



Seeds of Life

Fini ba Moris



Environmental Impact Assessment Report

Seeds of Life



September 2015



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Seeds of Life

for

Timor-Leste Ministry of Agriculture and Fisheries

Seeds of Life/Fini ba Moris

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Acronyms

ABD	Agro Bio Diversity
ANO	Assosiasaun Natarbora Oan
CA	Conservation Agriculture
CGIAR	Consultative Group for International Agricultural Research
CIAT	International Centre for Tropical Agriculture
CSP	Certified Seed Producer
CSPGs	Community Seed Production Groups
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organization
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
IFAD	International Fund for Agricultural Development
MAF	Ministry of Agriculture and Forestry
MTS	Mid Term Survey
NGO	Non-Government Organisation
OFDT	On-Farm Demonstration Trial
PDD	Program Design Document
SOL	Seeds of Life

Abstract

The purpose of the assessment was to review Seeds Of Life (SOL) Phase III activities with regard to environmental impacts. The review included:

1. Discussion with farmers, Ministry of Agriculture and Forestry (MAF) extension workers, Non-Government Organisations (NGO), MAF directors, and MAF/SOL personnel regarding the outputs of research, seed multiplication and extension programs.
2. Examination of the varieties released by the program and determination of whether unsuitable food crop varieties were introduced and distributed in Timor Leste.
3. Determination of whether plant genetic diversity has diminished or increased as a result of SOL activities and if so, to what extent.
4. Assessment of whether there has been any overuse of agricultural chemicals as a result of SOL program activities and recommendations.
5. Assessment of whether SOL program activities or recommendations have led to land degradation.
6. Visits to major SOL infrastructure sites to determine whether there has been any resulting environmental degradation.

Interviews were held with seed production groups, OFDT (On-Farm Demonstration Trial) farmers, MAF research and extension staff, research station and seed storage centre staff, SOL advisors, MAF directors and selected NGO partners (see List of interviews). Every SOL/MAF research centre was visited and inspected. A number of seed storage facilities were also inspected.

The main environmental impact of the SOL program has been introduction, formal launch and distribution of improved germplasm of five food crop varieties to the existing local seed pools; maize, sweet potato, cassava, rice and peanuts. All farmers interviewed reported that the crop types and varieties released by SOL were well-suited to the Timor agricultural environment.

SOL/MAF seed distribution systems ensure good quality, pure seed is distributed across Timor Leste. No environmental impacts were observed from unintentional weed or pest distribution across seed networks. Seed production and distribution activities were supported by the MAF National Seed Systems policy, and evidence of quality control systems were observed in the field and supported by documentary evidence within MAF and SOL. Some risk exists for pest-infected vegetative propagation material to be spread between SOL/MAF research stations, due to field staff (permanent labour) cutting propagation material for replicated trials whilst not being fully aware of protocols for seed selection. However, research staff and research assistants were knowledgeable on the importance of selecting clean samples.

While SOL has positively increased biodiversity through introduction of staple food crops and further improved germplasm of a number of non-staple food crop species, some loss of local plant germplasm has resulted from variety release and seed production activities (in this case 'local' seed refers to any seed planted and maintained by farmers within Timor Leste and given a local Timorese name). High

adoption rates of the new varieties, coupled with free distribution of released variety seed, has indirectly resulted in reduction of 'local' seed planting areas. In particular, NGO partners expressed concern for the lack of preservation of traditional maize and rice varieties which have been replaced by the improved varieties. Various attempts by SOL to encourage local germplasm preservation have been unsuccessful, and little interest in collection has been expressed from international seed centres due to the limited pool of valuable germplasm available in Timor Leste.

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.

Introduction

Due to SOL Phase III finishing in 2016 an Environmental Impact Study (EIA) was contracted to evaluate the impact of the SOL program on the agricultural environment in Timor Leste. The evaluation involved research activities, seed varieties released, genetic diversity, chemical use, land degradation and infrastructure development.

Methodology

Interviews were held with seed production groups (11), OFDT farmers (14) and MAF research and extension staff (15) across nine districts as well as with research station and seed storage centre staff (16), SOL advisors and coordinators (12), and MAF directors/department managers (4). Every SOL/MAF research centre was visited and inspected. A representative number of seed storage facilities were inspected (6). Key program staff from three NGOs were also interviewed. Anecdotal information was collected from farmers, with anecdotal and empirical data collected from MAF staff, NGOs and SOL advisors.

Findings

Outputs of research, seed multiplication and extension programs

OFDT farmers interviewed did not report any negative environmental impacts from SOL activities. It was observed that SOL's philosophy of participatory research and acknowledgement of traditional farming practices resulted in minimal interruption to traditional land use by the SOL program. MAF extension staff confirmed that seed distributed for participatory research was of high quality. No pests, diseases or weed seeds were observed within the distributed research seed by any farmers or MAF staff. OFDT farmers also confirmed that no use of inorganic fertilisers or pesticides had been recommended by SOL. 100% of farmers planting SOL/MAF varieties reported that existing agricultural land was used for research purposes; no land was cleared for participatory research activities, and land use was not changed as a result of extension service activity or advice.

SOL has worked with MAF for seed production via Certified Seed Producers (CSP) with support from the SOL-developed National Seed System¹ (NSS), hence reducing potential negative environmental impacts from seed distribution through improper channels. SOL has been instrumental in assisting MAF to establish a National Seed Council (NSC) and a National Seed Policy, and has been a key stakeholder for supporting national seed planning and development². Within the seed production groups interviewed, 10/11 group leaders reported that high quality, labelled and certified seed was provided for seed

¹8th SOL 3 program Steering Committee Meeting Minutes, 13/7/2015, Dili.

² Invitation to the Inaugural Meeting of the National Seed Council, Sr Lourenco Borges Fontes, 31/7/2014.

multiplication. In one case reduced quality seed with poor germination was reported by the Lakabasi Seed Producers in Bobonaro (Cailaco)³. This particular seed was replaced by SOL.

Fernando Soares, Head of MAF Seed Department, provided copies of seed quality control certificates and demonstrated how seed was tested for quality to ensure it was weed seed free, pest and disease free, and of suitable quality for distribution throughout Timor Leste⁴. Further evidence of quality control in SOL/MAF seed production activities was observed in the National Seed System document⁵ which described activity of district seed officers, regional seed inspection laboratories (Betano and Triloka), and registration processes surrounding community and commercial seed production. During interviews, the majority of seed production groups commented that seed quality control officers inspected their crops on multiple occasions to provide advice and guidance on quality seed production, such as rogueing and weed control. Seed sampling was passively observed in the field, as was seed testing in the MAF seed laboratory in Dili.

NGO staff interviewed (GIZ, FAO, Hivos) confirmed that SOL positively supported and involved SOL/MAF field staff in land-care and Conservation Agriculture (CA) extension activities.

Some risk was observed for pest-infected vegetative propagation material to be spread between SOL/MAF research stations, due to permanent labour staff cutting propagation material for replicated trials. Permanent labourers were not fully aware of protocols for seed selection, as evidenced by demonstration of pest-infected cassava planting material at Betano Research Station. Research staff and research assistants however were knowledgeable on the proper process, and importance of selecting clean samples.

³ Lakabasi Seed Production Group, Cailaco, Maliana, 12/8/15.

⁴ Personal communication, MAF seed laboratory staff, Dili, 10/8/15.

⁵ MAF National Seed System for Released Varieties, SOL, July 2014.

Suitability of food crop varieties introduced and distributed in Timor Leste

The National Seed System for Released Varieties publication⁶ confirms that SOL/MAF released varieties were tested for a minimum of five years for adaptation and suitability on research stations, and tested further through a minimum of 500 OFDTs before formal launch, seed multiplication and distribution activities. MAF Director General Lourenco Borges confirmed that the released varieties were preceded by five years of adaptation research to ensure their suitability, and confirmed that MAF supported their official release and distribution⁷.

All farmers interviewed reported that the five main crop types introduced by the SOL program were relevant to their ecosystem and farming practices. SOL Annual Research Reports (2006-2014) demonstrate that multiple year and multiple location research station activity was followed by OFDT research across nine districts of Timor Leste; evidence to support that released varieties were adapted to the majority of ecosystems in which they were tested; upland, lowland, dryland and paddy production systems.

Quality of introduced seed

In all cases of imported germplasm for released varieties, Import Certificates, Material Transfer Agreements and Phyto-Sanitary documents accompanied seed. Ameriku Britas, Head of the MAF Plant Protection unit and previously a MAF quarantine officer, confirmed that from the beginning of SOL the correct channels of seed importation had been followed. Ameriku had not observed any incidence of SOL-imported seed bringing pest or disease into Timor Leste⁸.

The National Seed System for Released Varieties publication⁹ confirmed that no genetically modified seed has been brought into Timor Leste by SOL, and all maize seed introduced was OP (open pollinated, non-hybrid). Non-GMO certification documentation was sighted for Climbing Beans, Rice, Sweet Potato, Winged Beans, Maize, and Cassava¹⁰.

Fernando Soares, Head of MAF Seed Department¹¹, demonstrated SOL/MAF seed quality control systems with an example of rice imported from Surabaya. Seed quality parameters from the accompanying foundation seed certificate (purity, moisture, germination, contamination) were checked for trueness in the laboratory. Fernando further described the intensive field monitoring of new germplasm via pre-plant site inspection, followed by four crop inspections to confirm the variety was pure (off-types reportedly occurred in rice and were rogued), and matched its's biotype, flowering habit, and characteristics.

⁶ MAF National Seed System for Released Varieties, SOL, July 2014.

⁷ Personal Communication, IFAD, Dili, 14/8/15.

⁸ Personal Communication, Dili, Plant Protection Unit, MAF, 17/8/15.

⁹ MAF National Seed System for Released Varieties, SOL, July 2014.

¹⁰ SOL Germplasm Import Database, Dili, 17/8/15.

¹¹ Personal Communication, MAF Seed laboratory staff, 10/8/15.

Further discussions with the SOL/MAF Seed Quality Control Co-ordinators¹² provided several examples of where locally produced foundation, breeding, commercial and certified seed were 'blocked' (prevented from distribution) due to improper quality, thus demonstrating quality control of distributed seed. Approximately 2.3 tonnes of rice from a Waiteque Venilale seed producer was rejected due to poor purity and germination in 2014. A further 4 tonnes of certified maize seed was rejected in Loskoni, Manufahe in 2014 due to poor quality (germination) and another 7 tonnes of rice seed in Leotela, Liquica in 2014, due to pest infestation and impurity.

Plant genetic diversity

Since program initiation and through to 2015, the main purpose of the SOL/MAF program was to introduce and test new genetic stocks of food staples on research stations¹³. Germplasm of 11 plant types have been introduced to Timor by the SOL/MAF program for testing. Five food crop species have been officially released and distributed; Maize (3 varieties), Rice (1 variety), Peanut (1 variety), Sweet Potato (3 varieties) and Cassava (3 varieties). Other species introduced by SOL, with most currently in the pre-release research phase, include; European Potatoes, Mung Beans, Wheat, Climbing Beans, Barley, Velvet Beans, and Winged Beans.

Non-staple foods and cover crops introduced

The Mid Term Survey (MTS) showed that only 33% of respondents interviewed by SOL in 2013 reported planting non-staple foods. SOL is currently in the process of increasing biodiversity via introduction of a number of non-staple food crops which are currently being researched in replicated research station trials and OFDT farmer plots.

Legumes:

Winged Beans, *Psophocarpus tetragonolobus*, exist in eastern Timor Leste as both a wild and cultivated food legume. A Winged Bean research program was implemented by SOL/MAF in 2012; 12 varieties were introduced from the Australian Tropical Crop and Forages Collection¹⁴ along with two local varieties from Los Palos and Baucau. Three varieties were further selected and distributed for OFDT adaptation trials in seven districts in 2014 (Baucau, Viqueque, Aileu, Ainaro, Liquica, Maliana and Manufahe)¹⁵.

Climbing Bean (*Phaseolus vulgaris*) research has also been implemented by SOL since 2011. 50 varieties were imported in 2011 and exist presently in research station trials in elevated research sites (800+

¹² FAM meeting, Dili, 14/8/15.

¹³ Seeds of Life Phase III Program Design Document, 2010.

¹⁴ 2013 Annual Research Report.

¹⁵ Winged Beans, SOL report draft, Maria Martins, June 2015.

MASL). Mungbean (*Vigna radiata*) research has also advanced to OFDT phase in 2013 in Viqueque, Bobonaro and Aileu, with 25 trials conducted in 2014¹⁶.

Temperate crops:

Wheat, *Triticum spp*, is anecdotally a traditional food source in the mountainous areas of Timor Leste however local germplasm has been lost. SOL research at the Urulefa High Altitude Research Centre in Maubisse involved introduction of 30 varieties of wheat, commencing research in 2009, however trials have been limited in area and seed bulk-up material has also been limited. Consequently wheat research has not yet evolved into the OFDT phase.

Cover crops:

SOL has facilitated seed production of the traditional cover crop and wild food, Velvet Bean (*Mucuna spp*), to at least 5 districts. Approximately 1.3 tonnes of Velvet Bean seed was purchased from seed production groups in Maliana and Los Palos in 2014 for distribution to seed producers, NGOs (FAO, Care) and OFDT farmers. 1kg packets of Velvet Bean seeds were provided to approximately 600 CSPGs across Timor in 2014¹⁷, with 10kg sacks of Velvet Bean seed distributed to a number of CSPs. Interviews with FAO Dili, confirmed that SOL provided approximately 200kgs of Velvet Bean from the Betano Research Station to support FAO CA groups in Manufahe, Manatuto, Baucau and Ermera (between 200g to 5kgs of seed were distributed to farming groups for soil fertility improvement)¹⁸.

Some incidence of Velvet Bean mulch attracting insects was reported by FAO at a Manufahe Velvet Bean research site, however good management (time of planting and breaks between maize and Velvet Bean plantings) was observed to eliminate the environmental risk of insect transfer to maize crops. Velvet Beans were also reported to harbour snakes and rats^{19,20}. However, while it is an aggressive climber and cover crop, the palatability of Velvet Bean fodder for ruminant species means that the crop has minimal potential to become a problematic species; a cover crop harbouring pest species could be rapidly controlled using animal grazing.

Perennial species:

Moringa tree species contain nutritious foliage and are used as a traditional food source in Timor Leste. SOL purchased local seed from an Atauro Women's working group in 2014 and distributed approximately 5000 packets, each containing 20 seeds, to CSPGs in Lautem, Oecuesse and Aileu. Another 1000 seed packets were provided to Wild Timor Coffee Co. for distribution in Aileu and Ermera²¹.

¹⁶ 2014 SOL Annual Research Report.

¹⁷ Buddhi Kunwar, FAM Meeting, Dili, 14/8/15.

¹⁸ Personal Communication, FAO Dili, Claudino Ninas Nabais, 14/8/15.

¹⁹ Personal Communication, Atas, Maliana, Anjelino Nunes, 12/8/15.

²⁰ Personal Communication, Natarbora, Manatuto, ANO seed production Group, 5/8/15.

²¹ FAM meeting, Dili, 14/8/15.

Reduction in local variety germplasm

The SOL MTS showed farming household adoption of at least one MAF/SOL released variety had increased nationally from 18% to 25% between 2011 and 2013²², and up to 33% in 2014²³, with maize having the highest adoption rate of released crop types. Of those farmers adopting released maize varieties in 2013, 90% of crop area was planted to the new variety. In comparison, rice had only 43% of the rice cropping area planted to new varieties. The maize crop type showed the highest adoption rate of all introduced varieties in the SOL Mid Term Survey (MTS) and 2014 Adoption Survey, hence the greatest risk for loss of local varieties occurs within maize (99% of farmers interviewed in 2014 planted maize, indicating it to be the main staple crop, followed by cassava and sweet potato).

FAO and GIZ key staff commented that their personal observations over the last three years indicated a reduction in planting and maintenance of local seed varieties, primarily in maize and secondly in rice. Claudino Nabais (FAO) expressed concerns that if local varieties are not planted during a period of three years, germplasm could be permanently lost²⁴. GIZ Team Leader for Agro Biodiversity, Beate Quilitzsch-Schuchmann also expressed concerns for lack of *in situ* cultivation of culturally important local varieties. Beate also provided documentation and mapping data to show that in 25 GIZ pilot biodiversity groups across 5 districts, all groups surveyed had stored seed of both introduced and local varieties²⁵.

From September 2013 to August 2014, a total of 37.7 tonnes of clean maize seed (Sele and Noi Mutin), and 21.3 tonnes of rice seed (Nakroma) was distributed to Timorese farmers by the SOL/MAF program for research and seed multiplication activities²⁶. This represents the potential replacement of 'local' varieties over an area of approximately 1900 ha of maize, and 1000 ha of rice.

Seed production activities were also observed to reduce the amount of local seed germplasm maintained by farmers. ANO seed production group in Natarbora reported having no time to plant local varieties in private fields (external to group seed production activities), due to the time demanded for maintaining quality in seed production activities²⁷. Venilale rice production group leader Regina Amaral also reported that she doesn't continue to plant any local rice varieties due to fear of contaminating seed processing equipment with local seed²⁸. Three out of eleven seed producers interviewed reported providing seed of new varieties to neighbouring farmers to ensure seed production activities remained pure and were not contaminated by local varieties.

As part of SOL/MAF seed production activities for the 2014-2015 crop, 3.4 tonnes of maize seed (Sele and Noi Mutin) was distributed to commercial seed producers²⁹; enough to plant 170 ha. The 2014

²² SOL III Mid Term Survey Report, 2013.

²³ SOL 2014 Adoption Survey.

²⁴ Personal Communication, FAO, Dili, 14/8/15.

²⁵ Personal Communication, GIZ, Dili, 10/8/15.

²⁶ SOL 2014 Annual Research Report.

²⁷ Personal Communication, Association Agrikultor Natarbora Oan, Manututo, 5/8/15.

²⁸ Personal Communication, Waiteque, Venilale, 5/8/15.

²⁹ SOL Annual Research Report 2014.

Adoption Survey showed that farmers living in villages where there was a CSPG, currently or in the past, more widely adopted the new varieties, with 49% of adopters living in a village where there is a CSPG³⁰. GIZ Agro Biodiversity (ABD) data showed that adoption of SOL/MAF-released varieties was also greater in areas closer to district capitals. The SOL MTS and the SOL 2014 Adoption Survey data also indicated a strong correlation between varieties adopted by farmers and those which are distributed for free by MAF. This suggests that opportunity remains for 'local' variety germplasm collection from more remote areas.

Planned release of local varieties

As of August 2015, SOL/MAF have plans for release of a number of local seed varieties. Further OFDT research has been determined necessary (1 more year) before the 'local Baucau' purple sweet potato variety can be released³¹. Research is also planned in order to enable release of the marketable local Batugade 'Balibo' Red Rice variety³².

Germplasm bank initiation and training

The SOL Phase II Program Design Document (PDD) described intention for SOL's collection of seed of local cultivars of Timor Leste's main food crops, with the objective of preserving valuable genetic material which has cultural and risk management roles in indigenous farming systems. This practice was to be continued under SOL III³³. During SOL II, SOL requested relevant CGIAR Centres to work with Timorese nationals to adequately sample local diversity and store it in their gene banks³⁴. CIAT reportedly showed initial interest in the SOL cassava collection, however little interest was expressed for germplasm collection by other centres due to rice and sorghum collections already containing some varieties from Timor Leste, and also due to Timor Leste not being considered a valuable centre of diversity for these crops³⁵.

SOL activities raised awareness of the importance of maintenance of local germplasm through staff training and through development of a local seed germplasm bank at the Betano Research Station.

A Germplasm Manager was appointed by SOL in 2012 to manage the Betano germplasm bank. The Germplasm Manager was sent by SOL to complete a three month course at UWA in 2012³⁶. Seven SOL and MAF staff (including the Chief of MAF Research Department) were also sent to Bogor in 2014 for a 2-week Germplasm Management course. However, initial efforts by SOL in germplasm bank

³⁰ SOL 2014 Adoption Survey.

³¹ SOL 2014 Annual Research Report.

³² National Seed System for Released Varieties, SOL/MAF, 2014.

³³ SOL II PDD.

³⁴ SOL II PDD, Annex 6, Environmental Analysis.

³⁵ Email communication, Rob Williams, 17/8/15.

³⁶ Email communication, Anibal da Costa, Training Coordinator, SOL, 1/9/15.

development were not sustained once the project was handed over to sole MAF management. No evidence of continued development of the local seed germplasm banks by MAF were observed in August 2015. Although a living cassava seed bank was observed at Betano Research Station details were not able to be confirmed.

Biodiversity research

Social science research has been conducted by SOL using OFDT survey data as a means to collect information on biodiversity. The number of crop types cultivated at each OFDT were listed by name, annually, at each research OFDT site³⁷.

Use of agricultural chemicals

All OFDT farmers and seed production groups interviewed confirmed that no advice was received from SOL to encourage the use of inorganic fertilisers, herbicides or pesticides. The minimal use of pesticides reported was conducted at the farmer's own will, was supported by MAF extension staff and was limited to the districts of Maliana and Liquica.

Limited insecticide use was reported on research stations. In 2014 dryland rice at Darsula Research Station was treated with insecticide seed dressing. Research assistants at the Rai Maten Irrigated Rice Research Centre mentioned occasional use of Deltamethrin pesticides, with only 200ml of the pesticide stored on site. Limited use of Glyphosate herbicide was reported (at Betano <5L of glyphosate was observed to be stored on site), and a minimal amount of inorganic fertilisers were used in research station trials (<0.25ha per year at each research station for agronomy trials).

OFDT data from 2010-2014 further indicated that no OFDT farmers used chemical fertilisers or pesticides in their OFDT trials³⁸.

Land degradation

In accordance with SOL program objectives, SOL field activities (OFDTs and extension activities) were not observed to significantly change traditional farming practices, but rather replace low-yielding varieties with germplasm. All interviewed farmers reported using existing agricultural land for SOL research and seed production activities; no trees were felled and no land was cleared.

Rotations of leguminous crops such as Velvet Beans were observed at several research stations, and crop rotation was employed at all research stations visited as well as allowing fallow plots where space was not limiting.

³⁷ SOL 2014 Annual Research Report.

³⁸ SOL OFDT Database 2010-2014.

Soil nutrition depletion

While there is some suggestion that higher yielding, introduced varieties of sweet potato and cassava could more rapidly deplete soil reserves when compared to local varieties, the ratio of soil nutrition to end product nutrition is likely similar between local and introduced varieties; smaller tubers use less soil reserves however produce less food. The improved varieties capacities to produce higher yields from a smaller area of land means that less area is cropped, allowing more land preservation and room for crop rotations. Soil type is a significant factor of sweet potato yield (regardless of variety planted), with highest 2014 OFDT trial yields obtained in heavy clay soils³⁹, indicating that crops are generally more productive in the more fertile soils where more soil nutrition is available. Released variety planting activity has also intermittently been coupled with corresponding advice on better suited planting systems from SOL/MAF extension staff, such as decreased planting rates and linear spacing recommendations to ensure soil reserves are not unduly depleted.

In 2013, research staff observation at the Kintal Portugal Research Centre at Maliana suggested the site was lacking in soil fertility. It has since been left fallow for two years and planted with Velvet Bean to enable soil improvement⁴⁰.

Recommendations of Velvet Bean intercropping and rotations for land protection were evident in farmer interviews and in the numbers of Velvet Beans distributed by SOL and collaborating NGOs. Further work in soil nutrition was observed through use of leguminous crops to improve soil fertility, such as implementation of Winged Bean, Climbing Bean and Mung Bean research in research stations and OFDTs⁴¹ in 2014.

Commercial seed production

Commercial seed production by community groups is limited to approximately 0.25 ha areas. 90% of seed production fields are on private land⁴² and hence do not extend additional agricultural production land. All seed production groups interviewed during the evaluation confirmed that existing agricultural land was used for seed production.

SOL's involvement with NGO programs such as the FAO Conservation Agriculture Strategy support positive environmental influences in the use of agricultural land. 38 SOL/MAF maize CSP growers participated in the FAO CA meeting in June 2015⁴³.

³⁹ SOL 2014 Annual Research Report.

⁴⁰ Personal Communication, Wayan Tambun, Maliana, 12/8/15.

⁴¹ SOL 2014 Annual Research Report.

⁴² SOL Component 3 CSPG Survey, 2015.

⁴³ Email communication, Buddhi Kunwar, Dili, 9/8/15.

Furthermore, as part of seed production activities, no fertilisers, pesticides or herbicides are recommended or supplied to the farmers. MAF/SOL also encouraged CSPs to adopt one or more of the following techniques to preserve land, labour, money and the environment;

- SOL encouraged the CSP to grow Velvet Beans with maize.
- SOL encouraged the CSP to intercrop seed plots with edible bean crops⁴⁴.

Use of local water supply

At SOL research centres some utilisation of local water supply was observed however the majority of crop research was rain-fed. Less than 0.25 ha of irrigated seed production area was observed at the Ululefe research site (watered only twice per week from the mountainside spring). Recharge point flow rates were not affected by SOL/MAF's use⁴⁵.

At the Loes Research Station approximately 0.3 ha of drip irrigation has been implemented by SOL. A 110,000L water tank is filled by groundwater pumped from an on-site bore in order to irrigate research and seed production plots. The tank was reportedly filled in 8hrs (3.8L/second flow rate) indicating abundant groundwater resource at the site, as would be expected in the Loes delta area.

Infrastructure sites

The following main development sites were visited:

1. Triloka Development Centre (Baucau).
2. Darsula Research Station (Baucau).
3. Betano Research Station (Manufahe).
4. Ululefe High Altitude Research Station (Maubisse).
5. Kintal Portugal (Aileu).
6. Loes Research Centre (Liquica).
7. Maliana Rai Maten Irrigated Rice Research Centre (Maliana).
8. Corluli Seed Storage Centre (ex Research Station) (Maliana).

Representative CSP seed storage facilities were also visited (6). Twenty out of a planned 55 Seed Storage facilities have been erected by SOL/MAF with commercial seed production group collaboration. Each facility consists of a concrete slab with a partially enclosed sub-wall and enclosed storage room, of approximately 90m² dimensions. At each storage facility inspected farmers interviewed confirmed that no environmental degradation had resulted from the construction works. In Ritabou, Maliana, one farmer reported voluntarily cutting down several Coconut, Jackfruit and Betel Nut trees to provide land

⁴⁴ Email communication, Buddhi Kunwar, Dili, 9/8/15.

⁴⁵ Personal Communication, Carlos Mendonza – MAF Research Assistant, Maubisse, 7/8/15.

for the seed storage facility⁴⁶. Each of the three tree species was abundant in the immediate vicinity of the facility upon site inspection.

A seed drying pad was laid at Darsula Research Station (100m²), as well as a small residence (70m²) and seed storage facility (120m²). A seed storage warehouse was also erected at the Corluli Station in Maliana (120m²). Buildings were erected on non-productive land.

At the Ululefe Research Station in Maubise minor cut and fill soil operations were conducted in 2014. Less than three cubic meters of soil were cut from the hillside immediately adjacent the office (upland) and relocated to the hillside below the office, to allow improvement of existing water drainage. Banyan Trees and Elephant Grass were planted in the filled sloping area to prevent soil erosion⁴⁷.

At the Darsula Research Station a number of Sandalwood and Eucalyptus trees were removed by MAF staff in collaboration with the local village chief in 2009, in order to allow cleared land for research activities (approximately 7ha of the total fenced 22ha research area was cleared). Felled timber was collected and removed by locals⁴⁸. More than 300 Eucalypt trees exist in remaining un-cleared areas within the research station. The un-cleared areas of the research station remain representative of the surrounding land in terms of biodiversity. None of the surrounding land is used for agricultural purpose and the immediate vicinity is considered unproductive. A number of annual weed species have populated some of the cleared research area (mostly dominated by Siam Weed, Snake Weed and Lantana), however these species were also observed to be prevalent in the understory of surrounding land. No introduced species were observed to have re-populated the cleared area⁴⁹.

Some earthworks were carried out at the Loes Research Station in 2014 in order to reduce flood water erosion. Minor water diversions and implementation of living fencing was employed.

Other minor infrastructure rehabilitations have been conducted at research stations, such as the seed testing laboratory at Triloka development centre. No earthworks or waterways were disrupted. No observation of land degradation was made at any SOL infrastructure site, and all interviewed parties confirmed this.

⁴⁶ Personal Observation, Ritabou, Maliana, 11/8/15.

⁴⁷ Personal Observation, Ululefe, Maubisse, 7/8/15.

⁴⁸ Personal Communication, Bosco Ribeiro, Darsula, 4/8/15.

⁴⁹ Personal Observation, Darsula, 4/8/15.

Summary

While the SOL program has expanded significantly since inception into many facets of research station activity, OFDTs and extension programs, the impacts of the program on the Timorese agricultural environment have been largely positive. An increase in improved germplasm, distribution of quality planting material and participation in environmental awareness activities by the SOL program was evident in positive feedback from the Timorese agricultural community. In addition to the enhanced germplasm to existing 'local' food gene pools through released varieties, SOL has further increased biodiversity via introduction of a number of non-staple food crops which are currently being researched in replicated research station trials and OFDT farmer plots.

Research and extension activities were not observed, or reported by farmers, to have any significant negative effect on the environment. Germplasm introduced to Timor Leste from international seed centres was imported through the correct channels. Phyto-sanitary certificates and Non-GM compliance documentation was sighted, ensuring no import of diseased, pest-infested or weed-seed infested materials. NGO staff confirmed involvement of SOL staff in field extension activities supporting environmental protection. Commercial seed production activities were observed to be managed by regulated quality control systems which ensured no spread of pest or disease in planting seed.

While SOL has actively increased biodiversity through introduction of new germplasm of 11 different crop types, some inadvertent loss of local plant germplasm has resulted from SOL/MAFs variety release and seed production activities. High adoption rates of the new varieties, coupled with free distribution of released variety seed and cuttings, has indirectly resulted in reduction in planting areas of 'local' traditional seed banks. NGO partners expressed concern for the lack of preservation of traditional maize and rice varieties which have been replaced by the new varieties. Opportunity exists however for collection of local germplasm from more remote agricultural areas within Timor Leste. Various attempts by SOL to encourage development of national germplasm banks have had limited success, and little interest has been expressed from external sources.

All interviewed farmers confirmed that SOL has not recommended the use of agricultural chemicals (pesticides or inorganic fertilisers). Limited pesticide use was reported and observed at research stations.

Some minor earthworks and infrastructure developments were observed at the SOL/MAF research stations. No environmental degradation was observed as a result of these activities. Use of crop rotations and cover cropping was observed at research stations and seed production sites. No farmers involved in SOL seed production or OFDTs reported clearing forested land. Some use of local water supply has been facilitated at the Urulefe and Loes Research Stations for seed production and irrigated research, however water sources were abundant and recharge rates for water sources observed to be unaffected by SOLs minimal usage.

List of interviews

Date	Location	Activity	Contacts
03-08-15	Dili.	Meeting with advisors and coordinators, preparation for field trips.	Ermelinda, Luis Pereira, Bueneffe Abdon, Luc Spycckerelle, John Dalton.
04-08-15	Triloka, Baucau.	Visited Triloka Development Centre.	Martin Brown, Bosco da Costa Riberiro, Basillio da Silva Pires.
04-08-15	Darsula, Baucau.	Visited Darsula Research Station.	Martin Brown, Bosco da Costa Riberiro, Basillio da Silva Pires, Marito Da Costa – MAF Research Assistant, Jacinto Boavida- MAF Research Assistant, Moises Lobarto – Research Coordinator MAF.
04-08-15	Gariuai, Baucau.	Visited Rai Mean seed production group.	Joao Gomez.
04-08-15	Baucau Villa	Meet with NGO Hivos about Raimuco activities and watershed management programs.	Raul De la Rosa (Hivos director).
05-08-15	Gariuai, Baucau	Met with MAF Technical staff – Constantino.	Constantino Da Costa
05-08-15	Venilale, Baucau.	Met with Waiteque seed production group and OFDT Farmer – Regina Amaral.	Regina Amaral
05-08-15	Viqueque	Met with MAF extension officer.	Domingos Carmo Pinto.
05-08-15	Fatunesu, Viqueque	Met with OFDT farmer Fatunesu, Viqueque	Claudino Fatunesu.
05-08-15	Natarbora, Manututo.	Met with Lao Hamutuk womens group.	Carlota Fatima
05-08-15	Natarbora, Manututo.	Met with ANO (Association Agrikultor Natarbora Oan).	Joao Da Cunha.
06-08-15	Betano, Manufahe.	Visited Betano research station.	Felisberto Soares, Jorge Amaral.
06-08-15	Bemetan, Manufahe	Met with BeMetan OFDT farmer.	Ense Lourenca.
06-08-15	Lihun tutu, Ainaro.	Met with Lihun Tutu OFDT farmer.	Antonio Da Silva.
06-08-15	Hohorae Kiik, Ainaro.	Met with MAF extension worker	Manuel Margona.
06-08-15	Maubisse, Ainaro	Met with MAF extension worker	Mario Jose Pacheco.
06-08-15	Lekite, Maubisse.	Met with SOL highland research staff	Apolinario Ximines.
06-08-15	Lekite, Maubisse	Met with OFDT farmer	Francisco do Rego.
07-08-15	Ululefa, Maubisse.	Visited Maubisse research centre Ululefe.	Armindo Moises, Carlos Mendonza – Research Assistant, Manual Mendonza – Security, Moreal Pereira – permanent labour.
07-08-15	Aileu Villa	Met with OFDT farmer	Verneranda Alvos Mendoca.
07-08-15	Seloi Malere, Aileu	Met with OFDT farmer	Eugenia Mesquita
07-08-15	Fahiria, Aileu	Met with seed production group, Tane Hamutuk	Alberto Lou-Teus, Domingos Mendoca.
07-08-15	Aileu	Visited Kintal Portugal Research Station	Nono Mendonca.
10-08-15		Met with NGO GIZ	Beate Quilitzsch-Schuchmann.
10-08-15	Dili.	Met with Rob Williams for Crop and Germplasm info.	Rob Williams.
10-08-15	Dili.	Seed Department	Fernando Soares.
11-08-15	Loes, Liquica	Visit Loes Research Station, Seed production activities	Avelindo Dos Santos, Lourindo Dos Santos.
11-08-15	Loes, Liquica	Met with MAF Research Assistant	Lucas Da Costa.
11-08-15	Rairobo, Liquica	Met with Jufosar Association Seed producers	Vetricio Maubere Rosario, extension worker, seed producer.
11-08-15	Atabae, Liquica	Met with Loesai Seed production group.	Claudio do Santos
11-08-15	Rai Maten, Maliana	Visited Rai Maten Irrigated Rice Research Centre	Adao Vicente – Research Assistant.
11-08-15	Corluli, Maliana	Visted Seed Storage Warehouse (ex research station)	Ananias De Araujo.
11-08-15	Ritabou, Maliana	Met with Unidade Sameklot seed production group	Agustu Guterres Barreto.
12-08-15	Cailaco, Maliana	Met with Lakabasi seed production group	Isabel Pereira.
12-08-15	Hatas, Maliana	Met with Halarai velvet Bean farmer, OFDT farmer	Anjelino Nunes.
12-08-15	Ritabou, Maliana	Met with OFDT Farmer, Seed producer	Anina de Jesus.
12-08-15	Ritabou, Maliana	Met with OFDT Farmer	Joao Borges Mauleta.
12-08-15	Holsa, Maliana	Met with OFDT farmer and seed producer.	Alexo Soares.
13-08-15	Liquica Villa	Met with MAF Head of Crops Department, Liquica.	Bendito Correia Riebero.
14-08-15	Dili	FAM advisor meeting	Modesto Lopes, Simao Belo, Sam Bacon, Martin Browne, John Dalton, Luis Almeida.
14-08-15	Dili	FAO	Dr Claudino Ninas Nabais.
14-08-15	Dili	Met with MAF Director General	Lourenco Borges.
14-08-15	Dili	Met with National Coordinator for Seed System Management	Modesto Lopes.
17-08-15	Dili	Met with head of MAF Plant Protection Department.	Ameriku Brito.