1	1	1	2
Manatuto	5	1	2	1	1
Manufahi	6	3	3		1
Oecussi	5	1	3		1
Viqueque	8	3	1	4	
Total	69	24	18	22	17

The **total seed production by the CSPGs and the CSPs** between 2011 and 2015 is given in Table 9.

Table 9. Seed production (kg) by CSPGs and CSPs, 2011-2015

Growing season	CSPG production				CSP production			
	Rice	Maize	Peanut	Total	Rice	Maize	Peanut	Total
2011-2012	1,760	13,291	2,700	17,751				
2012-2013	67,843	55,016	6,394	129,793				
2013-2014	71,200	95,903	17,911	185,014	33,000	49,015	700	82,715
2014-2015	74,500	103,645	13,056	191,201	110,000	185,000	10,000	305,000

As the number of CSPs rapidly increased – from 3 in late 2012, to 31 in late 2013, 57 in late 2014 and 69 in late 2015 – it was felt that it would be to the benefit of the CSPs if they had an umbrella organisation which could defend their common interests, act as a spokesperson for this emerging group, and provide some common services (e.g. procurement of packing materials; printing of seed labels; etc.). The decision to establish such an association was made by representatives of 55 CSPs in March 2015, and they established the National Association of Commercial Seed Producers (**Anaprofiko**, *Asosiasaun Nasional Produtor Fini Komersial*). Anaprofiko was officially registered by the Ministry of Justice on 16 October 2015 as an association.

One of the challenges for SoL3 was how to increase the uptake of **cassava and sweet** potato. Both crops are grown quite intensively by the farmers (the 2011 baseline survey found that 84% of the farmers grew cassava and 54% grew sweet potato), but the adoption rate of the improved varieties was quite low, i.e. 3.4% for cassava and 6.6% for sweet potato. In January 2013, the program had half a million cassava cuttings and more than 100,000 sweet potato cuttings available for distribution, but there was little demand for these. The program therefore decided to organize a “fast track” distribution of cassava and sweet potato cuttings to farmer groups, both MAF and NGO supported, throughout the country. In February and March 2013, nearly 100,000 cassava cuttings and 230,000 sweet potato cuttings were distributed to 512 groups in 234 sucos in 11 municipalities. Of the 234 sucos, 60 (26%) were sucos where SoL already supported CSPGs; the majority of the cutting recipients were thus households in 174 sucos that had little or no previous interaction with SoL. Unfortunately, the impact of this specific distribution did not show up in the results of the mid-term survey conducted in mid-2013; only 2.1% of the cassava growers encountered were growing an Ai-luka variety, and only 6.7% of the sweet potato growers in the survey were growing a Hohrae variety.

One of the difficulties that hampers the uptake of both cassava and sweet potato is that such cuttings are more perishable than seed. Transport over long distances often results in high losses of the planting material and low survival rates of the plants. To reduce such risks, and to improve access to such cuttings, it was decided to establish cuttings production centres in the municipalities. In the last quarter of 2014, 34 sweet potato cuttings centres covering a total production area of 25,920 m^2 were established in 11 municipalities, providing access to cuttings of Hohrae 1, 2 and 3. Similarly, in order to help increase the uptake of cassava, 11 cassava cuttings production centres, totalling 4.32 ha, were established in February 2015 in eight municipalities. This, and earlier cuttings distributions between mid-2013 and the end of 2014, may perhaps have had some effect: in the SoL3 end-of-program survey conducted in February-March 2016, the adoption rate of improved cassava was 5% and that of improved sweet potato 10%. There is however still a large scope for improvement.

One activity which was not anticipated in the program design, but which has been quite successful has been the inclusion of **savings and loans** (S&L) activities into CSP operations. SoL’s involvement with S&L activities is entirely due to the regional advisor Wayan Tambun. Before joining Seeds of Life in 2012, he had been working between 2005 and 2011 in Oecusse with World Neighbours, and promoting S&L activities with farmer groups had been a successful key activity of the program there.

A member of S&L-CSP Mota-Ain Furak in Ermera receives a loan from the group

A learning visit on S&L from two interested CSPs to the S&L group of CSP Lakabasi

Figure 21. Savings and loans activities of CSPs

When the first CSPs sold their first commercial seed, they generated a healthy profit, and the idea rose that the groups might appreciate some suggestions and guidance on how to use the group profits as a source of finance for the members of the group. The idea was put to them, together with examples of what had been achieved in Oecusse, and they were enthusiastic to do the same. So in mid-2013, a participatory "readiness assessment" was conducted with the CSPs Naroman in Liquiça and Fitun Leste in Baucau, and soon afterwards the S&L groups were established. As more CSPs were established, so did also expand the number of S&L groups linked to these. As of mid-2016, of the total 69 CSPs, 40 are integrating S&L into their activities. Table 10 shows the membership and the financial results of the 40 S&L groups linked to the CSPs as in May 2016.

Table 10. Savings and loans activities of Commercial Seed Producers, May 2016

S&L groups in CSPs	Total no. of members			Total capital (US $)	Total amount of loans provided (US $)	No. of members provided with loans	Total Profit (US $)
	Men	Women	Total				
15 S&L groups (e. 2013 & 2014)	242	173	415	48,567	114,904	535	6,455.07
25 S&L groups (est. 2015)	261	177	438	26,810	34,390	232	2,643.60
All CSP S&Ls	503	350	853	75,377	149,294	767	9,098.67

To stimulate the marketing and sale of improved seeds, the program has assisted in the expansion of **agriculture shops** (*loja agrikultura*) in the municipalities. This initiative was started by Mercy Corps in 2013, and SoL helped to expand it to all municipalities, on two occasions together with the DFAT-supported Market Development Facility (MDF). These shops, some of which are general supply shops that are interested to sell agriculture inputs, also sell vegetable seeds, animal feed, fertilizers and pesticides, and they help to disseminate information on good agricultural practices.

At the end of 2015, there were 32 agriculture shops (Table 11). In preparation for the 2014-2015 planting season, 1,747 seed packages (weighing 750 g and 1 kg) sourced from CSPs were made available to the agriculture shops; 75% of these were sold to customers at prices of $1.50 to $2.00 per kg.

Table 11. Agriculture shops, 2015

No.	Municipality	Number of Agriculture Shops	Established with support from
1	Aileu	1	MAF-SoL
2	Ainaro	5	Mercy Corps
3	Baucau	3	MAF-SoL and MDF
4	Bobonaro	4	MAF-SoL and Mercy Corps
5	Covalima	2	MAF-SoL
6	Dili	4	MAF-SoL and MDF
7	Ermera	2	MAF-SoL
8	Lautem	2	MAF-SoL and Mercy Corps
9	Liquica	1	MAF-SoL
10	Manatuto	2	MAF-SoL
11	Manufahi	3	Mercy Corps
12	Oecussi	1	MAF-SoL
13	Viqueque	2	MAF-SoL
	Total	32	

In January 2015 a two-day workshop was held in Dili with representatives from 26 agriculture shops, and a meeting was arranged with representatives from 58 CSPs, so that the two groups could start to get to know one another better, and establish contacts. In the second half of 2015, the Market Development Facility assisted the agriculture shops to establish a national network.

7.6 General and cross-component

An important key result is that linked to the **end-of-program target**: that 50% of foodcrop farmers would be using one or more of the improved varieties. The end-of-program survey conducted in February-March 2016 indicated that 48% of the respondents were growing at least one of the improved varieties, which was an increase of 30% over the adoption rate at the time of the baseline survey in 2011 (Figure 22).

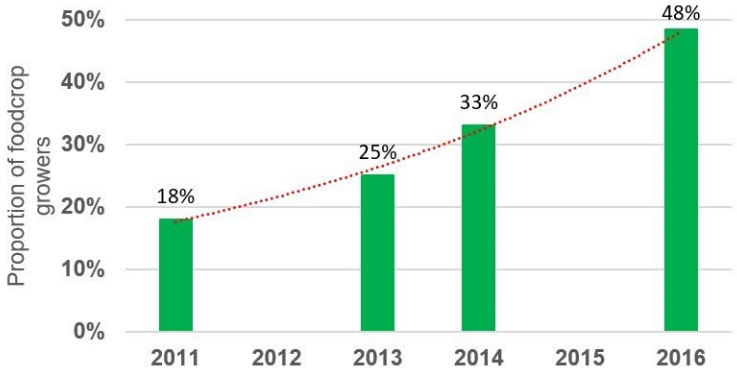


Figure 22. Adoption of improved foodcrop varieties, 2011-2016

The **adoption rates for the different crops and varieties** over the four nation-wide surveys the program conducted between 2011 and 2016 are given in Table 12.

Table 12. Adoption rates of improved varieties (% among crop growers)

Crop	Variety	2011	2013	2014	2016
Maize	Sele	13%	15%	20%	30%
	Noi Mutin	-	2%	10%	22%
	Nai	-	-	0.3%	0.6%
Rice	Nakroma	11%	15%	14%	8% / 21%[2]
Peanut	Utamua	16%	11%	12%	6%
Cassava	Ai-luka	3%	3%	5%	5%
Sweet potato	Hohrae	7%	7%	9%	10%

[Percentages for 2016 calculated among 691, 95/138, 217, 636, and 444 farmers growing respectively maize, rice, peanuts, cassava and sweet potato in the end-of-program survey]

For Nakroma in 2016 there are two adoption rates; the first one applies to February-March 2016, the second one to April-May 2016. The reason is that, when the survey was conducted in February-March 2016, many rice growers had not yet planted rice, nor even prepared seed nurseries. In several areas rice is often planted as late as March, and the El Niño condition of 2015-2016 had moved this backward even further. As it became clear that many of the interviewed rice farmers would only have planted rice later in the year, a revisit was made to **the same rice farmers** in some areas with larger concentrations of such farmers in the East of the country. As expected, many of the rice farmers who had

[2] The 8% is the proportion of Nakroma growers as of February-March 2016, while the 21% is the revised proportion of Nakroma growers after 51 households had been revisited in April-May 2016.

not been noted as improved variety adopters in February-March 2016 were confirmed as such in April-May 2016.

It is also interesting to see what **influence some factors had on adoption** (Table 13). Municipalities where the program has been active longer, have a higher adoption rate than other municipalities. If this is influenced by the presence and spread of improved varieties, then this holds good promise for a further increase in adoption rates after the end of SoL3.

Table 13. Proportion of adopters according to different factors, 2016 survey

Factors correlated to adoption		# of cases	% of adopters
Length of presence of the SoL program			
	More than eight years in Baucau, Manufahi, Aileu and Liquiça	219	66%
	Less than eight years in other municipalities	481	40%
CSPG or CSP in the suco of the respondent			
	There is a CSPG/CSP in the suco	644	50%
	There is no CSPG/CSP in the suco	56	27%
IFAD drums:	Owns an IFAD drum	115	69%
	Does not own an IFAD drum	585	44%
Total # of HH members working in agriculture:	0-2 members	260	45%
	2.5-4 members	353	47%
	4.5 to more members	87	63%

Sucos where there were CSPGs or CSPs also did better than sucos where there were no such groups or commercial growers. CSPGs and CSPs do seem to support diffusion of improved varieties. Adoption of the maize varieties Sele and Noi Mutin also received an important boost through the collaboration between SoL and the IFAD-supported Timor-Leste Maize Storage Project. Providing each drum buyer with a sample of improved maize contributed to the success of both initiatives. The end-of-program survey also showed that households who have more members active in agriculture are more likely to be growers of improved varieties.

Even though **communications** did not figure very prominently in the program design, it became an integral and important part of program operations, and undoubtedly contributed to making the varieties better known, and to publicize program activities, both in Timor-Leste and abroad. As shown in

Table 14, the program's communication activities were very diverse and reached several audiences. It should also be pointed out that communications was largely driven by a team of Australian Volunteers who were seconded to Seeds of Life for one to two year assignments.

Table 14. Range of SoL communication activities

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

One last key result were the many **publications and studies** that were produced by the SoL advisory team, or by others using program data. They are listed in section 10.2, “List of publications produced by the program”, and most of them are accessible on the Seeds of Life website.

8 Impacts

8.1 Scientific impacts – now and in 5 years

Seeds of Life started off as a crop variety research program, and over time morphed into a research and development program; the results of the agricultural research were disseminated throughout Timor-Leste and helped crop growing farmers to produce more food, either for own consumption or for sale. Over the three phases of the Seeds of Life program, many activities have been implemented which have had – and still have – scientific impacts.

Through the years a **system and procedure for variety releases** has been developed which works adequately for Timor-Leste at this moment. Potential crop varieties are identified internationally and genetic material is imported for on-station agronomic trials. Varieties that are not living up to the promise are dropped from the research program, and those that show potential are then tried out for several years by farmers in different agro-ecological zones. The varieties that still do well in the on-farm trials, and also score well for ease of food preparation and on taste are proposed to the National Seed Council's Variety Release Committee. The committee decides whether the tested variety should be recommended to the Minister of Agriculture for general release. By mid-2016 the variety release system and procedures have resulted in the official release of 19 improved varieties, and more crop and legume varieties are at different phases of trialling.

The Seeds of Life program has also clearly demonstrated that **participatory variety selection works**, even in a country like Timor-Leste where research faces lots of constraints. Variety research does not have to be a "single entity" activity, where a government research agency or a university conducts the research process alone, from start to end; involving local farmers early on in research on products and practices which are intended for their use gives more value and relevance to the research, and very much enhances its uptake.

The **improved foodcrop varieties** released so far by MAF are by themselves a scientific impact of the SoL program. It is expected that their spread will continue in the coming years, giving local farmers more options of crops and varieties to cultivate. It is not expected that all varieties will continue to be grown by Timorese farmers; as new varieties are released, it may well be that other varieties will correspond better to the economic, ecological and farming practice conditions of Timor-Leste at that time.

One program activity which had only started towards the end of the program, but may well have a significant scientific impact in the years to come, is the **registration of local seed varieties** linked to community seed banking. There are local varieties of commonly grown crops which farmers continue to grow, even as they take up improved varieties. Often these crops have certain characteristics – e.g. taste, resistance against disease, suitability for cultivation linked to specific soil or weather conditions, or marketability – which the farmers value and wish to preserve in the spectre of crops they grow. Such varieties may be shared within local farming communities in traditional and systematic manner but are not otherwise identified, described, evaluated and conserved. Registration of such crops and their inclusion in locally maintained community seed banks serves several purposes:

- The local varieties will be better documented,
- It will diminish the risk of the variety being lost,
- It will provide MAF, and the scientific community at large, with a pool of local Timorese genetic material which can serve as a source for research on local crop varieties.
- For the varieties which are in general demand, MAF can initiate a program of seed purification and multiplication so that the variety becomes more widely available.

Another program initiative somewhat related to the above, but which already started in SoL2 and has been continued in SoL3 is a **local germplasm collection with database and intellectual property data**. This also contributes to safeguarding Timor-Leste agro-biodiversity.

Over the years, SoL has conducted a lot of **research**, much of which has been documented in the **Annual Research Reports**, in various **maps** and other **publications**. The production of publications and papers, especially those that have been published in international journals, was very much helped by the program's association with the Centre for Plant Genetics and Breeding at the University of Western Australia. In some areas, such as climatology and meteorology, there are not only the maps and publications, but even the weather data itself is available for further use and exploration by other researchers. All of this constitutes a rich trove with resources on, and in support of agriculture in Timor-Leste.

Nineteen papers addressing a range of topics were published in international journals during SoL3 and five more were in preparation or had been submitted. Topics range from climate change to gender.

One recent research output deserves particular mention: a **typology of agriculture livelihoods and livelihood zones in Timor-Leste using national census data**. Using the 2010 census data, a cluster analysis was done to group sucos with similar crop and livestock profiles into livelihood systems, which were then mapped. Based on mapping the livelihood systems, seven livelihood zones were identified. These included three zones with irrigation (rice-based), two highland zones (coffee-based), and two lowland zones based on rain-fed agriculture (see Figure 23). The definition of these zones with common agricultural livelihoods can assist planning for national agricultural development.

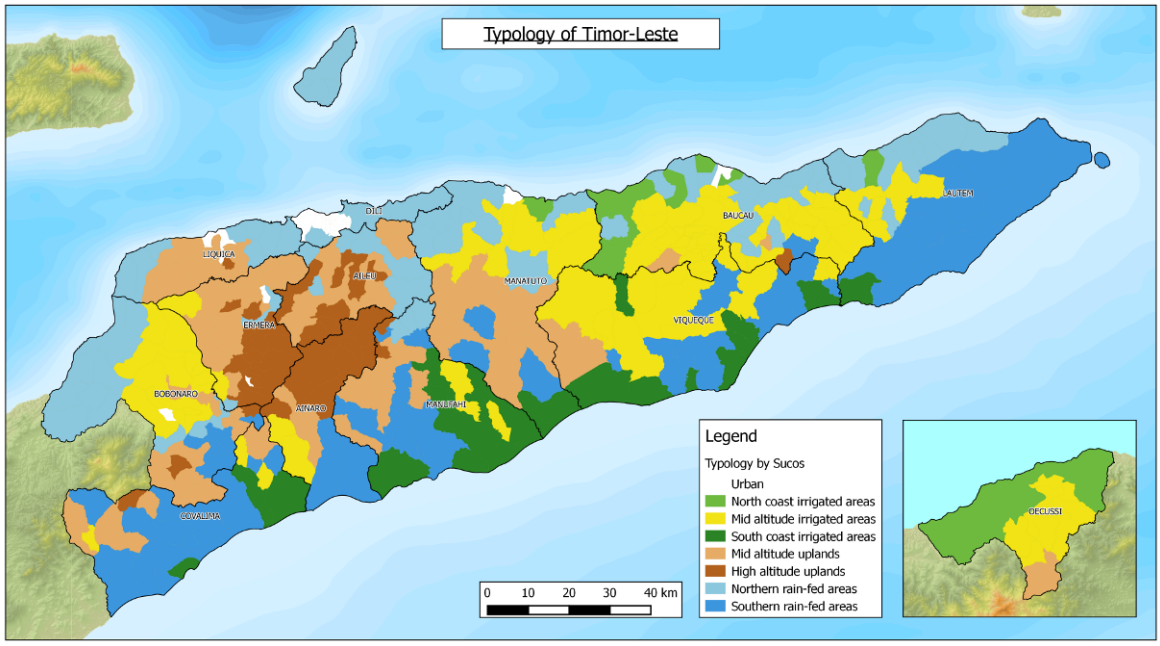


Figure 23. Map of livelihood zones of Timor-Leste with village boundaries

Last, but certainly not least in this list of scientific impacts, are the program's **effort in skills development and capacity building**. These are bound to remain important for the persons who took part in those activities, as well as the institutions and organisations in which they are currently active, and those in which they will become active in the future.

8.2 Capacity building impacts – now and in 5 years

The program's capacity building impacts are discussed in three areas: infrastructure, system development and human resource development. As some of these points have already been mentioned in earlier sections, they will not be discussed elaborately here.

8.2.1 Infrastructure

Between 2011 and 2016, Seeds of Life has provided resources for infrastructure development in several areas.

- **Research stations and centres**. Most of the rehabilitation of the research stations in Loes and Betano had been financed in SoL2, but additional investments were financed under SoL3. The research stations at Darasula in Baucau (for evaluation of varieties at mid-altitude on red acid soils), at Urulefa in Ainaro (a high altitude site for evaluation of temperate crops), and at Raimaten in Bobonaro (for the evaluation of irrigated rice varieties) also benefitted from investments.
- **Cold storage for seeds**. As part of the Seeds of Life office expansion in the MAF compound in Dili, a cold storage room was added for seeds, so that they could be safeguarded in better conditions.
- **Soil laboratories**. The program supported the installation of two soil laboratories.
- **Seed laboratories**. In 2012 construction started on a small seed laboratory in the MAF compound in Dili to house the seed quality testing equipment which had been purchased the previous year. The seed laboratory was inaugurated by the Minister in May 2013. Two more seed laboratories were also constructed and/or equipped at Triloka in Baucau, and at the Betano research station.

Figure 24. The plaque of the National Seed Laboratory in Dili

- **Seed warehouses with equipment**. Seeds of Life supported MAF with the construction of seed warehouses and/or the installation of seed cleaning, processing and packaging equipment in six locations (Bobonaro, Liquiça, Manufahi, Baucau, Viqueque and Aileu). By the end of 2014, all these warehouses were operational and possessed essential equipment including silos (2,000 and 1,000 litres), air screen cleaners, rice and maize threshers, batch driers, sealers, compressors, generators and germinators.
- **Community seed houses**. This was an investment which had not been anticipated at the start of the program, but it made sense as part of the effort to establishing a functioning seed system, especially at municipal levels. Commercial Seed Producers were supported in the construction of community seed houses which function as seed storage locations and meeting places for the CSPs. About 40% of the cost of constructing the community seed house originated from the CSP, and about 60% from the program. The program's contribution was in the form of cement, reinforcement bars for concrete, metal sheet roofing, and some basic furniture (plastic chairs, a cupboard, etc). SoL provided such support to 65 of the 69 CSPs.
- **Means of transport**. The program purchased cars – single cab cars with an open back for transport – for municipal MAF offices to facilitate program implementation in the municipalities. The program also bought motorbikes for Suco Extension

Officers who did not yet have a motorbike, to support them in their extension service delivery to the sucos.

8.2.2 System development

"Towards a sustainable **national seed system** for Timor-Leste" was the subtitle on the Project Design Document for SoL3, and this has been an overarching goal of the program activities in the various components. Some elements of the seed system had already been started in the previous SoL phases – e.g. agronomic variety trials on-station, participatory variety selection with farmers, seed multiplication and distribution – but bringing it all together in a coherent and sustainable system only happened during SoL3. Learning from experiences elsewhere, and from Nepal in particular, the decision was made to build the national seed system in an organic manner. In this way, the seed system can grow and expand gradually, thereby leaving scope and flexibility for adjustments and corrections as concerns and problems are faced, rather than trying to build the seed system on the basis of a grand master plan.

The development of the seed policy in 2012-2013 was done in a very participatory manner, involving a broad range of stakeholders – at central ***and*** municipal levels – in the consultation and policy formulation process, an approach which many of the participants and observers characterised as exemplary, and which should become more the norm than remain the exception. The resulting seed policy was proposed to the Minister of Agriculture and Fisheries in March 2013, and endorsed by him. In the ensuing months and years, the institutions and processes envisaged in the national seed system were gradually put in place and started to operate.

Since the endorsement of the seed policy in March 2013, MAF has experienced a change in leadership and a reorganization. The impact of these changes, and more clarity on rules and procedures for the effective functioning of the seed system, could easily be incorporated into a revision of the seed policy which is on the point of being submitted to the Council of Ministers. This proves the point that, for the benefit of the national seed system, it is more advantageous not to formalize the system too quickly in legal enactments, but rather to wait with such steps until a time when the institutions and procedures have already proven their value and relevance.

A second system to be mentioned is the approach developed for **agronomy research** in Timor-Leste. The different steps in the approach – i.e. identification of promising varieties through searches, and sourcing genetic material from abroad; on-station testing followed by participatory on-farm testing – have been described in some detail in previous sections of the report. This approach will be continued by MAF's National Directorate for Research, Statistics and Geographical Information.

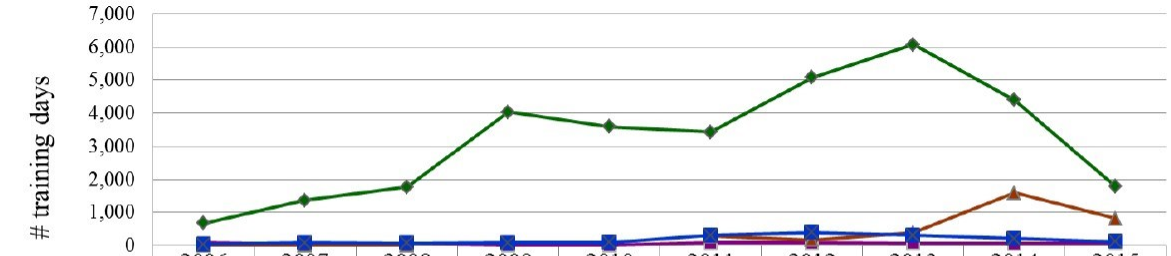
The system of **seed quality control** has also been firmly established in MAF's Department of Seed Production and Seed Certification in the National Directorate for Agriculture, Horticulture and Extension. The Seed Officers and Seed Analysts have received extensive training (at the Agricultural University Bogor in Indonesia and on-the-job in Timor-Leste), and have in turn provided training on harvest and post-harvest technology for maize to members of maize CSPs, Municipal Community Seed Production Coordinators and SEOs. Apart from sharing technical skills, these meetings also helped to build better relationships between the seed producers, extension staff and Seed Department staff.

There are two steps to quality assessment for seed certification. The first assessment is during the growing period and before seed processing. The second assessment is done after seed processing by taking seed samples for seed quality testing in a seed laboratory. Field assessments are done by field seed inspectors (which in Timor-Leste are Seed Officers assigned as field inspectors). Seed sampling is conducted by authorized Seed Officers and seed laboratory tests are done by a Seed Analyst. To increase the objectivity

in the quality assessment process, field inspections are performed by Seed Officers from other municipalities than the one where the seed is being grown, and seed samples are coded for testing in the laboratory, so that the origin of the seed is not known by the Seed Analyst.

8.2.3 Human resource development

Human resource development has been a major focus area for the Seeds of Life program, and, as indicated in section 7.2, the training and capacity building conducted between 2006 and 2015 reached more than 2,600 persons, consisting of farmers, MAF staff, NGO staff and SoL staff. The number of training days provided over that period by year is graphed in Figure 25.



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
MAF Staff	673	1369	1767	4029	3593	3433	5078	6066	4394	1777
NGO Staff	85	30	52	8	5	78	81	65	51	68
Farmers	3	6	6			282	167	389	1597	815
SoL Staff	37	83	65	86	95	307	399	309	207	126

Figure 25. Number of training days provided by SoL by year

The impact of such training and capacity building will differ from person to person. Most of the training was conducted in-country, and much of it was rather informal in nature. Some of the informal training, like cross-visits between farmer groups, has been captured in the records of the training database, but other events – like the on-going mentoring and impromptu one-on-one on-the-job training – was not recorded but therefore no less effective.

It is believed that some of the most lasting and profound impact of human resource development for the national seed system will come from the Timorese program staff who completed masters degrees. As of June 2016, key coordinator positions in agricultural research, seed production and quality control, and overall seed system management are held by master graduates, and they help to provide continuity to the post-SoL period.

8.3 Community impacts – now and in 5 years

8.3.1 Economic impacts

The spread of improved varieties has undoubtedly had an economic impact, and will continue to do so for many years. Based on the MAF-published production figures for foodcrops in Timor-Leste in 2015, and the improved variety adoption rates of the 2014 survey, it was estimated that the **value of the seed and food produced by the improved varieties** in 2015 was more than US $ six million. The value of additional agricultural production due to the use of seeds of improved varieties consists of two parts:

- The value of the **seeds of improved varieties** grown in 2015**.** This is estimated to be US $ 695,101. It consists of $ 247,850 rice seed, $ 401,495 of maize seed, and $ 45,756 of peanut seed. The value of the seed grown by contract growers was $ 46,418; CSPs grew $ 457,482; and the contribution of the CSPGs was $ 191,201.

- The value of the **additional production obtained by farmers growing crops with the seeds and cuttings of improved varieties.** In 2015 this was estimated to be:

1)	7,399 ton of maize, with a value of	$	3,329,378
2)	1,633 ton of rice, with a value of	$	571,588
3)	583 ton of peanut, with a value of	$	583,136
4)	1,242 ton of cassava, with a value of	$	62,087
5)	5,789 ton of sweet potato, with a value of	$	868,341
	Sub-total	$	5,414,530

In early 2016 a **financial and economic analysis** of the Seeds of Life program was conducted which investigated what benefits could be generated for Timorese farmers over the next 20 years, and how this could affect the production of food in the country. The study found that the economic internal rate of return (EIRR) was at least 13%. Sensitivity analysis indicated that higher adoption rates of improved varieties, increases of farm-gate prices for foodcrops, and increases in crop yields could substantially increase the EIRR. On the other hand, a further reduction in the number of farming households compared to 2010, reduction in cropped areas of maize and rice, and stagnation or decline in the adoption rate of improved varieties or crop yields would reduce the EIRR. As for incremental staple food production, it was estimated that for the country this could increase from 14,980 Mt to 19,220 Mt over a period of 10 years.

The Seeds of Life program has also assisted with the **incubation of a private seed industry** in Timor-Leste. Before 2012, there was no private seed industry to speak of. There certainly were occasional seed sales by individual farmers, and in the markets foodgrain was sold as seed, as well as overseas seed of unknown quality, but none of this was very organized. With the emergence of Commercial Seed Producers, of which the seeds are quality checked by MAF's Seed Department, and with the formation of associations of seed producers (Anaprofiko) and agricultural shops (Ansa), the initial steps towards the establishment of a private seed industry have been taken.

The Government of Timor-Leste makes substantial savings by **purchasing locally grown seed instead of importing seed**. In 2015, locally grown maize and rice seed was bought at US $ 2.50 per kg, whereas the cost of imported seed was at least $ US 3.50. MAF contracted private companies to purchase in-country and distribute to the municipalities 100 Mt of maize seed and 100 Mt of rice seed. For peanut, there was no need for seed import; 20 Mt could be bought locally at US $ 3 per kg.

In section 7.5 the **savings and loans groups linked to CSPs** have already been mentioned. These groups are important sources of funding for the group members. One study done by the program was on the impact of the S&L activities of the first two S&L groups linked to CSPs. S&L group members were visited a first time in the middle of their first year of S&L operations, and then again a year later. Even over this short span, the S&L groups showed remarkable results, with positive trends for the involved households for: food sufficiency, investment, housing, ability to send their children to the school, and for dealing with emergencies. The study found that the most common use of the loans was to pay for education fees, followed by small-scale trading, and improving the house or buying assets for the household. Such borrowing schemes clearly fulfil a need for access to finance in rural areas, and there was keen interest from others to join the S&L groups.

SoL's involvement in **aflatoxin research and testing** has also had a positive economic impact. Thanks to new research by SoL and Sydney University, the local company "Timor Global" is showing interest to buy maize from local farmers to produce food products. A new aflatoxin quick test will ensure that only grain that is safe to eat is purchased and turned into food products. Since 2010 Timor Global has been importing maize to produce

"Timor Vita" at their factory in Railaco. Timor Vita is then distributed throughout the country to children and pregnant women, to assure good nutrition. It is based on maize and soybean, with additives to make it a fully nutritious meal.

Imported grain came with an assurance that it was free of aflatoxin, but no such guarantee could be given for local grain. To ensure that Timor Global can purchase grains from local farmers that are free of aflatoxin, they needed a rapid and affordable method to test the grains at the point of purchase. This is now possible with the introduction of the new "Aflatoxin Quick Test". Seeds of Life and Sydney University have demonstrated that the quick test accurately measures aflatoxin in maize and peanut sampled in Timor-Leste. Samples collected throughout Timor over three years were measured using the quick test and the standard HPLC method. This research has shown that about one in 15 samples of maize has more than 20 parts per billion of aflatoxin, the maximum safe level for consumption.

Figure 26. Mr. Francisco Sanchez-Bayo from Sydney University demonstrates the Aflatoxin Quick Test with the Minister of Agriculture and Fisheries to farmers at Fahilebo, June 2016

The Aflatoxin Quick Test produces results in 30 minutes and can be conducted in very simple laboratories. It is also as accurate as the longer chemical method that uses HPLC. The demonstration in Fahilebo on 27 June 2016 was done at the community seed house of CSP Naroman. In 2015 Naroman produced about 20 Mt of quality seed. As seed is selected for large size before sale, they have had significant quantities of grain that was not large enough to be sold as seed. Such grain they can easily sell to Timor Global.

8.3.2 Social impacts

Growing foodcrops with improved varieties seed has an impact for the households that do so. One of the questions to farmers in the 2016 end-of-program survey was to what extent the household had **experienced hunger** in the 12 months prior to the interview.

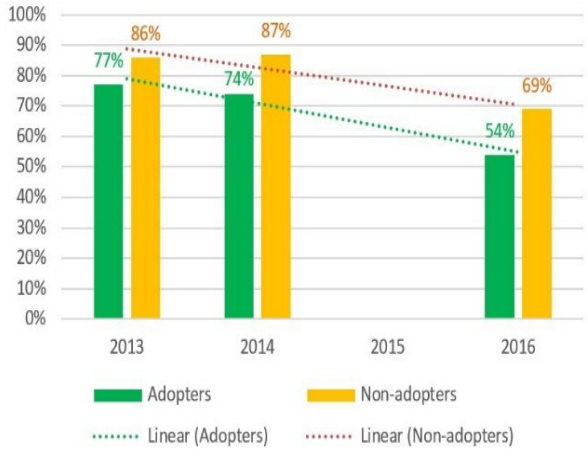


Figure 27. Evolution of the proportion of adopting and non-adopting households who experienced hunger

In the 2013 survey, 82% of the respondents stated that they had experienced hunger during that 12-month period; in the 2016 survey, this figure had dropped to 65%.

When differentiated between households that had been growing improved varieties since 2014-2015 or before, and household which had just planted improved varieties for the first time, or not yet, the percentages were 54% for the longer-term adopters versus 69% for those growing it for the first time or not yet. Figure **27** shows what the percentages were for experiencing hunger of adopting and non-adopting households in the surveys of 2013, 2014 and 2016.

Growing improved varieties also seems to **improve food self-sufficiency**. In 2015, households were able to eat their own foodcrops for longer periods than in previous years.

Also, households who grew an improved variety of maize for more than a year were able to eat their own maize for 8.3 months on average vs. 7.6 months only among other households. Similarly, improved variety adopters bought less rice in 2015 than non-adopters: on average 371 kg of rice for adopters vs. 396 kg for non-adopters. Long-term adopters also had a smaller average reduced Coping Strategy Index (4.9) than that of other households (5.4), which means that adopters had to rely less on coping strategies during the hungry season compared to other households.

Longer-term adopters could also more often **earn money from selling foodcrops** compared to other households: 56% vs. 43% among other households. This is probably due to the higher productivity of the improved varieties. For example, most of the farmers growing improved maize varieties, and who sold part of their maize harvest in 2015, said they purposely chose to sell harvest coming from the improved varieties. The perception that growing improved varieties has made them better off was also shared by the adopting households themselves; a significantly higher proportion of long-term adopters believe they are better off now than five years ago: 51% vs. 40% among other households. Part of this improved situation is certainly the result of growing the improved varieties.

Several of the SoL activities have also had a **gender impact**. Women participation in both CSPGs and CSPs is quite high (30% or more of membership), and they are also well represented in the positions of either Leader, Secretary and Treasury of such groups (81% of the CSPs had a woman Treasurer). Also in the S&L groups do women play an important role, both in taking out loans, and in the management of such groups.

One of the initiatives taken by SoL was to provide maize growing groups – both CSPGs and CSPs – with **labour saving devices** such as screens, shellers and grinders. Farmer groups that grow maize seed and have good results have lots of maize to handle after the harvest, and post-harvest activities are traditionally very often handled by women. To reduce the post-harvest workload, Seeds of Life provided labour saving devices to the farmer groups. A study was made in 2015 to assess whether and how the introduction of these devices had an impact on the gender division of tasks within the groups.

The study showed that the gender division of labour was very much balanced between men and women members. Grading cobs and shelling are activities where women seem to be slightly more involved than men, as women are considered more thorough in performing these tasks. Tools such as shellers and screens help to reduce the workload of women within groups. Overall, both men and women respondents were very satisfied with the tools as they help to save time, the tools are easy to use, and they give good results. If anything, the groups wanted to have more of these tools.

8.3.3 Environmental impacts

One of the assessments conducted in the last year of the program was to **evaluate the impact of the program on the agricultural environment** in Timor-Leste. The study found that the main environmental impact has been the introduction and distribution of improved germplasm of five food crop varieties to the existing local seed pools. All farmers interviewed reported that the crop types and varieties released by MAF were well-suited to the Timor agricultural environment, and no environmental impacts were observed from unintentional weed or pest distribution across seed networks. No use of agricultural chemicals was advised by SoL in research or seed production activities. Infrastructure developments by the SoL program were minimal. Minor earthworks and groundwater usage on research stations were observed to be implemented and maintained in environmentally friendly manners.

Linked to the agricultural research, there have also been studies on the **impact of climate change and crop modelling**, to assess the influence of certain parameters on crops. The crop modelling program, Agriculture Production Simulation (APSIM), allows investigation into the development and yield of maize in Timor-Leste. A maize variety was developed in

APSIM to match the growth duration of LYDMR (CYMMIT, India) researched and released in Timor-Leste under the name “Sele”. Simulations were run with weather data from nine locations for one cropping season and compared with the observed growth duration of approximately 100 trials close to the weather station locations.

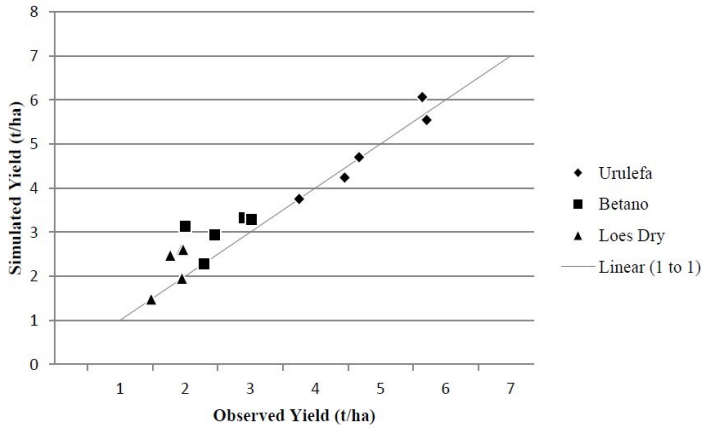


Figure 28. Maize yield in the APSIM model compared to observed maize yield

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

Soil Organic Matter in the simulation was calibrated using the 0 kg of N trial so that the yield of the simulation matched the observed yield in the field. The increased N rates were then applied to the model and compared with field results (Figure 28)

8.4 Communication and dissemination activities

The program’s communication and dissemination activities have already been described in detail before.

The SoL communications team also did a **study comparing 20 communication channels** used to raise awareness of new cultivars among farming households in Timor-Leste. The channels were evaluated on: value for money, reach, impact to change behaviour and overall effectiveness. Channels found to be highly effective in terms of reaching rural communities and raising awareness, and affordable, were: a community magazine which was distributed through schools to some 80,000 households in Timor-Leste, cinema sponsorship and mass media. Other effective channels were interpersonal channels (Suco Extension Officers and word of mouth) as those involved are highly trusted and valued, rendering them influential. What seemed to work less well were: promotional items, Printed materials (banners, booklets, brochures and seed labels), community theatre and mobile phone animation

9 Conclusions and recommendations

9.1 Conclusions

The Seeds of Life program, in collaboration with the Ministry of Agriculture and Fisheries and other development partners, achieved significant progress in the establishment of a national seed system for Timor-Leste, as well as significant advances in research and capacity building, which resulted in a positive impact for Timorese foodcrop farmers.

The research and development activities which the program undertook were **relevant** for the problems that Timor-Leste faced. The yields of foodcrops in Timor-Leste was substantially lower than that in neighbouring countries, and although some progress has been made in improving yields, the gap between average yields in Timor-Leste and the neighbouring countries is still large. Food insecurity and malnutrition is still high, and tackling these is a high priority for the government of Timor-Leste.

The program was largely focused on achieving good quality of implementation in research, certified seed production and quality control, and seed multiplication and dissemination, but it also realised that these activities had to be encapsulated in a coherent seed policy that matched Timor-Leste's management and financing capabilities.

The program was largely **effective** in reaching its intended output and objective. As a result of the program activities, and of other activities from the government and development partners in support of agriculture, basically half of all Timorese foodcrop farmers currently grow one or more improved varieties. This enables farmers to grow more food, which makes them less likely to suffer hunger, or to suffer it less severely. Farmers who grow improved varieties are also often able to earn more money from the sale of surplus crops.

The program was well designed, but there was also enough built-in flexibility in the design. A high level of trust and independence was granted to the SoL team, to assess the relevance of the planned outputs and activities, and to make changes to these in light of the evolving conditions and emerging opportunities. This flexibility and trust allowed the team to reduce the scope, or altogether drop, some activities which had become less relevant than anticipated during program design, and to expand the scope of other activities, or even initiate unplanned ones, which held good promise to contribute significantly to the overall program objective.

The national seed system that has been developed so far holds good promise to be **sustainable**, and the adjustments made to the program design during implementation – such as reducing the amount of certified seed produced, and a shift towards more commercial and community seed production – have improved the prospects of sustainability. The savings which Timor-Leste makes by no longer having to import seed of common foodcrops, or only importing them in much smaller quantity, are more than enough to cover the operation of a national seed system, at central and municipal levels.

A seed system does however not operate on its own; it depends on having skilled and trained people in place in various positions to make the different sub-systems of the national seed system work effectively, and steps have to be taken to train other people in what is needed to operate the system, to be able to deal with inevitable changes in personnel. The smooth functioning of the seed system also depends on having financial systems in place which allow to have resources available in sufficient amount and in time to implement the necessary activities.

9.2 Recommendations

The Ministry of Agriculture and Fisheries is well equipped to continue to build and expand the national seed system. A clear identification of the roles and responsibilities of the key actors, and the key actions that have to be taken throughout the annual cycle for both certified seed and commercial seed production and supervision, will contribute to a better management of the national seed system.

The ACIAR and DFAT funded programs which follow on the SoL program have few resources allocated to support the operation of the national seed system. A small allocation of separate DFAT resources for occasional advisory inputs may well prove useful to safeguard the investments made over the years into the seed system.

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10.2 List of publications produced by the program

The Seeds of Life program has an impressive list of publications of various types. These are listed below under the categories: journal papers, program reports and conference presentations. In each of these categories, the publications are listed by year. Not included in this list are SoL3-related publications in local and international media.

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Conference presentations

2011

Soares F. A., da Costa J. B., Pereira L. C. R., de Fatima A. and Williams R. L. 2011. *Varidade ba batar balu, bele hetan produsaun aas, ho bele tahan ba fuhuk.* 'Knowledge, Attitudes and Skills for Timor-Leste's Development: an Opportunity for Dialogue', 4 July 2011

Vidal M. C. and Williams R. L., 2011. *Lehe bele hasae produsaun batar iha Timor-Leste.* 'Knowledge, Attitudes and Skills for Timor-Leste's Development: an Opportunity for Dialogue', 4 July 2011

Fernandes L., Pereira L., Moises A. and Williams R. L. 2011. *Hili varidade ai horis trigu (titboa ho asinata) nian nebee resultadu diak hamutuk toos nain sira.* 'Knowledge, Attitudes and Skills for Timor-Leste's Development: an Opportunity for Dialogue', 4 July 2011

2012

Lopes M. and Nesbitt H. 2012. Improving food security in East Timor with higher yielding crop varieties. Paper presented at the Australian Agricultural and Resource Economics

Society Mini Symposium “Food security in the South Pacific, PNG and East Timor”, Fremantle, Western Australia, Australia, 8-10 February, 2012

International Maize Conference, Gorontalo, Sulawesi, Indonesia, November 22-24, 2012

- Pereira L. C. R. 2012. Maize in Timor-Leste: A Summary. Poster
- Williams R., Aguilar L. and Correia M. 2012. Maize and Velvet Bean Systems in Timor-Leste. Paper
- Kunwar B., Marcal J., Gama F., Amaral R., Setiawan A., Dalton J. 2012. Timor-Leste’s efforts to achieve maize seed security using ‘community seed production’. Paper

2013

Timor-Leste Study Association conference, Dili, 15-16 July, 2013

- Pereira I. S., Neto F, M., Mau R., Bacon S. A. and Williams R. 2013. *Oinsa Lalaok Mudansa Klimatika Hahu Husi Tempo Portuguesa To’o agora?* [How the climate has changed from Portuguese time to now?]
- Moises A., Fernandes L., do Rego A., de Fátima A., Vicente T. M. and Ximenes A. 2013. *Koto Nani Afrika Hetan Produsaun Aas Iha Timor Leste*. [Climbing beans from Africa produce a good yield in Timor Leste.]
- Maia J. dJ., Brito D. and Williams R. 2013. *Konserva aihoris leguminosa iha timor leste* [Conserving legumes in Timor-Leste.]
- Da Cunha R., Martins C., Vicente T. M. and Lopes E. H. 2013. *Ho hare varidades Introdus sei aumenta Aihan iha Railaran*. [Introduced rice varieties can increase food production in Timor-Leste.]
- Freygen J. dC. R. 2013. *Duhaen Nudar Fore Ida Riko Ho Nutrisaun*. [Wing beans, a wild and cultivated food good for nutrition.]
- Freygen J. dC. R., Belo J. B. C., Vidal M. C. and de Fatima A. 2013. *Aifarina varidade foun nia produsaun a’as no sabour diak iha Timor Leste*. [New cassava varieties for Timor-Leste have a good production and taste.]
- Soares F. A., Pereira L. C. R., Belo J. B., Brito D. R. and Moises A. 2013. *Fehuk introdusaun haforte seguranca aihan Timor-Leste*. [Introduced Sweet potatoes increase food security.]
- Pereira L. C. R., Soares F. A., Moises A., da Cunha R., Brito D. R. and Williams R. 2013. *Varidade Batar Mutin Sai prekupasaun ba To’os Nain iha Timor- Leste.* [Looking for a white maize variety for Timor-Leste.]
- Vicente T. M. and Lopes E. H. 2013. *Efeitu tempu muda Viveros no quantidade Bele Hasae Produsaun Hare*. [Effect of planting time and seedling age on rice yield.]
- Vidal M. C., Freygen J. dC. R. and Williams R. 2013. *Variasaun Fore Munggu hodi hadia Moris Toos nain no hamenus mal nutrisaun iha Timor-Leste*. [Mung bean varieties can increase food production and reduce malnutrition in Timor-Leste.]
- Pereira I. S. 2013. *Efeitu Adaptasaun Variedade Fehuk Ropa iha Tempu Udan no Tempu Bailoro*. [Adaptation of potatoes to wet and dry season in Timor-Leste.]
- Martins M., de Jesus S., Ximenes A., do Rego A. P., Ximenes A. dC., Pereira I. S., Tavares M., Mauleto L., Fernandes L., Patrocinio L. dC. and da Costa J. F. 2013. *Batar Noi Mutin produsaun a’as no k’or mutin*. [White maize variety Noi Mutin has increased yield.]
- Bacon S., Neto F. M., Pereira I. S. and Robert Williams R. 2013. The impact of the El Niño Southern Oscillation on Rainfall Variability in Timor-Leste.

2015

Bacon S., Neto F. M. and Gonçalves J. Q. A. 2015. Developing meteorological data systems for agricultural applications in Timor-Leste. Paper presented at the TropAg2015 Conference “Meeting the Productivity Challenge in the Tropics”, Brisbane, Australia, 16-18 November 2015

2016

21 presentations were made at the Food Security in Timor-Leste through food production conference sponsored by the Seeds of Life program in April 2016. These are reported in Nesbitt H., Erskine W., da Cruz C.J. and Moorhead A. (eds) 2016. Food security in Timor-Leste through crop production. Proceedings of TimorAg2016, an international conference held in Dili, Timor-Leste, 13–15 April 2016. ACIAR Proceedings No. 146. Australian Centre for International Agricultural Research: Canberra. 187 pp.