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Final report

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1 Acknowledgments

This project was initiated when Dr Peter Jarvis came to Timor-Leste in 2006 as an International advisor for the Directorate of Agribusiness Division, MAF. An initial field visit by Dr Jarvis, Calisto da Costa Varela as Senior Livestock Officer and other staff to Manufahi District was conducted to observe and to clearly understand prevailing livestock systems. A follow-up visit to Liquica, Aileu and Lospalos by a team that included Dr Dahlannudin from the University of Mataram, Indonesia (UNRAM) was conducted on 22-25 October 2007.

To demonstrate MAF's commitment to an ACIAR project, Mr Calisto da Costa Varela, and Mr Adelino Pimental (Director of Agribusiness) then led a Timor-Leste team to Mataram, Indonesia in 2007 where they were hosted by Dr Dahlannudin. Field research conducted by UNRAM and ACIAR was inspected. Immediately after, two senior MAF livestock staff were invited by Dr Dahlannudin to participate in a CSIRO-supported workshop in Mataram.

On 9 December 2009, Mr Calisto da Costa Varela, Dr Peter Horne (ACIAR) and Philip Young (independent consultant, Australia) had a short meeting with the MAF Minister. The most important agenda item was the possibility of implementing an ACIAR project in Timor-Leste. An MoU was signed on 8 July 2010 between MAF (represented by the Director General) and UNRAM. At the same time, MAF's National Director of Livestock and Veterinary Services signed an agreement with UNRAM's Faculty of Animal Husbandry to implement a feasibility study on pasture development in Timor-Leste. On 25 October 2010, Mr Calisto da Costa Varela and Dr Peter Horne (ACIAR) met with the MAF Secretary of State for Livestock and the Director General to inform them about negotiation for an ACIAR project in Timor-Leste.

In parallel with the MoU between MAF and UNRAM, ACIAR signed an MOU with UNRAM on 28 February 2011. Timor-Leste MAF, represented by The Secretary of State for Livestock and the National Director of Livestock and Veterinary Services were witnesses. This enabled implementation of the ACIAR small research and development activity (SRA) titled "Strategies for improving Bali cattle productivity in Timor-Leste" (ACIAR LPS/2011/004) led by Dr Dahlannudin from UNRAM.

Between 27 August and 1 September 2011, a Timor-Leste Delegation (MAF and UNTL) went to Australia to participate in the selection of a lead project agency from three Universities which had been short-listed by ACIAR from 11 candidates. The contenders were James Cook University, University of Queensland and the University of New England. The selection panel from ACIAR, MAF and UNTL selected the University of Queensland to implement the ACIAR project in Timor-Leste.

Dr Peter Horne, Dr Werner Stür, Catherine Hanley and the broader ACIAR team have provided very professional and complete support during the project. The project team sincerely thanks them for this support.

2 Executive summary

Situation. Timor-Leste is a post-conflict nation with poor natural resources where 50% of the population lives below the poverty line on daily incomes of less than US$1.90. The average contributions of total dietary protein and protein from animal origin are near the minimum daily requirement of 55 g/day/person and 17%, respectively.

More than 150,000 cattle, 100,000 buffalo and 200,000 small ruminants graze over approximately 200,000 ha of public lands. These lands are mostly highly degraded with dense woody and herbaceous weed infestation and very low annual pasture production. Bali cattle (*Bos javanicus*) are the predominate species of cattle and are very well suited to smallholder production systems, as well as the existing transport, marketing and processing infrastructure and systems.

Ruminants and pigs are a valuable part of the Timor-Leste culture as a source of income and for ceremonies. They are sold either for traditional ceremonies or to commercial traders on an as-needs basis. Large ruminants have also traditionally been used for dowries. Ownership of maximum numbers of livestock usually takes precedence over productivity. Very little control of cattle is used other than to seasonally exclude them from crops. Traditionally, there is little hand feeding and no weaning or mating management.

Demand for livestock products is growing rapidly both within Timor-Leste and from Indonesia, creating an opportunity to improve beef cattle systems. Experience in neighbouring eastern Indonesia following many years of directly-relevant ACIAR-funded projects indicated that with appropriate policy support, simple interventions may increase protein available for human consumption, farmers' incomes from domestic sales, and in the longer-term, export returns from live sales to Indonesia. All these elements directly align with the Ministry of Agriculture and Fisheries (MAF) in Timor-Leste's Policy and Strategic Framework, and as a result, the government and its development partners have accorded highest priority to increasing food-crop production.

Project. To assist meeting Timor-Leste's objectives, a project was established as the first stage of a 10-year program to answer the following research questions: (i) how do beef cattle contribute to smallholder livelihoods and what are the associated risks; (ii) which low- or no-cost (financial and time) interventions can increase local beef production efficiency; (iii) what market opportunities exist to complement increased production and how can they be developed; (iv) what feasible mechanisms are required and will provide farmers with access to information and services that would effectively support them to integrate improved cattle management practices into their farming system?

The project commenced in mid-2012 and was completed in early 2016 after an extension to facilitate flow-on to a follow-on project. It was led by the University of Queensland with the primary partners being MAF and the Universidade Nacional Timor Lorosa'e (UNTL). There was also close collaboration with two consecutive ACIAR small research activities led by Indonesian scientists familiar with relevant research from the University of Mataram (UNRAM) in Lombok and Universitas Nusa Cendana (UNDANA) in Kupang, West Timor.

The project aim was to use a whole-of-chain approach to provide the basis for, and initiate a shift in Timor-Leste smallholder beef farming practices from mostly keeper to producer systems with better market access, thus increasing family incomes. The objectives were to: provide a situation analysis that characterises Timor-Leste smallholder beef cattle systems and associated beef industry stakeholders as a basis for site selection and ensuing project operations; increase annual live weight production per cow by at least 50% by adapting practical innovations and systems suited to a large majority of livestock farmers to village-based cattle production systems; recommend market systems and policy settings that can alleviate constraints to profitable beef production and achieve sustained increases in smallholder household income, and ultimately national wealth; and, produce a communication strategy that improves smallholder farmer access to information and services that support them in adapting innovations into better farming practices.

Outcome. Cattle ownership and beef production and consumption are valued parts of Timor-Leste community and economy, and can contribute significantly to the non-oil GDP. Annual domestic cattle off-take and beef consumption were calculated at 21,000 and 1.66 kg per capita, which are much higher and lower, respectively, than previously thought. Beef consumption in Dili is probably double that in provincial areas, and is growing rapidly with the increasing population and increasing disposable income. A detailed assessment of the costs, benefits and feasibility of meeting international protocols would be useful for the Government of Timor-Leste in developing a practical cost-effective way - with incentives - to formalise, and thus boost, the trade of live cattle to Indonesia; the informal trade was estimated at 5,000 annually. Modelling of data collected suggested that the national beef cattle herd may be reducing by ~5% annually as off-take appears to substantially exceed a level that sustains the herd size at current performance levels. No data were available to validate the size of the national cattle herd, which 2010 census data suggested was in the vicinity of 160,000.

Low average calving rates (<50%) and growth rates (~0.2 kg/d for surviving juveniles) and very high mortality rates (10% for adults; up to 27% for calves) of all age classes are the primary contributors to low annual live weight production and low efficiency of Bali cattle systems in Timor-Leste, estimated at ~25 kg and ~0.15 kg/kg cattle, respectively. Under-nutrition caused by lack of feed and water and almost no management or husbandry are the primary reasons for low cattle performance and productivity per animal, which are less than half of what is achievable.

A range of acceptable options was indicated for cattle owners in Timor-Leste to improve the financial benefits from cattle, thus livelihoods. The fundamental change that appears to underpin significant change in cattle farming systems in Timor-Leste is better control of feed, water and cattle, with cattle yards a key component. Use of grown forages and crop residues to increase growth of bulls and calves is a high-priority in early-stage change to cattle systems. A good range of options for forage tree legumes, herbaceous legumes, and grasses was identified as suited to the variable conditions across potential cattle production areas in Timor-Leste. For cow management, good weaning practice is the primary husbandry that should be introduced. Further research will produce practical solutions to the high reproductive wastage. Selling based on live weight has also commenced and creates more equitable trading for both farmers and the beef supply chain.

Training was provided at different levels leading to substantial development of capacity. MAF and UNTL staff were involved in formal post-graduate training, regular training events and learning through participation in research. Participating farming communities received ongoing advice during implementation of project activities, and selected MAF district personnel were offered a training-of-trainers course at the end of the project. This capacity had to be produced to form the basis of further research and scaling out.

To achieve change in cattle systems practices requires further capacity development and implementation of practices as part of systems that will be effective in Timor-Leste environments. Farmers and traders need to be involved in decisions about what problems and opportunities they have in directing research and adaptation of practice changes to Timor-Leste cattle farming systems. There is limited advanced RD&E capacity servicing the beef cattle industry in Timor-Leste despite very large numbers of university graduates, and this limits appropriate development of livestock systems.

It was concluded there is opportunity to achieve widespread improvements in cattle production and marketing systems, but this requires mechanisms that allow the smallholders to have control of the change process with appropriate support.

3 Background

The situation

Timor-Leste (TL) is a post-conflict nation with poor natural resources for agriculture. A majority of farmers and support agency staff are under-skilled. Since 2000, the government and its development partners have accorded highest priority to raising food-crop production. Despite non-oil GDP increasing from 17% to 27% between 2000 and 2007, due mainly to growing livestock populations following the end of post-independence violence, production is among the lowest in the world; average annual productivity is ~10 kg live weight per animal (FAOSTAT, 2007) or 5% production rates (kg of live weight/kg of animal/year). This is extremely low compared with efficient systems in north Australia's dry tropics that have production rates of 30%, with the least efficient systems being as low as 15%[1].

Bali cattle (*Bos javanicus*) are the predominate species of cattle in Timor-Leste. This species is very well adapted to the environment. Their small mature size is also very well suited to smallholder production systems, and the existing transport, marketing and processing infrastructure and systems.

A 2012 review of Timor-Leste beef production[2] indicated there was no evidence against reports of low reproduction rate (e.g., inter-calving interval of 18-24 months; calf mortality of 30%), low milk production, slow growth rate, low meat quality, prevalence of diseases such as brucellosis and haemorrhagic septicaemia. More than 150,000 cattle, 100,000 buffalo and 200,000 small ruminants graze over approximately 200,000 ha of public lands. These lands are mostly highly degraded with dense woody and herbaceous weed infestation (e.g., *Chromolaena odorata*) and produce an average of not more than 0.5 t of of pasture DM/ha when the grazing ruminants feed intake requirement is at least 2.5 t/ha annually. Very little control of cattle is used other than to seasonally exclude them from crops. Traditionally, there is little hand feeding and no weaning or mating management. Despite this, cattle are a valuable part of the Timor-Leste culture. Ruminants and pigs are kept as a source of income and used for ceremonies. They are sold either for traditional ceremonies held by others or to commercial traders on an as-needs basis. Large ruminants have also traditionally been used for dowries. Ownership of maximum numbers of livestock usually takes precedence over productivity.

With very low inputs to cattle systems, farmers have traditionally not adopted a production approach with cattle, and combined with poor market access, has led farmers to maximise numbers of unproductive animals; the famers' are "keepers" of livestock, rather than "producers". This may be perceived as a problem outside this situation, but given the objectives of cattle owners, their system may be very efficient. As opportunities arise as a result of this or other projects, astute farmers will alter their objectives, and it is then that they will require effective communication on alternate cattle management.

A drift of young people from regional Timor-Leste to Dili is very apparent, leaving older generations to maintain farms. Many fields remain fallow in the wet season. Lack of knowledge on how to increase farm productivity and profitability is partly why young people do not want to farm. This must be addressed to sustain productive farming.

Animal science capacity is limited in Timor-Leste, thus limiting support for change for households to more productive and financially-efficient systems. ACIAR previously supported small projects in the country. There have been limited opportunities for post-graduate study taken by Timor-Leste animal science graduates. The total number of animal science degree staff employed by MAF and UNTL is approximately of 50 people.

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[1] Fordyce G, McGowan MR, McCosker K and Smith DR (2014). Live weight production in extensively-managed beef breeding herds. *In*: Proceedings of the 28th World Buiatrics Congress, Keynote lectures, 27 July to 01 August 2014, Cairns. pp.87-93.

[2] Dahlanuddin, Mullik ML, Sutaryono YA, Varela C da C, Coimbra L, de Deus P, Supriyadi M (2012). Strategies for improving Bali cattle productivity in Timor-Leste. 1. Overview of the current production system. Project report, ACIAR, Canberra.

Project justification

The most recent census indicates 50% of Timor-Leste's population lives below the poverty line on incomes of less than US$1.90 (2011 international prices) per day[3]. Food insecurities and poor nutrition have contributed to a high rate of stunting and malnourishment. Food insecurity, especially in rural areas, manifests itself in fewer meals per day from the early to mid-dry season, progressing to the "hungry season" which extends from the late dry season into the early wet season until the first new crops can be harvested[4]. The average contribution of total dietary protein and protein from animal origin are near the minimum daily requirement of 55 g/day/person and 17%, respectively[5], though recent data suggests food and energy deficits have been reducing since 2011. Developing cattle, pig and chicken production will boost protein supply.

As Timor-Leste's economy grows the demand for livestock products is growing rapidly, thus making it an ideal time to support its cattle sector development, and thereby increasing protein for human consumption, farmers' incomes from domestic sales, and in the longer-term, export returns from live sales to Indonesia. Realising the opportunity of achieving significant live cattle exports for generating national wealth is limited by a range of factors including poor infrastructure, ability to supply saleable cattle, and endemic diseases (e.g., brucellosis and classical swine fever are endemic). All these elements directly aligned with the Ministry of Agriculture and Fisheries in Timor-Leste's (MAF) Policy and Strategic Framework (2004).

The opportunity to improve beef cattle systems in Timor-Leste is high based on the experience in neighbouring eastern Indonesia following 10 years of directly-relevant ACIAR-funded projects. Simple interventions such as controlled bull mating and weaning were demonstrated to double annual live weight production per kg of live animal and the profitability of beef production. The major impact of this work in NTB is on-going increases in beef production (e.g., 60% sales increase between 2008 and 2009) without change in the cattle population which indicates that efficiency is improving.

In 2009, ACIAR and MAF jointly developed a 10-year strategy for livestock research and development with the vision…….*that within 10 years it will have led to the establishment of a significant number of small- and medium-scale livestock production enterprises (i.e. farmers raising livestock as a small business) in Timor-Leste's main livestock producing districts.*

As the first stage of the 10-year strategy, this three-year project was the foundation for ensuing projects in:

- characterising beef cattle systems and production
- identifying marketing and policy recommendations to provide outlets for increased beef production
- developing systems to support smallholders in adapting better farming practices to their situation
- advancing the knowledge and skills of the RD&E sector to provide the impetus and support all industry sectors need to achieve the improved beef production

Subsequent projects will advance the research, scale up suitable smallholder beef farming systems, and continue to support capacity building in the RD&E, beef cattle farming and associated commercial and community sectors.

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[3] UNDP (2012). Population below income poverty line (%), PPP $1.25 a day, 2002-2012. Multidimensional Poverty Index, Human Development Reports, United Nations Development Programme. http://hdr.undp.org/en/content/table-6-multidimensional-poverty-index-mpi

[4] Lopes M and Nesbitt (2011). Improving food security in East Timor with higher yielding crop varieties. In: Food security in East Timor, Papua New Guinea and Pacific island countries and territories, ACIAR (Ed: D Templeton), Canberra. pp.12-26.

[5] Anon (2015). FAO Food Security Data, June 2015. http://knoema.com/FAOFSDD2015Jun/fao-food-security-data-june-2015?location=1002000-timor-leste

The major research questions for this project were: (i) how do beef cattle contribute to smallholder livelihoods and what are the associated risks? (ii) which low- or no-cost (financial and time) interventions can increase local beef production efficiency; (iii) what market opportunities exist to complement increased production and how can they be developed; (iv) what feasible mechanisms are required and will provide farmers with access to information and services that would effectively support them to integrate improved cattle management practices into their farming system?

4 Objectives

Aim: As part of an overall aim to develop beef cattle research capacity, the operations aim was to use a whole-of-chain approach to provide the basis for, and initiate a shift in Timor-Leste smallholder beef farming practices from mostly keeper to producer systems with better market access, thus increasing family incomes.

Objective 1: Provide a ***situation analysis*** that characterises Timor-Leste smallholder beef cattle systems and associated beef industry stakeholders as a basis for site selection and ensuing project operations.

- Understand the social and financial benefits and risks to smallholder livelihoods of beef cattle ownership and management
- Select sites for the main project phase and innovations to test and be adapted
- Map existing human resource and infrastructure capacity for beef cattle production RD&E within Timor-Leste (specifically within MAFF and UNTL)

Objective 2: Increase annual live weight production per cow by at least 50% by adapting ***practical innovations and systems*** suited to a large majority of livestock farmers to village-based cattle production systems

- Conduct detailed monitoring at five sites of the biology, cash flow and related social impacts during serial implementation of innovative beef production practices
- Evaluate options for tree legume, crop, grass and forage legume farming to meet cropping and beef cattle dietary needs
- Develop principles for efficient forage production and storage and beef production from available forage
- Develop and evaluate cattle infrastructure designs

Objective 3: Recommend ***market systems and policy settings*** that can alleviate constraints to profitable beef production and achieve sustained increases in smallholder household income, and ultimately national wealth

- Conduct detailed analysis of local, regional and international supply chains for Timor-Leste beef production
- Analyse the regulatory environment for Timor-Leste beef production and marketing
- Develop farmer – trader-butcher-banker groups to take advantage of production opportunities

Objective 4: Produce a ***communication strategy*** that improves smallholder farmer access to information and services that support them in adapting innovations into better farming practices

- Conduct detailed analyses of how beef production fits within smallholder livelihoods and of their perceptions and aspirations, as a basis for an effective communication strategy
- Design and pilot effective communication methods that deliver adaptable, practical information on better farming practices
- Improve the technical and critical skills, knowledge and practices of government advisers and university staff in forage production, cattle management, economic evaluation, marketing, and facilitating farmer practice change and scientific methods so they can research and identify suitable innovations and make them available for effective widespread farm-specific adaption
- Support the adaptation of a best-bet beef farming system with up to 5 farmers each in at least 3 research sites
- Conduct “train the trainer” workshops for field staff and develop supporting resources

5 Methodology

This project was conducted in collaboration with two consecutive Indonesian-led SRAs:

- LPS/2011/004 *Strategies for improving Bali cattle productivity in Timor-Leste*, May11 – May13, and
- LPS/2013/022 *Improving farmer profits from beef cattle by using dry land forage production systems in Timor-Leste,* Sep14 – Feb16.

Final reports for the above projects have been submitted separately[6]. This project commenced in June 2012. After a project review in Jan-Feb 2015, the project completion date was extended to December 2015.

Objective 1: Provide a situation analysis that characterises Timor-Leste smallholder beef cattle systems and associated beef industry stakeholders as a basis for site selection and ensuing project operations

Research question: How do beef cattle contribute to smallholder livelihoods and what are the associated risks?

When: September to December 2012

Who: All MAF-based project team members and project staff participated:

- Training: Assoc Prof Elske van de Fliert, Ms Lauren Hinthorne
- MAF: Latino Coimbra, Pedro de Deus, Celestino G.T. Mali
- Project staff: Anita Eka Martins, António Daos, Feliciano Fernandes, Jorge dos Santos, Rita Pinto, Joana de S. Gusmão, Muhamad Supriyadi (Indonesian-led SRA)

After meetings with District MAF representatives to determine aldeias[7] that met project criteria, the team aimed to interview a man and a woman from each of 5 households in each of two aldeias in each of 5 Districts, i.e., 100 interviews for 50 households:

	Women		Men		
Education	No.	Average age	No.	Average age	All
Illiterate	12	55	23	59	35%
Primary	4	48	26	50	30%
Pre-Secondary	5	34	6	35	11%
Secondary	3	37	21	36	24%
All	*24*	*47*	*76*	*48*	100%

[6] Dahlanuddin, Mulik M, Sutaryono YA, Varela CdaC, Coimbra L, Supriyadi M, de Deus P (2014). Strategies for improving Bali cattle productivity in Timor-Leste. Final report, Project LPS/2011/044, ACIAR, Canberra.

Dahlanuddin, Mulik M, Puspadi K., Sutaryono YA, Varela CdaC, Amaral A, Sudarma IMA, and Soares D (2016). Improving farmer profits from beef cattle by using dry land forage production systems in Timor-Leste. Final report, LPS/2014/022, ACIAR, Canberra.

[7] The 13 districts (now called municipalities) in Timor-Leste are the equivalent of provinces, states or territories. Most have a population of 50,000-100,000, except for Dili with near 250,000 of just over 1M people in Timor-Leste. Within sub-districts, villages are called sucos, and hamlets within villages are called aldeias.

Where: Aldeiasin which households were interviewed were distributed across the country, with specific focus on areas with higher cattle populations. The sites selected for future project research are highlighted in italics:

Area:	West	East	NW	South	Far West
District:	Bobonaro	Lautém	Liquiçá	Manufahi	Oecusse
Sub-District:	Atabae	Moro	Maubara	Fatuberlihu	Makassar
Suco:	Aidabalaten	Parlemento	Guiço	Fatucahi	Naimeco
Aldeia:	*Tutubaba*	*Asir*	*Pandevou*	*Welenas*	*Bonemesse*
Sub-District:	Balibó	Tutuala	Maubara	Same	Makassar
Suco:	Batugadé	Mehara	Vatuboro	Betano	Lalisuk
Aldeia:	Lotan	Porlamano	Tatamolobu	Bemetan	Manuimpena

How: Initially, Ms Lauren Hinthorne (a facilitator from Australia) applied a new method called LEGO® SERIOUS PLAY® to motivate the participants and help them seek solutions to their day-to-day problems.

After the project team established the interviewees, the men were interviewed separately from the women. Suco chiefs and other randomly-met villagers were also interviewed. Interviews focussed on:

- Demography
- Individual and community infrastructure and land tenure, description and use
- Income sources and household consumption of primary produce
- Annual systems for cropping, animals (including fisheries), ceremonies
- Cattle rearing activities, feed supply and government support
- Problems and potential solutions for cattle systems

One objective of this process was to select five sites for future research using the following basic criteria:

- The suco population cattle is at least 100
- Ready access in the wet and dry seasons to roads, markets, and potable water
- Ability to cultivate forage for animal feeding
- Good cooperation with authorities at the district and sub-district levels
- Ready to implement research activities if selected

Full details are provided in Appendix 1.

Objective 2: Increase annual live weight production per cow by at least 50% by adapting practical innovations and systems suited to a large majority of livestock farmers to village-based cattle production systems

Research question: Which low- or no-cost (financial and time) interventions can increase local beef production efficiency?

When: Jan 2013 to Dec 2015 after selection of project sites through the situation analysis.

Who: Neal Dalgliesh (CSIRO) managed forage evaluation research with assistance by Flaviano Soares (UNTL) in the first year of the project and thereafter by Yuliaty (UNTL). Dr Simon Quigley (UQ) managed the beef production systems research with assistance from Latino Coimbra and Celestino Mali (MAF). Graduates from the University of Timor-Leste

were employed full-time by the project as Field Researchers[8], with one positioned at each project site. In the final year, extra Field Researchers were employed to cope with the work load. Eric Thorne-George was employed to manage in-country operations during the final six months of the project.

Area	Suco	Field Researcher	
West	Aidabalaten	Anita Eka Martins Seran	Jan 13 – Feb 15
		Regina Ikin Cardosa	Mar 15 – Dec 15
East	Muapitine	Feliciano Fernandes	Jan 13 – Dec 15
		Jaime Moises Tomas	Oct 15 – Dec 15
NW	Guiço	Rita Pinto	Jan 13 – Feb 15
		Ezequeil de Jesus Pires	Mar 15 – Dec 15
South	Fatucahi	Jorge dos Santos	Jan 13 – Dec 15
		Joanita Xavier de Araujo Magalhaes	Mar 15 – Dec 15
Far west	Naimeco	Antonio Daos	Jan 13 – Dec 15
General	Dili	Joana Agusta Gusmão de Sousa	Jan 13 – Dec 15

Where: The project sites are listed above and shown in the map below. The Muapitine site was adopted after failure at the Parlemento site on the NE coast. The failure was due to inability to access cattle for monitoring, combined with unrealistic expectations created by a team member who left the project.

Symbol	Site	Symbol	Site
M	Muapitine	L	Loes Research Station
F	Fatucahi	A	Aibabalaten
D	Dotik Research Station	N	Naimeco
G	Guico		

How: There were five components to this work:

2.1 Forage evaluation and production. Full details are provided in Appendix 3. It was considered that a combination of browse and herbaceous legumes and grasses would form

[8] These staff were young scientists. The term Field Researcher was used as it has a meaningful translation into the most widely used local language, Tetum, and into Bahasa Indonesian which is also widely used.

the basis for more intensive village feeding systems. As the research being conducted by Indonesian colleagues was focusing on the use of browse legumes in the farming system it seemed appropriate that this project investigate the potential for herbaceous legumes and grasses to contribute to animal productivity.

Prior to each experiment, all staff involved were provided with detailed intensive training. Detailed research protocols were developed for each experiment; these were reviewed by project staff prior to publication and implementation and from the second year onwards, were translated into Bahasa Indonesia.

Sites used in the research:

District	Sucos	Soils	Av annual rainfall (mm)	Wet season (months)	Elevation (m)
Bobonaro	Aidabalaten	Neutral medium-heavy clay	1000	3-4	<200
Liquica	Loes, Pandevu, Irlelo, Caicasavu	Alkaline loamy levee	1500	5-6	<100
Lautem	Muapitine	Black forest; acid plain	2000	5-6	360
Manufahi	Dotik, Fatucahi	Neutral medium-heavy clay	1250	8	<100
Oecusse	Naimeco	Sandy levee	1000	3-4	<100

Daily temperature and rainfall records were taken at one site in each District. Soil types were derived from Portuguese studies in the 1950s and 60s (Garcia and Cardosa 1978). In all experiments, fertiliser applications were: 10 kg/h phosphorus pre-planting; 45 and 90 kg/ha nitrogen three times for growing legumes and grasses, respectively.

In 2012/13 grass and browse legume evaluation experiments were established in January 2013 and cut at 60 day intervals to emulate a cut and carry scenario at three sites: Loes Research Station (Liquica District - West), Dotik Research Station (Manufahi District - south) and Fuiloro (Lautem District – east). Inability to control the plantings at Dotik and Fuiloro resulted in no results, with only Loes yielding useful data. Forage evaluations continued here till the end of the project. The legumes, *Lablab purpureus*, *Centrosema pascuorum, Clitoria ternatea*, *Macroptilium bracteatum, Stylosanthes guianensis* and *Stylosanthes hamata* and grasses *Brachiaria spp.* (Mulato), *Setaria sphacelata var. Splendida, Panicum maximum cv Simuang, Panicum purpureum x glaucum, Paspalum atratum* and *Brachiaria brizantha* were compared for environmental adaptation and productive capacity.

Replicated evaluation experiments, designed to further clarify productivity across climatic zones were established in the 2013/14 season at a bimodal rainfall site in the district of Lautem and a unimodal site in Oecusse.

To expose participating farmers to the potential for the use of herbaceous legumes and grasses in combination with alley cropped browse legumes, demonstration sites were planned for the districts of Liquica (Guicu-3), Lautem (Muapitine-4), Manufahi (Fatucahi-2), Bobonaro (Aidebelatan-2) and Oecusse (Naimeco-1) in 2013/14. Some alley crops of *Leucaena leucocephala* and *Sesbania grandiflora* were established.

Learning from past experiences, in 2014/15 a less ambitious research program was planned. Evaluation experiments were established on, a) an acid soil in Lautem to identify acid tolerant legume and grass species and to quantify the impact of soil amelioration on productivity and, b) the Oecusse evaluation experiments are being continued after replanting.

As a foundation for implementation of forage production by farmers, one team member (Yuliaty, UNTL) was trained in Queensland in seed production techniques. Yuliaty then established seed production at Loes Research Station with storage facilities in Dili.

2.2 Beef production systems. Full details are provided in Appendix 4. Full beef systems monitoring of on-farm beef production commenced in Liquica (Guico), Bobanaro (Aidebalaten), Manufahi (Fatucahi), Oecusse (Naimeco) and Lautem (Muapitine) districts between July and December 2013. At each site field researchers worked with farmers to develop simple infrastructure systems to monitor beef cattle production. Field Researchers received considerable training in all aspects of data and sample collection, data recording and entry, but skills development took a year before they were able to consistently record useful data.

All households participating in the project had their cattle individually identified and described. Data collected across two wet and two dry seasons (Nov13 to Oct 15 inclusive), describing cow-calf production in Timor-Leste, included:

- Live weight and girth 6-monthly and monthly body condition scores
- Reproductive outputs of each cow
- Ownership and transactions
- Diets, management, health and survival

In late 2015, participating household were surveyed to assess the role of cattle in their livelihoods.

Until the implementation of the Outreach Strategy (see below) It was not possible to implement weaning and strategic feeding of high quality feedstuffs to both suckling and weaned calves. This was because of several reasons including poor climatic conditions, lack of access to materials, and the developing ability of Field Researchers to support farmers in producing the necessary forages.

2.3 Forage and beef cattle demonstration. The project maintained the cattle fattening demonstration established by project LPS/2011/004 at Loes Research Station to the west of Dili. This demonstration is used by field staff to show farmers the outcome of feeding pure leucaena diets to cattle, thereby enhancing the likelihood of farmers planting this and other forages, and of production feeding of their cattle.

2.4 Creep feeding experiment. Full details are provided in Appendix 5. An on-farm experiment to compare the growth of suckling calves with and without tree-legume supplementation (20 g/kg live weight daily of 50:50 rice bran and dried leucaena leaf) during the late dry season was established in the Manatuto district, east of Dili. This activity involved the participation of 7 UNTL undergraduate students and 3 UNTL staff to develop skills in animal health treatments, feeding cattle, conducting measurements and collating and interpreting data. After completion of the supplementation period, all calves resumed free grazing with dams and wet season live weight responses were measured.

2.5 Develop and evaluate cattle handling infrastructure. Full details are provided in Appendix 6. To enable cattle measurements in the research, rudimentary cattle yards and holding facilities were constructed. A yard suitable for Timor-Leste smallholders was designed and constructed from locally available resources (e.g., bamboo, gliricidia, palm fronds) with the aim of producing reliable, functional and accessible cattle management infrastructure (communal cattle yards and/or household cattle pens). The efficacy of the design (e.g., for weaning, strategic supplementation, animal health treatments) was assessed by the farmers.

Objective 3: Recommend market systems and policy settings that can alleviate constraints to profitable beef production and achieve sustained increases in smallholder household income, and ultimately national wealth

Research question: What market opportunities exist to complement increased production and how can they be developed?

When: Jul 12 – Dec 15

Who: Dr Scott Waldron (UQ) led this research. His primary assistance initially was from Carlos da Conceicao De Deus (UNTL) until he moved to Portugal to undertake studies towards a PhD. From this time, primary support came from Dr Vicente de Paulo Correia, Adelino de Rego (UNTL) and Calisto da Costa Varela. Field Researchers assisted during any research when the team was in the region they were located.

Where: Data was derived from across the country, with most emphasis on sites where there was maximum cattle numbers or high-volume trading. Fieldwork was conducted in Dili, Lautem, Liquica, Manufahi, Bobanaro, Oecusse and Cova Lima Districts. Some research was conducted in neighbouring West Timor to document the border trade. Most focus was in the areas where cattle production research sites were established.

How: An extensive literature review included a limited number of published articles and larger number of unpublished reports, which were critically reviewed and updated. Interviews were conducted in all project sites with the full range of stakeholders including farmers, traders and spotters, slaughterhouses, butchers and retailers in Dili, government officials at central, district and sub-district levels, suco level chiefs, extension agents and vets. This was complemented by expert opinion of project staff and workshop discussions.

The research took a “whole-of-industry”, sub-sector approach. Rather than being treated separately, socio-cultural, institutional, governance and policy dimensions were incorporated into the sectoral analysis. The report draws upon all relevant statistical data available, especially from the 2010 Agricultural Census, but also a range of household and agricultural surveys conducted by the TL Government and foreign agencies. This sets the context in which lower level industry and household activity takes place. The industry analysis is predominantly qualitative in nature, which is required to understand the complex relationships in the industry given the paucity of reliable quantitative data available. Analysis is set mainly at macro- and meso-levels.

Local, regional and international supply chain maps have been examined for Dili, project districts and for border flows. Key policy issues have been identified with collaborators and experts.

The research is subject to several limitations including:

- Research was conducted in seven districts of TL and is not therefore national or comprehensive in nature.
- Project resources prohibited surveys on consumption, which was beyond the scope of research (although other measures have been used to understand consumption volumes).
- Economic data has been collected (through detailed interviews) on household and agribusiness activity, and will be incorporated into forthcoming project activities.
- Does not address the embedded, long term, cross-sectoral problems that impact on the beef industry – including land tenure and infrastructure – that are outside of the scope of the research.

Recommendations for siting the ensuing project were derived from this research. This was based on cattle populations, opportunities for commercialisation of cattle systems, and existence of functional cattle trading systems.

Full details are provided in Appendix 2.

Objective 4: Produce a communication strategy that improves smallholder farmer access to information that they can adapt into better farming practices

Research question: What feasible mechanisms are required and will provide farmers with access to information and services that would effectively support them to integrate improved cattle management practices into their farming system?

When: Jun 12 to Dec 15

Who: Associate Professor Elske van de Fliert managed this research. In the final year of the project, she was assisted by Dr Nurul Hilmiati (BPTP, Lombok, Indonesia). All project staff were involved, with most emphasis on the Field Researchers. Eric Thorne-George was employed to manage in-country operations during the final six months of the project.

Where: The five cattle production systems research sites, plus Loes Research Station were the main research and training sites.

How: There were four elements to this program as follows.

4.1 Communications training. One of the issues faced is the low level of understanding by project staff of basic scientific and community engagement methods. Intensive training in methods of communication for all Timor-Leste based project staff was conducted on a 6-monthly basis.

4.2 Outreach. Project outputs and experience from Indonesia informed the design of a communication strategy for best-bet cattle management interventions that was labelled "outreach". It aimed to have five additional farmers in each project area to learn about and plant forages that will be used for implementation of cow and suckling calf supplementation during the dry season and of weaning. The introduction of either of these interventions relies on the successful establishment of sufficient quantities of forages for feeding the weaners or calves. It involved establishment and cultivation of forages, both herbaceous and tree legumes, supplementary feeding of calves and cows with herbaceous forages, and penning of calves. The strategies were expected to improve beef production at a household level. While training methodologies were tested, the participating farmers also helped to critically review and adapt the technologies offered in order to develop systems that suit the local conditions in each location for scaling up later.

4.3 Training of trainers. Full details are provided in Appendix 7. In the final stages of the project, a major workshop was held during which a comprehensive communication strategy was tested. The primary focus was on developing capacity in project staff and in a large number of MAF staff to help households adapt new cattle systems options. Emphasis was placed on technical content as well as communication and extension methods. In the lead up to this workshop a video was produced targeting smallholder farmers and their advisers on opportunities for implementing alternate cattle systems.

4.4 Post-graduate training. As Timor-Leste's agricultural RD&E has a major requirement to develop capacity in statistical methods (biometrics) and in communications science, the project funded scholarships for Masters degrees by course work and research. Two have a required content of biometrics training in their course at the Mataram University in Lombok. The third student's target degree was a Master of Communication Science at Gadjah Mada University in Yogyakarta.

6 Achievements against activities and outputs/milestones

Objective 1: Provide a situation analysis that characterises Timor-Leste smallholder beef cattle systems and associated beef industry stakeholders as a basis for site selection and ensuing project operations

<table>
<tr><th>no.</th><th>activity</th><th>outputs/ milestones</th><th>completion date</th><th colspan="3">comments</th></tr>
<tr><td>1.1</td><td>Implement a project structure that maximises the probability of success</td><td>Six junior scientists selected and trained in monitoring methods (A, PC)</td><td>Oct 12</td><td colspan="3">Six graduates of the National University of Timor-Leste (UNTL), 3 men and 3 women, were recruited to the project in July 2012 through a competitive selection process. These people are future cattle scientists within Timor-Leste, and their positions are titled “Field Researcher” (to enable translation into local languages).

The field researchers received considerable training, including techniques for needs and opportunity assessment, data management, basic statistical methods, conduct of forage evaluation trials and farmer group facilitation.</td></tr>
<tr><td></td><td></td><td>Five project sites selected (A, PC)</td><td>Oct 12</td><td colspan="3">Through a rigorous objective process of village selection within a situation analysis, five initial project sites were selected:</td></tr>
<tr><td rowspan="7"></td><td rowspan="7"></td><td rowspan="7"></td><td rowspan="7"></td><td>District</td><td>Suco (village)</td><td>Aldeia (hamlet)</td></tr>
<tr><td>Oecusse</td><td>Naimeco</td><td>Bonemese</td></tr>
<tr><td>Bobonaro</td><td>Aidabaleten</td><td>Tutubaba</td></tr>
<tr><td>Liquiça</td><td>Guico</td><td>Pandevu</td></tr>
<tr><td>Lautem</td><td>Parlamento</td><td>Asir/Iparira</td></tr>
<tr><td>Manufahi</td><td>Fatucahi</td><td>Weleness</td></tr>
<tr><td></td><td></td><td>Changes to project milestones due to situation analysis outcomes agreed and ratified (A, PC)</td><td>Dec 12</td><td colspan="3">There were no requests for alteration to milestones.</td></tr>
</table>

1.2	Conduct a situation analysis in 10-15 villages in 5 sub-districts	Detailed location reports describing smallholder beef systems (A, PC)	Dec 12	The situation analysis found that 98% of households kept cattle, generally by free ranging or herding. Family herd size ranged up to 70 with medians of 6.6 cows and 2.2 bulls. Cattle were the most important cash income enterprise in 37% of farms, ahead of maize and rice. Social status from having large numbers of cattle was important for 31% of families interviewed. The annual net return for families from cattle was estimated at US$440 with high variability, including a negative net return for two of ten survey areas. Modelling of situation analysis data indicated that annual live weight production per beef animal averages ~25 kg, with a live weight production ratio (LWPR) of ~0.15. LWPR is a measure of efficiency and is calculated as net live weight produced / live weight of cattle that produced it, the denominator being a measure of feed intake. The low productivity is about half of what is achievable based on experience in northern Australia. Though annual growth of surviving juveniles is three times the average LWP, productivity is drastically reduced by high adult cattle and calf mortality rates. The model estimated annual calf mortality in Timor-Leste at >10,000 and close to calculated annual sustainable off-take from the national herd at current performance levels, highlighting a major production opportunity. A full report is available.
		Possible best-bet beef farming options identified (A, PC)	Dec 12	The situation analysis suggested implementation of management to improve calf survival and pre-weaning calf growth are likely to improve household beef production. Best-bet options to improve beef cattle production and efficiency are likely to include improved calf management, introduction of weaning and targeting of higher quality forages to weaners and growing animals.
		Stakeholders' capacity mapped (A, PC)	Dec 12	A process was implemented in which in-country team members conduct self-assessment on an annual basis. The first assessment was conducted in late 2012. Change in capacity is measured by the individuals' own realisation of how they have developed over annual periods.

PC = partner country, A = Australia

Objective 2: Increase annual live weight production per cow by at least 50% by adapting practical innovations and systems suited to a large majority of livestock farmers to village-based cattle production systems

no.	activity	outputs/ milestones	completion date	comments
2.1	Implement and monitor all aspects of beef production within each project site where innovations have been introduced	Description of more efficient Timor-Leste beef and forage production systems at 5 project sites (PC)	Jun 13	Forage evaluation and production sites were established with progress generally as planned. High biomass yields were achieved with both legumes and grasses. The experience of the field researchers with these evaluations is invaluable when they assist farmers alter forage cropping practices. Field researchers were located at each of the five sites identified through the situation analysis. At each site field researchers worked with farmers to develop simple infrastructure systems to monitor beef cattle production. The field researchers were trained in all aspects of data and sample collection, data recording and entry. Enrolment of cattle into the project commenced with cattle identification and baseline data collection. The activity commencement was approximately 3 months behind schedule. The village-based beef production systems were monitored over the duration of the project with opportunities to improve beef production identified in 2013/2014 and evaluated on-farm in a participatory approach with farmers in 2014/2015. The allied ACIAR project LPS/2011/004 provided valuable cattle forage and management systems information considered for alternate management at each of the 5 project cattle research sites.
			Jun 14	Monitoring of on-farm beef production commenced in Liquica (Guico), Bobanaro (Aidebalaten), Manufahi (Fatucahi) and Oecusse (Naimeco) districts in July 2013; monitoring in Lautem (Muapitine) commenced in Dec 2013 after the Parlemento site was discontinued due to inability to access cattle for monitoring, combined with unrealistic expectations created by a team member who left the project. Variable on-farm forage demonstrations of a range of grasses and herbaceous and tree legumes integrated within the existing farming systems occurred at Guico, Muapitine, Fatucahi and Naimeco. A poor 2013/2014 wet season limited establishment of these demonstrations. The project's experience was that village-wide or farmer group implementation of innovations is generally inappropriate in Timor-Leste. It was more effective is to work with only one or two households to demonstrate successful change in cattle management to other farmers. Subject to availability of feedstuff, innovations included weaning and strategic feeding of high quality feedstuffs to both suckling (Lautem) and weaned (Liquica, Manufahi, Oecusse) calves. No innovations were be implemented at the Bobonaro site.

			Dec 15	Longitudinal monitoring of household cattle production in five districts from 2013 indicated 70% of calves are born in the peak of the dry season, calf mortality is between 7% and 17%, cows are generally in body condition score of 3 or more at calving, live weight gain of male cattle is typically 0.1 and 0.3 kg/day in lower (Oecusse and Aidebalaten) and higher rainfall districts (Muapitine and Fatucahi), respectively. A relationship between girth and live weight of Bali cattle in Timor-Leste was developed and shown to be almost identical to that for Bali cattle in Indonesia. Production was monitored until October 2015, with simple improved management strategies introduced in a small number of households. Surveys of participating households were conducted to better define their specific farming and livestock production systems. Live weight gain of suckling calves supplemented with rice bran and leucaena was 0.2 kg/day over the dry season, while un-supplemented calves barely maintained live weight over the same period. Supplementation did not occur over the subsequent wet season and the advantages of dry supplementation were eroded. 2013-14 forage research results were tempered by later planting and sub-optimal climatic conditions although insights into species able to handle dry conditions and acid soils were highlighted leading to modification of subsequent research. Forage research and demonstration sites were successfully established in 2014-15 at Loes (seed increase and field researcher/student training), Oecusse (low rainfall species evaluation and demonstration) and Los Palos (acid soils species evaluation and demonstration).
		Develop and evaluate cattle infrastructure designs (A, PC)	Dec 15	A cattle yard designed for Timor-Leste smallholder conditions was constructed at Muapitine. The farmers were extremely pleased with it. Modifications were made in building a second yard in a highly-visible site at Aidabalaten.
		Principles for efficient sown forage production and feed utilisation available (PC)	Dec 15	A training document ‘Producing forages for cattle feeding’ was developed and translated into Bahasa Indonesia for use in the outreach program managed by MAF.
2.2	Conduct an experiment to assess the relative efficacy of animal management options	Alternate methods of implementing a new farming practice compared (PC)	Jun 14	To address the issue of high calf mortality and low calf growth rates in the dry season in Timor-Leste, an experiment testing the effects of several months of leucaena plus rice bran supplementation of suckling calves was conducted near Manatuto. Supplementation increased calf growth by 0.2 kg/d, though full compensatory growth subsequently occurred. This activity involved many UNTL students and staff for capacity building, with their involvement in animal health treatments, feeding cattle, conducting measurements and collating and interpreting data.

PC = partner country, A = Australia

Objective 3: Recommend market systems and policy settings that can alleviate constraints to profitable beef production and achieve sustained increases in smallholder household income, and ultimately national wealth

no.	activity	outputs/ milestones	completion date	comments
3.1	Describe how beef cattle and beef production fit within smallholder livelihoods	The costs and benefits of smallholder beef ownership described (A, PC)	Jun 13	To complement other components of the project that concentrated on cattle production at site and household levels, a report provided regional and national level analysis with context for: • Agro-climatic conditions • Other agricultural activities • The role of cattle in household income and sales • Socio-cultural settings
3.2	Conduct detailed analysis of local, regional and international supply chains for Timor-Leste beef production	Current beef production and supply chains mapped (A, PC)	Jun 13	Industry structures were examined and analysed through a sub-sector approach. Each sector (consumption and retailing, processing, cattle marketing, cattle production and inputs sectors) was examined in detail. Estimates were made on the relative importance, structures and functioning of major chains (Dili wet markets, Dili higher value, local slaughter and ceremony, and cross-border). This information has been incorporated into a comprehensive review.
		Marketing and policy solutions for supply-chain restrictions identified (A, PC)	Dec 15	Based on 3.3, comments were made about the logic and efficacy of the full range of policies and marketing interventions undertaken by the Timor-Leste government and development agencies. These range from failed policy experiments (especially the privatisation of the inputs sector), to understandable policy measures (centralisation of processing and retail) that will need to be revised to be implementable, to policy voids (in the key areas of cattle production and international trade) that will need to be strengthened. Marketing systems were examined in detail and the benefits and feasibility of various interventions were assessed. These vary enormously between areas and groups, so need to be assessed and implemented on an individual basis (in the follow-on project).
3.3	Analyse the regulatory environment for Timor-Leste beef production and marketing	Policies affecting beef production and marketing are reviewed (A, PC)	Jun 14	The project has documented in detail policy settings at industry and sector levels, along with the logic and trajectory of policy development. This provides a base from which to understand the impacts on production and marketing, and to provide recommendations on policy reform.
3.4	Develop farmer – trader-butcher-banker groups to take advantage of production opportunities	Innovation platforms established in three Districts	Dec 15	Discussions were conducted with these key stakeholders about a range of value chain interventions. There was strong interest in participation amongst the stakeholders, especially in Bobonaro and Manufahi. However, it was decided that detailed discussion of the organisational, logistic and commercial aspects of group development - and implementation – should be undertaken in a careful and orchestrated way in the follow-on project.

PC = partner country, A = Australia

Objective 4: Produce a communication strategy that improves smallholder farmer access to information that they can adapt into better farming practices

no.	activity	outputs/ milestones	completion date	comments
4.1	Design and pilot effective communication methods that deliver adaptable, practical information on better farming practices	Interim report on the development of a communication strategy (A, PC)	Jun 13	The situation analysis identified the level of access to information, services and infrastructure of the communities. This information informed the design of an outreach strategy that focused on forage productions and calf management (penning, weaning, feeding) that was introduced to farmers through learning-by-doing coupled with a thematic training approach. An initial batch of technical livestock, animal health and extension officers were trained as facilitators of further local government-managed outreach.
		Interim report on the development of a communication strategy (A, PC)	Jun 14	Progress was limited as results from forage and cattle management research systems ("content") were still being produced. Training in methods of communication was conducted. This activity was scaled up considerably in the final year of the project.
		Final report including the communication strategy (A, PC)	Dec 15	An Outreach Strategy Development Workshop was conducted from 4-6 August 2014. The strategy aimed to provide Timorese smallholder cattle farmers with access to information, learning opportunities, required inputs and services that relate to improved components of the cattle management system that has been researched by the project to date. Concretely, the strategy focuses on (1) Reducing calf mortality, (2) Weaning, (3) Fodder production and feeding, and (4) Integration of farm enterprises, while innovations relating to fattening, animal health and marketing would require more research before they can be integrated. In terms of process, the strategy involved the following elements: 1. ***Socialisation and awareness raising*** through meetings at village level with local government and farming community, and a field day demonstrating good practice. 2. ***Participatory field-based training*** (pilot) involving the four content areas over six training sessions. 3. ***Development of training materials and media***: technical manuals on content areas, facilitation manual for a cattle production outreach program, supporting media (promotional video). 4. ***Influencing policy/R&D*** to meet requirements for effective commercial cattle production systems. A full report on the communication strategy was prepared.

		Support the adaptation of a best-bet beef farming system with up to 5 farmers each in at least 3 research sites (A, PC)	Dec 15	Pilot implementation of the outreach strategy was conducted in four of the five project Districts. Five farmers commenced with plantings of leucaena in each of 5 project sites. Very poor seasonal conditions or hungry cattle breaking into plantings (primarily Naimeco site) resulted in failure of half the leucaena crops. Where the leucaena was successful, most of these farmers were able to successfully implement weaning of calves and or fattening of bulls. These practices were made possible by having cattle yards available. All farmers who were successful were very pleased with the outcomes. The Field Researchers also gained considerable capacity through this process.
4.2	RD&E agency capacity developed to deliver the communications strategy	3 Masters students selected (A, PC)	Dec 12	After a competitive selection process, Pedro de Deus and Walter Oliviera Soares commenced Master of Science degrees including coursework in biometrics at the University of Mataram. The third selected candidate, Quintaliano Afonso Belo, commenced studies for Master of Communication Science at Gadjah Mada University (Jogjakarta) in the second half of 2013.
		Project staff have demonstrated competence in conducting RD&E relevant to the communications strategy (A, PC)	Dec 15	Field Researchers have been delivering the Outreach Strategy following training: • Two MAF researchers and five field researchers (old group) participated in a three-day Outreach Strategy Development Workshop in August 2014, which enhanced their understanding of the elements required to build a strategy and • Eleven project and district staff (4 old FRs, 3 new FRs, 3 district Technical Staff) participated in a three-day training in March 2015, involving two days at MAF in Dili and one day with farmers in Guiço, Liquiça. The focus of the training was on enhancing facilitation skills of the participants and preparing them for delivering farmer learning and planning activities that are interactive and experience based, and also involved technical topics that form the core content of the Outreach Strategy. • Follow-up training has been be delivered in September 2015.
		Three students complete Masters degrees (PC)	Dec 15	Scholarships for 3 students ended in mid-2015. Pedro de Deus and Quintaliano Afonso Belo graduated in 2015. Walter Oliviera Soares has to complete his research and associated dissertation before he will graduate; he is using a diet digestibility study led by Dr Dahlanuddin as part of LPS/2013/022 for the research component.

		Conduct “train the trainer” workshops for field staff and develop supporting resources (A, PC)	Dec 15	A very comprehensive and successful work shop was conducted at Loes Research Station over several days bringing all research results and recommendations together for project staff and a large number of MAF extension staff. Content included: • Cattle farming in Timor-Leste: traditions, opportunities for improvement, and a vision for the future • Role of a facilitator • Establishing and working with farmer learning/business groups • Producing and feeding forages to meet nutritional requirements • Cattle live weight production – what is it and how is it achieved with all classes of livestock? • Cattle control – facilities and behavioural management • Estimating live weight and feed requirements • Bull fattening: managing nutrition of bulls to achieve efficient live weight production • Achieving high rates of pregnancy and calf survival • Participatory Monitoring and Evaluation: Why, who and how? • Business development and marketing • Workplan development

PC = partner country, A = Australia

7 Key results and discussion

7.1 Results

7.1.1 Situation analysis

Objective 1: Provide a situation analysis that characterises Timor-Leste smallholder beef cattle systems and associated beef industry stakeholders as a basis for site selection and ensuing project operations

Research question

How do beef cattle contribute to smallholder livelihoods and what are the associated risks?

Achievements

The situation analysis in the latter half of 2012 of 100 rural households in 5 sub-districts with relatively-high cattle populations in Timor-Leste found that 98% kept cattle, generally by free ranging or herding. Family herd size ranged up to 70 with a median of 8. The herds were typically 60% cows, 20% bulls and 20% calves.

About one-third of all respondents, and up to 50% of the women, reported as illiterate, while only one-quarter, who were mostly younger farmers, had enjoyed secondary high school.

Of the 100 farm households interviewed, 98% ranked cattle as one of their five most important enterprises, and for 37% it was their most important enterprise. Other enterprises of major importance included chickens, maize and pigs.

The reason why cattle are important, however, tended to be quite different from other enterprises, in that cattle primarily serve as a source of cash income (88% of the households interviewed) and also has an important role in establishing and maintaining social status in the community (31%). Very few (6%) of the households reported using cattle for home consumption.

It was very difficult to gather business records from the households due to a lack of records and illiteracy. However the data that was collected from 66 households indicated that average costs and sales revenue associated with their cattle were <USD100 and >USD500, respectively. Costs are mostly associated with some livestock purchases. Negligible other costs were associated with the almost universal lack of control and husbandry of cattle.

The most common constraint perceived by farmers was the occurrence of “diseases”. The lack of water, feed and grazing areas during the dry season were considered a major problem in all but the wettest areas such as Fatucahi (south-central coast).

Through a structured process during the situation analysis, five cattle production research sites with suitable infrastructure were identified and established: Guico (Liquica), Aidebalaten (Bobanaro), Fatucahi (Manufahi), Naimeco (Oecusse) and Parlamento which was later moved to Muapitine (Lautem). The Lautem site had to be altered to the current site after one year because the prevailing management system prevented any longitudinal data collection at this site. So a site where we could actually monitor cattle was selected within the same district.

Full details are presented in Appendix 1.

7.1.2 Situation analysis

Objective 2: Increase annual live weight production per cow by at least 50% by adapting practical innovations and systems suited to a large majority of livestock farmers to village-based cattle production systems

Research question

Which low- or no-cost (financial and time) interventions can increase local beef production efficiency?

Achievements

7.1.2.1 Forage evaluation and production

In 2012/13 all grasses, with the exception of Mulato, achieved cumulative rain-fed yields of >20 t DM/ha over 4 harvests, with the locally sourced *Panicum purpureum x glaucum* being the most productive at 27 t DM/ha at Loes Research Station, Liquica, (Table 7.1.2.1). The legumes, *Lablab purpureus*, *Clitoria ternatea and Macroptilium bracteatum* produced seasonal yields of 8-11 t DM/ha while the *Stylosanthes spp.,* which were slow to establish, produced yields of 2-3 t DM/ha during the same period.

Table 7.1.2.1 Cumulative seasonal biomass yield (mean kg DM/ha) for grasses and herbaceous legumes evaluated at Loes, Liquica (2012-13)

Harvest No-Year **Days after sowing**	**H1-2013** **59 d**	**H2-2013** **117 d**	**H3-2013** **148 d**	**H4-2013** **197 d**	**Total Yield**
Grass					
Paspalum atratum (Atratum)	0	0	0	0	0
Brachiaria sp. (Mulato)	2988	3238	2670	1342	10237
Brachiaria brizantha (Brizantha)	7444	7263	5360	2507	22574
Panicum maximum (Guinea)	6300	6100	5134	2083	19618
Pennisetum purpureum x *P. glaucum* (King)	8506	8288	8129	2437	27359
Setaria spachelata (Setaria)	7214	7038	4055	1485	19791
Legume-perennial					
Clitoria ternatea (Butterfly Pea)	4233	3990	2181	2017	12422
Macroptilium bracteatum (Burgundy Bean)	3730	3475	0	2001	9206
Stylosanthes guianensis (Brazilian Stylo)	0	0	3238	0	3238
Stylosanthes hamata (Verano)	0	0	2038	0	2038
Legume-annual					
Centrosema pascuorum (Centro)	4097	0	0	0	4097
Lablab purpureus (Dolichos)	4320	3828	0	0	8148

The low pH of the soil at Lautem and the late establishment of all experiments impacted on establishment and productivity in the 2013/14 season at a bimodal rainfall site in the district of Lautem and a unimodal site in Oecusse. As a consequence, limited information was gained from the Lautem experiments and yields were lower than anticipated at Oecusse (Table 7.1.2.2) where the successfully established grasses (*Brachiaria spp.* (Mulato), *Panicum maximum cv Simuang* and *Brachiaria brizantha)* yielded between 1.75 and 2.5 t DM/ha and the legumes, *Macroptilium bracteatum* and *Lablab purpureus* between 3 and 4.5 t DM/ha.

To expose participating farmers to the potential for the use of herbaceous legumes and grasses in combination with alley cropped browse legumes, demonstration sites were planned for the districts of Liquica (Guicu-3), Lautem (Muapitine-4), Manufahi (Fatucahi-2),

Bobonaro (Aidebelatan-2) and Oecusse (Naimeco-1) in 2013/14. Some alley crops of *Leucaena leucocephala* and *Sesbania grandiflora* were established although in the case of the acid soil sites at Muapitine, these were severely affected by termite attack. No grasses or herbaceous legumes were successfully grown at any of the sites. This was a result of wet season failure, poor timing of establishment, insect attack, deliberate fence breeches to feed local livestock, other farmer priorities and a lack of commitment from several field researchers responsible for this work.

Table 7.1.2.2 Cumulative seasonal biomass yield (mean kg DM/ha) for grasses and herbaceous legumes evaluated at Naimeco, Oecusse (2013-14-15). NB: *Clitoria ternatea* is shown as an annual as it was planted in both 2014 and 2015 seasons.

Harvest No-Year **Days after sowing**	**H1-2014** **137 d**	**H2-2015** **466 d**			**Total Yield**
Grass					
Brachiaria sp. (Mulato)	877	590			1467
Brachiaria brizantha (Brizantha)	903	141			1044
Brachiaria decumbens (Signal)	0	0			0
Digitaria milanjiana (Jarra)	0	0			0
Panicum maximum (Guinea)	0	0			0
Pennisetum purpureum x *P. glaucum* (King)	978	5009			5987
Setaria spachelata (Setaria)	0	0			0
Harvest No-Year **Days after sowing**	**H1-2014** **81 d**	**H1-2015** **380 d**	**H2-2015** **431 d**	**H3-2015** **466 d**	**Total Yield**
Legume-perennial					
Macroptilium bracteatum (Burgundy Bean)	4597	4905	1783	0	*4597/6688
Stylosanthes guianensis (Brazilian Stylo)	164	0	0	0	164/0
Stylosanthes seabrana (Seabrana)	965	8496	0	813	965/9303
Harvest No-Year **Days after sowing**	**H1-2014** **81 d**	**H1-2015** **64 d**	**H2-2015** **109 d**		**Total Yield**
Legume-annual					
Clitoria ternatea (Butterfly Pea)	0	345	0	**0**	0/345
Centrosema pascuorum (Centro)	348	-	-		348/-
Lablab purpureus (Dolichos)	2891	3221	5240		2891/8461
Mucuna pruriens (Velvet Bean)	-	1680	0		-/1680

'-' the species was not grown in a particular year
*xxx/xxx indicates a species that was grown in 2 consecutive seasons with yield attributed to the particular production season

None of the legumes, with the possible exception of *Stylosanthes guianensis* (yield of >5 t/ha DM including leaf and stem) reached their productive potential on the acid plains soil at Muapitine in the 2014-15 season (Table 7.1.2.3) even with seasonal rainfall of >1000mm. The next highest yielding legumes were the annuals, *Lablab purpureus* and *Mucuna pruriens* both of which produced ~2 t/ha DM, mostly in the first 66 days of production. *Clitoria ternatea* was the least well adapted legume with all plants (+/- lime) dying soon after the first harvest. *Stylosanthes seabrana* did not establish. While grasses appeared to grow and to yield reasonably well, even without lime, the legumes were generally unthrifty and spindly even where lime was applied. These results suggest that, a) grasses were less affected by soil acidity, although it is possible that plants would respond to higher rate of lime, whereas b) the legumes were adversely affected by soil acidity and the lime application rate of 2.5 t/ha was insufficient to ameliorate soil condition.

Table 7.1.2.3 Cumulative seasonal biomass yield (mean kg DM/ha) for grasses and herbaceous legumes evaluated at Muapitine, Lautem (2014-15)

Harvest No-Year **Days after sowing**	**H1-2015** **66 d**	**H2-2015** **124 d**	**H3-2015** **201 d**	**Total Yield**
Grass				
Brachiaria brizantha (Brizantha)	2246	6678	6054	14978
Brachiaria sp. (Mulato)	519	3062	6511	10092
Brachiaria decumbens (Signal)	987	5217	5538	11742
Brachiaria humidicola (Humidicola)	1780	6156	4119	12055
Pennisetum purpureum x *P. glaucum* (King)	3841	4305	5747	13893
Setaria spachelata (Setaria)	2122	6004	0	8126
	H1-2015 **66 d**	**H2-2015** **201 d**		**Total Yield**
Legume-perennial				
Clitoria ternatea (Butterfly Pea)	210	0		210
Stylosanthes seabrana (Seabrana)	0	0		0
Stylosanthes guianensis (Brazilian Stylo)	368	3988		4356
Legume-annual				
Lablab purpureus (Lab Lab)	1423	863		2286
Mucuna pruriens (Velvet Bean)	2067	0		2067
Vigna unguiculata (Cowpea)	1349	0		1349

At Muapitine in 2013-14 and 2014-15, leucaena was successfully established on black forest soils. The crop failed on acid soils where its roots were eaten by termites. The crop is providing fodder to livestock. The alleys are being used for chili farming. A frustration however, is that while *Gliricidia sepium* has been observed to grow well on the acid soil, farmers consider it unpalatable to stock and will not attempt to feed it to their animals.

Seed production systems were competently established following the training of Yuliaty in Australia (Table 7.1.2.4).

Table 7.1.2.4 Seed increase yields (kg/ha) at Loes between 2013 and 2016

	2013-14	**2014-15**	
	Clean & dry	**Clean & dry**	**In-shell**
Stylosanthes seabrana (Seabrana)		6.2	831
Lablab purpureus (Dolichos)	4.5	26	1733
Macroptilium bracteatum (Burgundy Bean)	2.3	13.5	1800
Clitoria ternatea (Butterfly Pea)	1.5	12	1600
Stylosanthes guianensis (Brazilian Stylo)		yet to be harvested	
Mucuna pruriens (Velvet Bean)	8.5		
Panicum maximum (Guinea)	Veg available	Veg available	
Pennisetum purpureum x *P. glaucum* (King)	Veg available	Veg available	
Brachiaria sp. (Mulato)		Veg available	
Setaria spachelata (Setaria)		Veg available	
Total seed supply by year (kg)	**16.8**	**57.7**	
Current total seed supply (kg)		**74.5**	

Full details are provided in Appendix 3.

7.1.2.2 Beef production systems

Approximately 100 cattle in 10-18 households were monitored within each of the 5 sites. Average land owned was 2.3 ha, of which three-quarters was fenced and 13% irrigated. On average, land owned was 2 km from the householder's dwelling.

Cows comprised 40-50% of household herds which averaged 6-9 cattle. The largest household herds were ~30 cattle in all project sites. The proportion of households with other livestock and the average number of those livestock when present was: 92% with 6 pigs and 15 poultry, 71% with 6 goats, 10% with 5 buffalo, and 18% with 3 horses.

Average household population was 6 people with half of each gender and half being children. Households typically invested 3-7 hours daily in cattle management.

Cattle dietary crude protein (CP) across all sucos estimated using near-infrared reflectance spectroscopy (NIRS) of faecal samples generally fell within 6-12%, tending to be lower in the dry season as expected; e.g., data for Naimeco is presented in Figure 7.1.2.1. Dry matter digestibility (DMD) reflected that of CP across all sites and ranged from 42% to 70%. The higher than expected predictions of diet quality consumed by cattle are attributed to a high proportion (typically 20-40%) of non-grass in the diet, particularly in the dry season. Stands of local leucaena, gliricidia and other shrubs and trees are available across much of Timor-Leste and generally provide small quantities of green, high protein material in the dry season. The prediction of the proportion of non-grass in the diet appeared highest in Guico and lowest in Muapitine, which largely reflects observations of the availability of feed resources in these areas during the project; i.e., cattle in Muapitine spent much of the year grazing on an open grass-land, acid soil plain dominated by low quality local grasses. While the quality of the diet consumed by the cattle in the sucos may be high, the quantity may have been limiting production, particularly in Aidebalaten and Naimeco where only small quantities of leaves and pods from trees and shrubs and crop residues would be available for cattle, thereby providing small amounts of a relatively high protein diet but limited amounts of metabolisable energy. The phosphorus content of the faeces was lowest in Aidabalaten and Naimeco at 2 g P/kg faecal DM at some stages during the year, which may indicate a response to P supplementation if dietary protein and energy are not also limiting at this time.

Body condition scores of cows averaged close to moderate (3 on a 5-point scale) at the driest sites of Naimeco and AIdabelaten, and moderate to forward (3-4) at the other sites. Neither time of year nor lactation status appeared to have substantial influence on cow body condition.

In the 2-year monitoring period, approximately 75% of all calves were born in the mid- to late-dry season (June to October; Figure 7.1.2.2) with average calf birth weight within site and year at 14-17 kg. Cows calving annually was lowest at 25% in Naimeco (Oecusse) which was the driest site, and highest at 64% in Fatucahi on the south coast which was the wettest site. This calving rate appears to include neonatal mortalities which were not usually recorded, partly because of the extensive nature of the production systems used. Post-natal mortalities were very high and averaged 13% across the project. In addition, 12 abortions were recorded at Muapitine.

Though six Aidabalaten farmers weaned calves during the dry season at an average calf age of 10 months (7 to 14 months), most calves were naturally weaned (up to 26 months of age), usually when the cow had another calf.

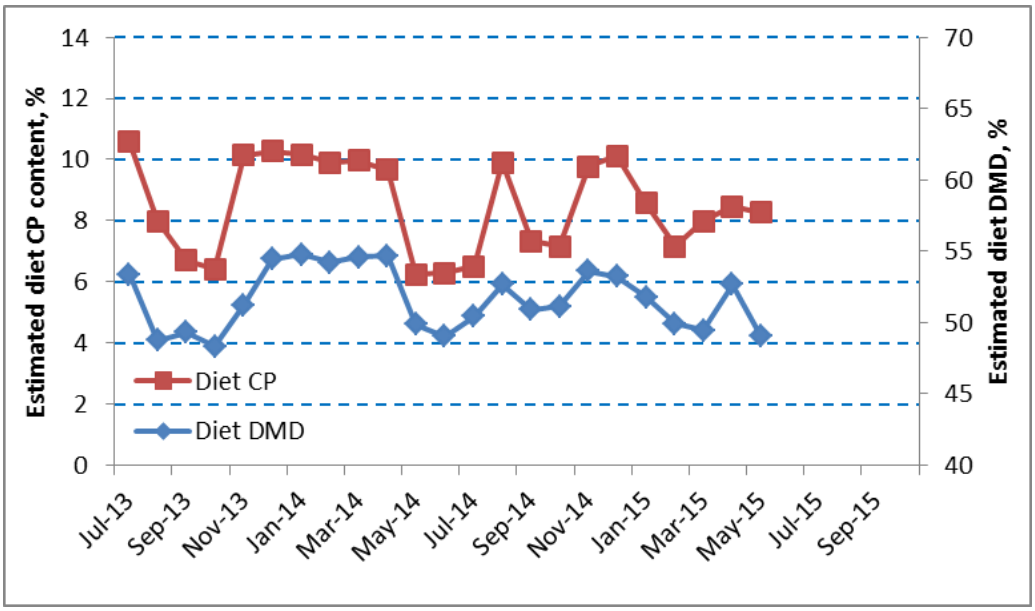

Figure 7.1.2.1 Monthly variation in estimated crude protein (CP) and dry matter digestibility (DMD) content of consumed diet of Bali cattle at Naimeco suco

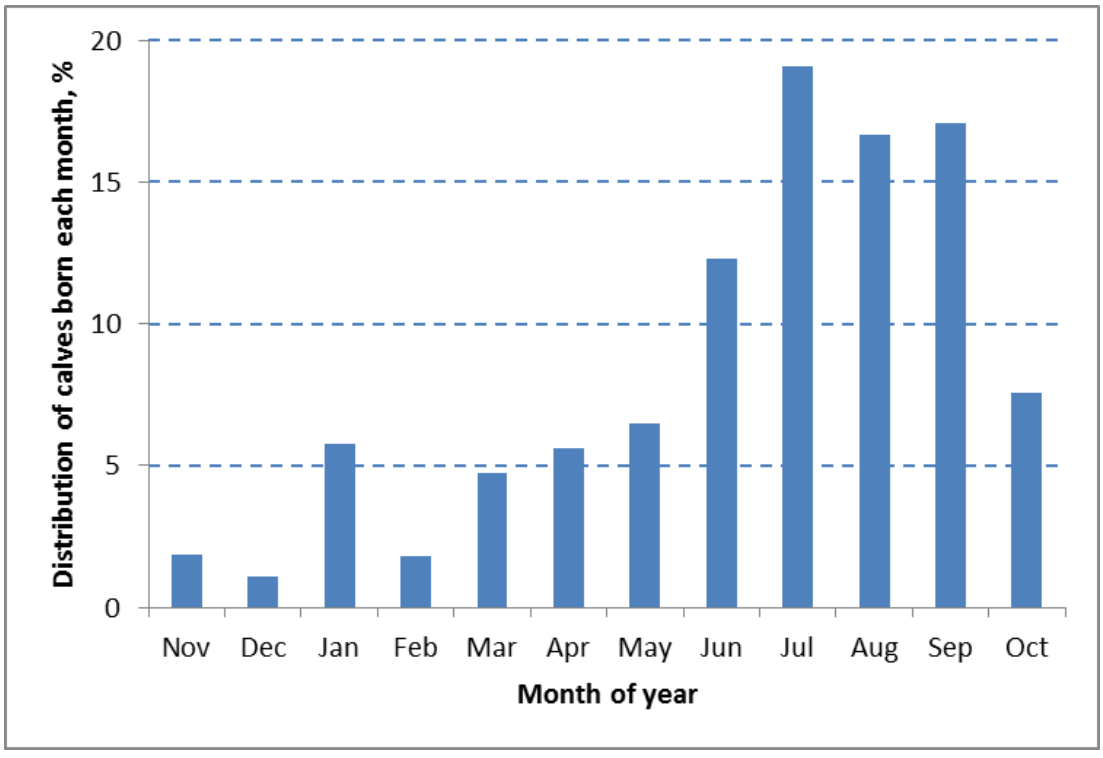

Figure 7.1.2.2 Distribution of calving across two years of monitoring at five suco sites in Timor-Leste

Live weight gain of bulls ranged from 0.1 to 0.35 kg/day across the five sucos, with bulls in Fatucahi and Muapitine having the highest live weight gain (approximately 0.3 kg/day) and Aidebalaten and Naimeco the lowest (~0.1 kg/day; Figure 7.1.2.3). The higher growth rates in Fatucahi and Muapitine reflect the longer wet season and greater availability of green feed throughout the year. Lactating cows lost live weight during the dry season (peak calving period and hence peak milk production) in all sites with only modest live weight gains over the wet season (0.1 to 0.15 kg/day). Non-lactating cows recovered live weight in the wet season (0.1 to 0.2 kg/day) at all sites but lost live weight in the dry season in Aidablaten and Naimeco, reflecting the drier conditions in these sucos. Growth of calves

and heifers was comparable to that of bulls and cows, with highest average daily gain (0.3 kg) in Fatucahi, and lowest average daily gain in Aidebalaten and Naimeco (0.1 kg). There were no bulls weighing >150 kg at the dry site of Aidabalaten. Only at the wetter sites of Fatucahi and Guico did more than 20% of bulls weigh >200 kg.

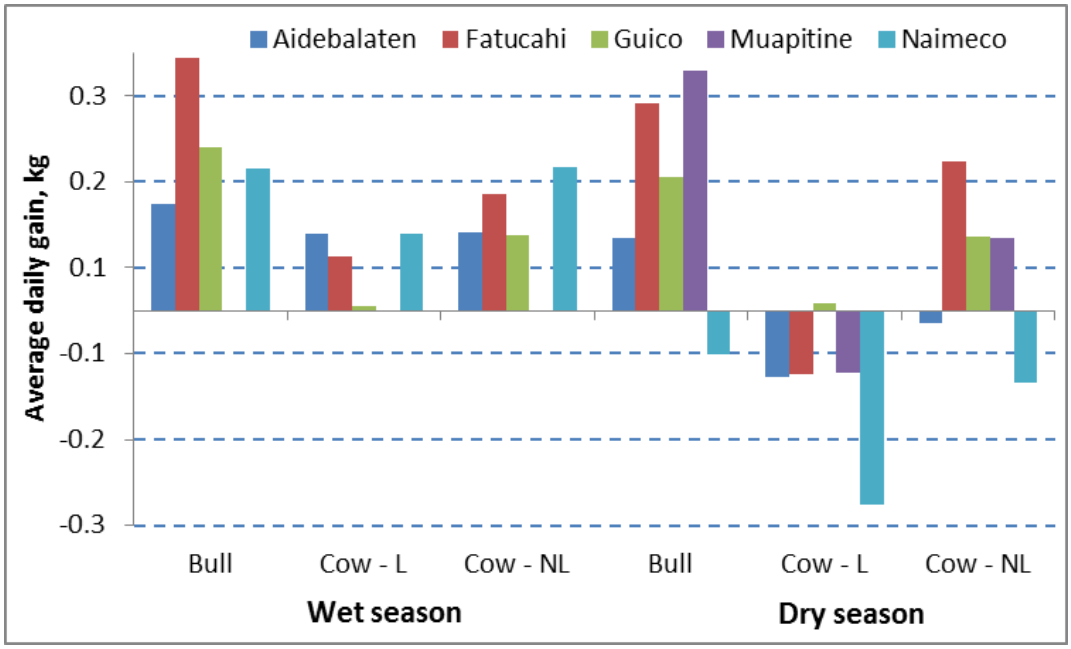

Figure 7.1.2.3 Average daily gain of bulls, lactating (Cow-L) and non-lactating (Cow-NL) cows over the wet and dry seasons at five suco sites across Timor-Leste

Despite highly variable cattle management, environmental and measurement conditions and significant differences in operator capacity and animal temperament, girth was a reliable and robust predictor of live weight of Bali cattle when scales are unavailable: LW (kg) = 6.6972*EXP(0.0228*Girth in cm). This was comparable to the relationship developed for Bali cattle on Lombok (Figure 7.1.2.4).

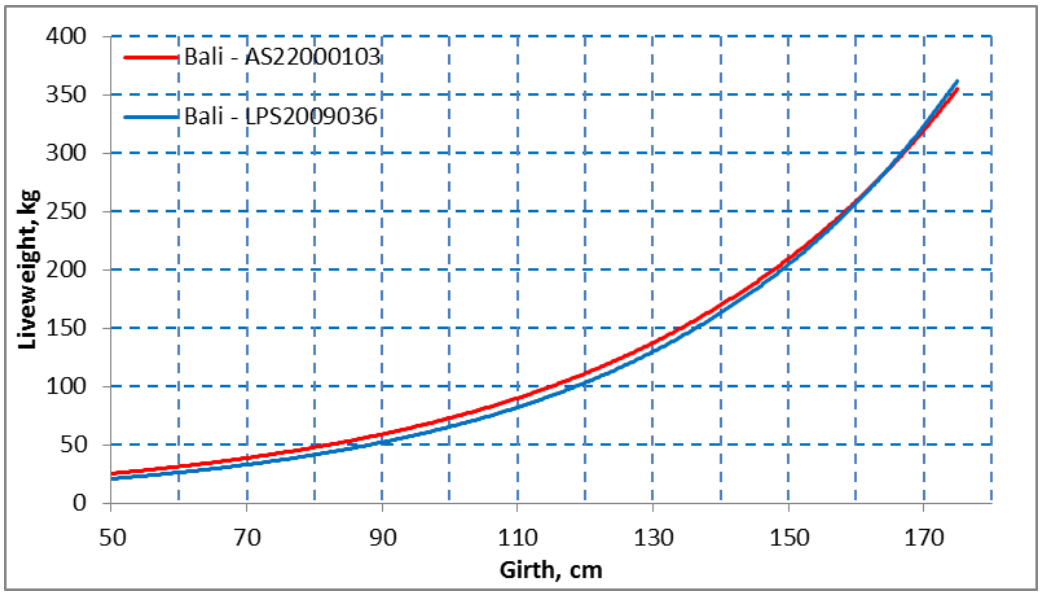

Figure 7.1.2.4 The relationship between live weight and girth of Bali cattle at five suco sites across Timor-Leste and in Kelebuh village, Central Lombok, Indonesia (AS2/2000/103)

Household surveys suggested that social reasons (status, ceremonies) were as important as financial reasons (income, savings) in owning cattle. This was partially supported by the disposal type data (Figure 7.1.2.5). Cattle were the highest income generator in one suco on the south coast (Fatucahi) where most cattle are traded. While bulls (~45%) and dry cows (~30%) were the main classes of cattle disposed of, small numbers of calves, heifers and lactating cows were also disposed. Controlled disposal with or without remuneration occurred for 22% of cattle annually, with a reported mortality rate of 18% and a further 2% reported stolen. There were no obvious peak times for disposal. Prices paid to farmers for the different classes of cattle tended to be lower in Aidebalaten and Naimeco which is attributed to the lighter condition and live weight of cattle at these sites compared to the other three sucos. In support of this, price per kg appeared to be around $2/kg irrespective of animal class, well below prices that could be obtained if cattle were sold through the Dili abattoir.

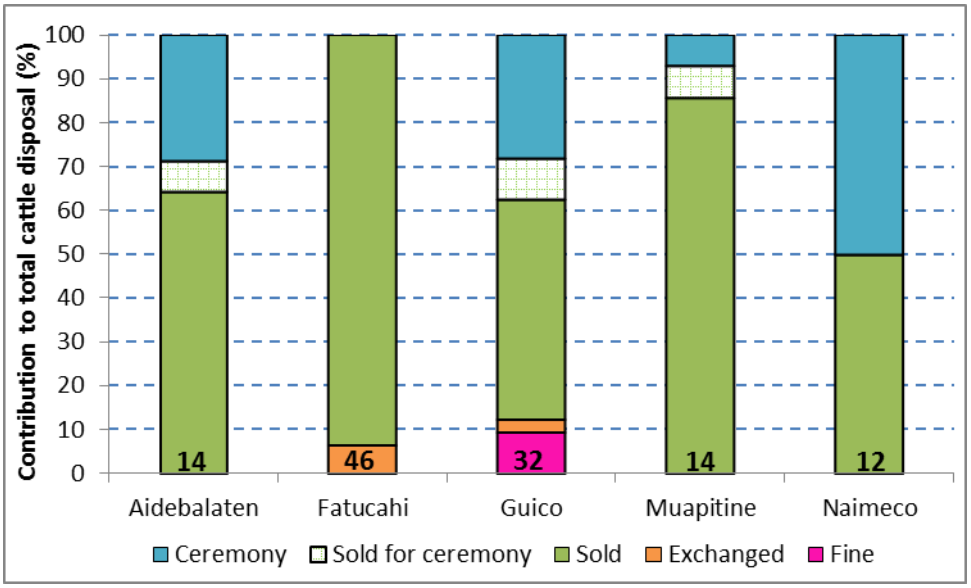

Figure 7.1.2.5 Total number and type of cattle disposal over two years from five suco sites across Timor-Leste

From the data available, it is estimated that annual live weight production on cattle at the driest sites of Naimeco and Aidabalaten was <40 kg, ~50 kg at Guico, and in the vicinity of 100 kg at both Muapitine and Fatucahi. The most obvious limiters to production were low weaning rates, low growth rates and high mortality rates, all of which appeared primarily driven by poor nutrition.

It was not possible to implement interventions such as weaning and strategic feeding of high quality feedstuffs to both suckling and weaned calves across all project sites to improve live weight production because of the inability of Field Researchers to support farmers in producing the necessary forages. As a result, no systems effects of interventions were obtained other than through application of the Outreach strategy (see Section 7.4.2).

Full details are provided in Appendix 4.

7.1.2.3 Forage and beef cattle demonstration

The project continued to support the on-going maintenance of the cattle fattening demonstration at Loes Research Station to the west of Dili in the hiatus between the SRA projects LPS/2011/004 and LPS/2013/022 led by Dr Dahlanuddin.

This simple but powerful demonstration was used by field staff to show farmers feeding of pure leucaena diets to cattle, which has not been a common practice. The outcome was

enhanced likelihood of farmers planting this and other forages, and of production feeding of their cattle.

Having these cattle penned also provided an ideal situation for training of UNTL Animal Science undergraduates. A large number of students completed their compulsory projects using these cattle demonstrations through monitoring feeding and growth.

Further details on these cattle are available in the final reports on the above-mentioned projects.

7.1.2.4 Creep feeding experiment

Bali calves (43 kg live weight) in the Manatuto district supplemented with leucaena and rice bran (20 g/kg LW.day) and allowed to suckle dams in the evening grew at 0.18 kg/day while unsupplemented calves maintained live weight (0 kg/day) over the same period (Figure 7.1.2.6). In the subsequent wet season, while they were allowed to continue to suckle, the difference in live weight diminished. There were no impacts on cow live weight (200 kg) or body condition (moderate).

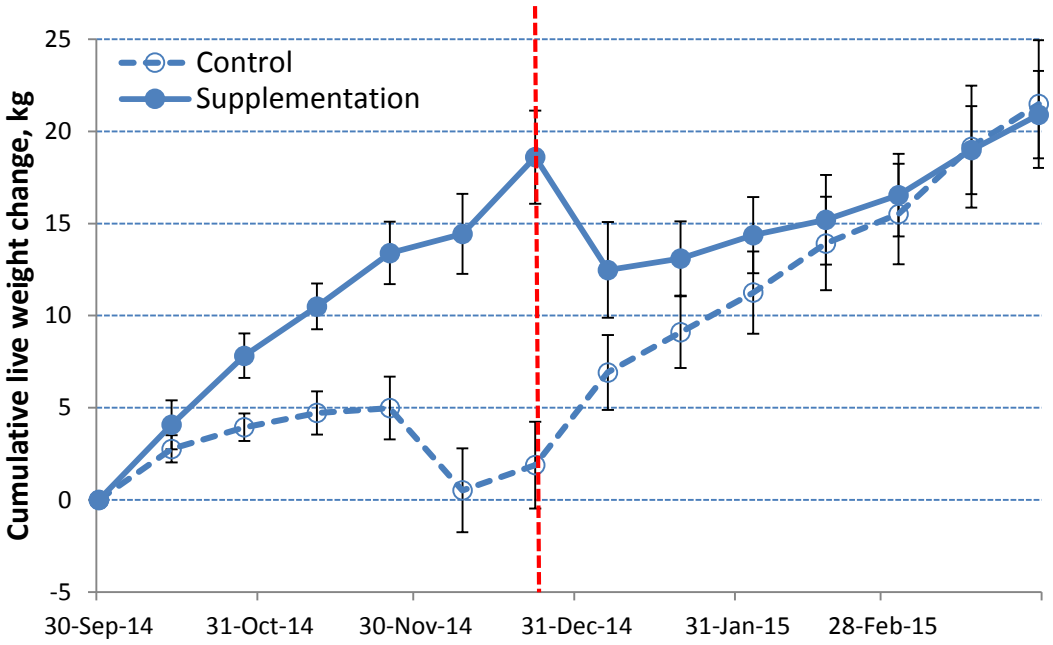

Figure 7.1.2.6 Cumulative change in live weight of pre-weaned Bali calves that either did (Supplementation) or did not (Control) receive supplementation in the dry season up to 23-Dec-14 in Manatuto municipality, Timor-Leste

Full details are provided in Appendix 5.

7.1.2.5 Develop and evaluate cattle handling infrastructure

The cattle yards built using cheap local materials for monitoring in the five municipalities provided an immediate, tangible result to farmers from their participation in the project. They realised the value of the yards and the holding facilities (Figure 7.1.2.7) for cattle control which has many advantages. These include being able to catch animals for transaction or consumption, being able to wean and feed calves, feeding bulls, and for animal health treatments. Animal health workers also quickly saw the value in the yards as treatments could be administered with much more safety and much less stress to themselves, the farmer and the animal than if yards were not available. The monitoring yards initially were a means to an end, where they allowed the collection of regular data from the household herds but were poorly designed for any other activities. The main issue was related to cattle flow, where race-ways existed with no force yard, race-ways were too long (or wide) and

exited into open grazing areas. This presented several problems, cattle were difficult to move into the race for measurements and farmers were reluctant to let them free graze upon completion of measurements as it became increasingly difficult to move the next animal into the race-way. As a result, animals were often returned to the remainder of the herd after data was collected, rather than out the exit of the race-way. Additionally farmers rarely released animals from the holding pen via the race-way, so animals never became accustomed to passing out the race-way stress free.

Figure 7.1.2.7 Typical holding facility on the periphery of a cattle yard constructed by collaborating farmers for cattle measurements

The yard with the new design built in Muapitine was very favourably perceived by the farmers. The materials were relatively inexpensive (~US$200). It featured sturdy construction, a raceway, yarding up areas, “Simon” slide gates, and provision for a loading ramp. Despite this, the yard did not incorporate all recommended features:

- The raceway was not even and too wide.
- A weaning and holding pen was needed.
- A secure feed storage area was needed.
- There was no water available at the yards – 500 m away.
- The yard needed to be set so that cattle were lured into the yard daily by water and supplements via the raceway.
- A loading ramp was not incorporated.

Materials were purchased for the next stage design to be built in early 2016 at a highly-visible place on the main highway in Aidabalaten.

7.1.3 Situation analysis

Objective 3: Recommend market systems and policy settings that can alleviate constraints to profitable beef production and achieve sustained increases in smallholder household income, and ultimately national wealth

Research question

What market opportunities exist to complement increased production and how can they be developed?

Achievements

To answer the research question, a detailed overview of beef cattle in Timor-Leste was conducted.

Statistics from 2004 and 2010 (most recent census) indicate that cattle are raised by approximately 40,000 (a quarter) Timor-Leste households. In 2010 the cattle population was reported at 161,654 and increasing at approximately 3% annually. For comparison,

buffalo numbers are 60% of this and static. A reported 9% of livestock meat production is from beef cattle (FAOStat), though this is likely to be a significant underestimate. Cattle are widely distributed across Timor-Leste (Figure 7.1.3.1) except in the northern Bacau-Dili region where there are relatively few. Beef imports from Australia and New Zealand in 2014 were estimated at 153 tonnes, which is the equivalent to slaughter of 1,000 domestic Bali cattle.

Figure 7.1.3.1 Cattle distribution in Timor-Leste. Source: 2010 national census. One dot represents 100 cattle, distributed randomly within suco boundaries.

Beef is of significant interest as a development activity for the TL government. Cattle are raised by a large number of households, have an established production position in TL farming systems, and make up a significant proportion of household income. There are established cattle and beef markets, both domestic and export, and beef has an established place in the Timor-Leste diet.

Features of the Timor-Leste beef cattle industry (Figure 7.1.3.2) include:

- Bali cattle are vastly superior for smallholder farming systems in Timor-Leste as: their small mature size confers low maintenance requirements; transport to slaughter is also much easier and safer than large cattle; and, they are preferred by live cattle traders in Indonesia.
- There are few commercial inputs in the predominant low input-low output systems.
- No farmers encountered in projects or fieldwork took out loans or held savings accounts. Opportunities exist for loans but are restricted by limited householder experience with banking and lack of collateral.
- In a 2012 survey of 1,800 households in 11 districts by MAF and the Seeds of Life project (ACIAR) found that 78% have no education or only primary school education.
- Extension services are very limited with most of the nominated village livestock workers no longer operating in that role.
- All animals including cattle are used extensively in a wide range of rituals and ceremonies and play a major role in demonstrating social position, fulfilling powerful social obligations, maintaining complex social networks and distributing resources. These traditions combined with local traditional law limit the transition to commercial cattle systems.

- Despite considerable investment by state and development agencies to building public and private systems, farmers manage most animal health problems independently. Programs aimed at controlling brucellosis and haemorrhagic septicaemia are having limited success.
- The vast majority of cattle are produced in "mixed" cow-calf and feeding households, in production systems dominated by grazing, supplemented by crops residues and forages in some areas. There are only a small number of specialised cattle fattening households.
- The primary health problem of cattle is under-nutrition as highlighted by less than 20% of the minimum requirements for dry matter intake by grazing livestock being produced on available grasslands.[9] This problem is potentiated by the lack of individual tenure over a majority of land.
- The majority of domestically-consumed cattle are slaughtered and retailed under very poor conditions and standards. However, the government is slowly shifting the situation using staged introduction of regulations, especially in Dili.
- Timor-Leste has a broad, comprehensive policy framework for development of the beef cattle sector. Interviews with MAF district offices suggest that broad national directives are indeed incorporated into planning at district levels and below but that implementation is highly variable. Policy-makers have taken an apparently staged approach to the implementation of regulations in the face of deeply embedded traditional institutions.
- Lofty goals for the Timor-Leste cattle sector have been set by the government, with resourcing to achieve these undefined, and emphasis being on increasing numbers rather than production. To achieve the latter requires fewer animals more efficiently utilising available forages, highlighting a fundamental policy problem.

Despite this relatively gloomy outlook, there remains opportunity to transition to more commercial systems as evidenced by a small number of households that are growing finishing penned cattle e.g., CCT-supported fattening in Oecusse) and the emergence of a few suppliers of forage. Most of this activity is in western Districts.

Full details are provided in Appendix 2.

[9] Requirements were calculated using ruminant population statistics and feed intake requirements of each class of livestock.

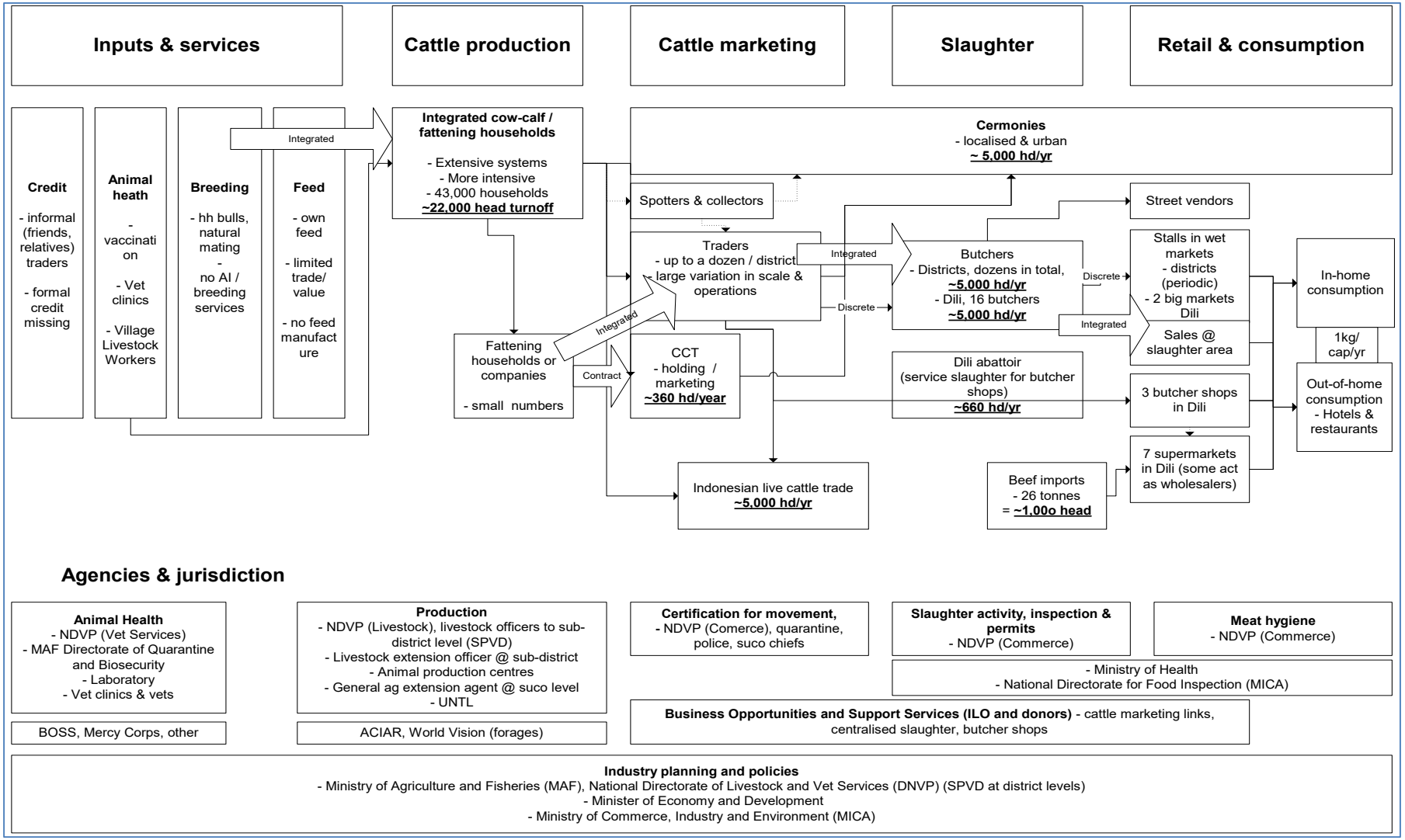

Figure 7.1.3.2 Supply chains and agencies in the TL beef industry

Various methods were used to reconcile beef cattle off-take, with the conclusions being:

- Beef cattle sales account for an average of 8% of rural household incomes in Timor-Leste (Table 7.1.3.1).
- Annual sales exceed 0.2 cattle/household almost exclusively in western Districts (Rob Williams, unpublished data; Figure 7.1.3.3). Net supply by the Timor-Leste population is approximately 1.66 kg/person/year.
- Dili is a major consumption area (806 tonnes) followed closely by the live export markets (750 tonnes equivalent). It is likely that about the same volume of beef is consumed in the districts (district slaughter and ceremonies) (801 tonnes), where 73% of the Timor-Leste population live.
- With no large abattoir that takes ownership of cattle, and only one case of contract production (CCT), the vast majority of cattle are traded through spot markets, where cattle are usually purchased by cash “on the spot”. Spot marketing systems are via collectors progressing to small and then large traders, with many traders slaughtering their own cattle.
- The overall off-take estimate is 21,000 cattle with 5,000 slaughtered for ceremonies, 5,000 sold through spot markets in Dili, 5,000 in the 13 districts, a further 1,000 into “higher value” Dili supply chains, and 5,000 cattle or so traded live across the border to Indonesia. This off-take is approximately 13% annually, which is half what occurs in countries such as Australia.
- There appears to be no financial incentives for either the Timor-Leste or Indonesian governments to police the cross-border trade from western Districts where there is a well-established supply chain. This trade has been officially constrained since 2010 by the difficulties of supplying health certification, with only very occasional disruption by government officials.
- Sales are seasonal, being limited during low-growth periods and peaking in holiday periods, especially for cross-border trade leading into Idul Fitri and Idul Adha.
- Government, development agencies and larger agribusiness actors aim to increase the relative importance of the higher value sector (especially centralised slaughter and butcher shops) and reduce the relative importance of other chains, including ceremonies.

Table 7.1.3.1 Average monthly income of rural households in Timor-Leste (2010 survey)

Income source	Income
All crops	$84.90
Chicken	$8.03
Pigs	$27.22
Cattle	$19.87
Buffalo	$15.83
Other livestock	$1.37
Fishing	$2.42
Forestry	$5.09
Total non-agricultural business and incidental work	$44.95
Total other income and money transfers	$41.83
TOTAL	$251.51

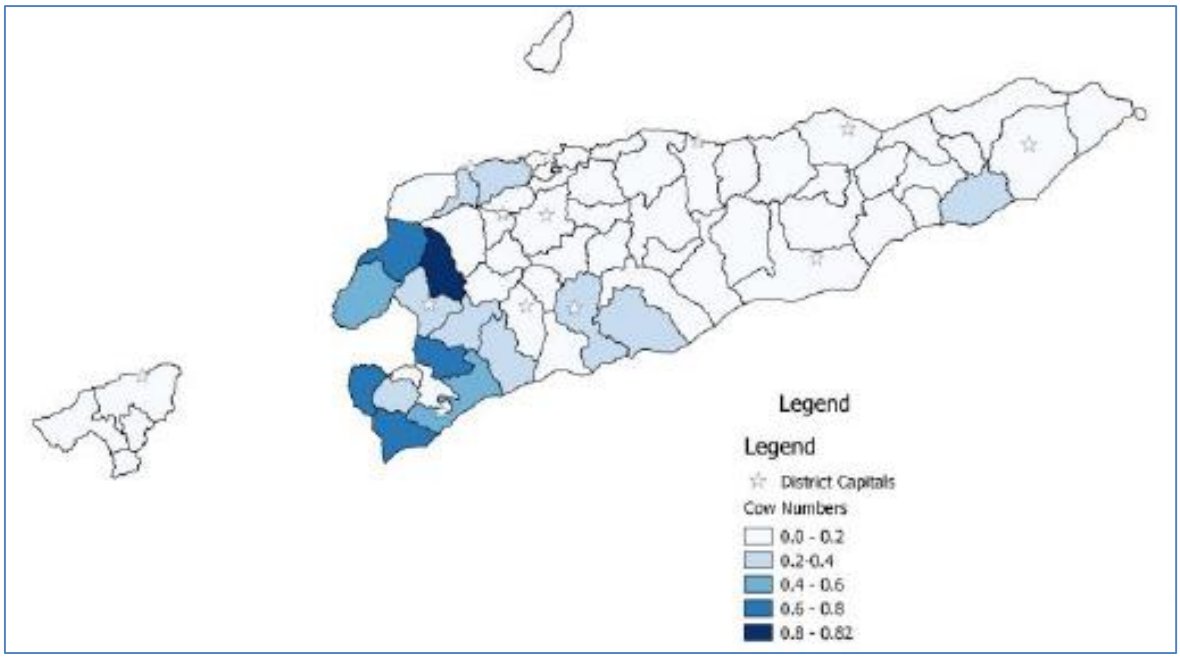

Figure 7.1.3.3 Average number of cattle sold per household per year by subdistrict (Source: Anon 2007)

The development of markets is most clearly seen in Dili, where it is being led by the emergence of over-the-scales purchase of livestock using a basic price grid (~2 cattle/day over the whole year in 2015), more hygienic slaughter practices through a government-owned abattoir and retail sales through modern butcher shops with refrigerated facilities. Higher median per capita income in Dili, double that of rural people, combined with its increasing population (5% annually due to urban migration), is supporting the increasing beef demand where annual consumption is estimated at 3.5 kg per capita in comparison to 1.3 kg per capita in rural areas.

Formalisation and development of the live cattle trade into Indonesia does not appear insurmountable and are supported by:

- On-going dialogue between the respective governments on facilities and logistics to achieve trade within agreed conditions.
- The lack of real differences in health status across the border.
- The on-going operation of a high-standard animal health laboratory in Dili.
- Timor-Leste's membership of OIE.

For both primary trade options, there is opportunity to improve the efficacy of the supply chain for the benefit of both farming and trading households. Options for doing this, such as contracted aggregation, will be studied in future research.

7.1.4 Situation analysis

Objective 4: Produce a communication strategy that improves smallholder farmer access to information that they can adapt into better farming practices

Research question

What feasible mechanisms are required and will provide farmers with access to information and services that would effectively support them to integrate improved cattle management practices into their farming system?

Achievements

7.1.4.1 Communications training

The six-monthly intensive training (Table 7.1.4.1) in communications for the project team was enthusiastically received at all times. A large range of participatory research and communication skills was taught with both theory and practical delivery: group problem and solution identification, planning, monitoring, evaluation, facilitation, elements to build a communication strategy, delivering farmer learning, incorporating technical content. At the project outset, project staff had previously received almost no training in communications. By the end of the project, the staff on the team were working very well with farmers. This was enhanced by establishing pairs of project staff where possible. There appeared definite advantages of a male and female field researcher pairs working with farmers as they were able to communicate better with all householder members.

A continuing challenge in communication is the technical content – e.g., general science methods, forage science, livestock science, marketing, communication. Technical elements provide context and communication is meaningless without content.

Technical training had to be delivered in a rudimentary way during the project to the employed staff. Under-graduate training had not fully prepared selected staff in scientific knowledge and methods. It is possible this is partly a function of the severe disruption to early education during the relatively-recent civil conflict, and the on-going development of UNTL with very limited resources. The project recommends structured training for staff in future projects.

During the project, two international visitors were invited to contribute to technical development within the project. Dr Richard Copland visited the project in February 2013. Dr Copland has many years of association with ACIAR-sponsored activities in Timor-Leste. He made an excellent contribution to training of staff in research methods and was able to provide all team members with detailed compilations of relevant research that has been conducted in the region. Dr Di Mayberry who has considerable experience in ACIAR research in the region, contributed by participating in the 2014 annual project meeting and activities around that meeting.

An interesting observation encountered during technical research and communications training was that aldeia-wide/farmer-group implementation of innovations is generally inappropriate in the cultural context of Timor-Leste. The experience in the project was it was more effective to work with only one or two households in a location to demonstrate successful change in cattle management to other farmers.

In the final year of the project, the communication training received was synthesised and put into practice in an outreach strategy (explained below). Though the strategy implementation was not as complete as hoped, it demonstrated the skills learned by participating project and MAF staff in particular.

A list of people who received regular and irregular training is presented in Table 7.1.4.2.

Table 7.1.4.1 Primary formal training provided to project staff

Date	Location	Topic	Delivery by	Training
Sep-12	Dili MAF; Liquiça district	Conduct of a situation analyses	Elske van de Fliert, Lauren Hinthorne	Survey methods; data collection; group problem and solution identification
Oct-12	Dili MAF; Loes res stn	Forage legume evaluation	Neal Dalgliesh	Experimental evaluation of grasses and legumes
Nov-12	Dili MAF	Science methods and the use of Excel	Geoffry Fordyce, Dick Copland	Data entry in Excel; basic statistics
May-13	Dili MAF	Data collection, entry and management	Simon Quigley	Hands-on animal data collection; secure data entry
Feb-12	Dili MAF	Budgeting using Excel	Geoffry Fordyce	Methods of building a budget
Mar-13 to Dec15	UNRAM, UGM, Indonesia	Masters degree scholarships – 3 students	Respective university staff	Biometrics; forage, animal & communication science; writing
Jul-Aug-13	Dili MAF	Participatory Research and Communication	Elske van de Fliert	Planning, monitoring, evaluation, and communication skills - theory and practical
Sep-13	Dili MAF	Basic excel training	Simon Quigley	Simple excel formatting and functions
Nov-13	Denpasar, Lombok, Sumbawa	ACIAR project workshop and study tour – 2 staff	ACIAR Straw Cow project team	Straw Cow annual meeting and research
Jan-14	Research sites	Forage legume research	Neal Dalgliesh	Forage evaluation research protocols
Mar-14	Dili MAF	Research data management	Simon Quigley	Entry of data to books, Excel, and database
Mar-14	Research sites	Cattle measurements	Simon Quigley	Measures for monitoring of breeding cattle
Jun-14	Dili MAF	Data management and analyses	Oleg Nicetic	Research methods, Excel, basic stats, data presentation, communicating results
Jul-14	Dili MAF	Smallholder production systems	Simon Quigley	Systems of cattle production; interventions
Multiple	Dili MAF	Excel	Simon Quigley	Data entry and management

Aug-14	Dili MAF	Outreach strategy development	Elske van de Fliert	Elements to build a communication strategy
Sep-14	Walkamin, Charters Towers, Australia	Forage production and seed increase	Neal Dalgliesh, Kendrick Cox, Geoffry Fordyce	Forage production and use in Australian animal systems and efficient seed production for grasses and herbaceous legumes
Sep-14	Canberra, UQ, Charters Towers, Katherine	International Symposium on the Nutrition of Herbivores and study tour	Australia-based project team members	Livestock production systems research
Nov-14	Jogyakarta, Lombok	AAAP conference and study tour – 3 staff	Straw Cow project team	Livestock production systems research
Mar-15	Dili MAF, Guiço	Facilitation skills	Elske van de Fliert	Delivering farmer learning; technical content of the Outreach Strategy
Mar-15	Loes, Liquica	Experimental design, the role of forages in animal production	Neal Dalgliesh, Yuliaty Brito	Legumes and grasses: use in cattle production; evaluation experiments; seed increase; safe application of pesticides; operating a met station
Mar-15	Loes	Forage and animal production	Simon Quigley, Dahlanuddin, Marthen Mulik	Crop-forage systems for production feeding of livestock
Sep-15	Research sites	Facilitation for Outreach activities	Elske van de Fliert	Farmer group establishment and dynamics; communication and facilitation skills; participatory monitoring and evaluation
Dec-15	Loes res stn	Train the trainer	Elske van de Fliert, Latino Coimbra, Adelino do Rego, Quintiliano Belo, Celestino Mali	Cattle and forage production; business; communicating information to farmers

Table 7.1.4.2 Training participants during the project

Male	Female
Jorge dos Santos, Field researcher, Manufahi	Joanita Xavier de Araujo Magalhães, Field researcher, Manufahi
Ezequiel de Jesus Pires, Field researcher Liquiça	Regina Ikin Cardoso, Field researcher, Bobonaro
Antonio Daos, Field researcher, Oecussi	Joana Agusta Gusmão de Sousa, Dili
Feliciano Fernandes, Field researcher, Lautem	Anita Eka Martins Seran, Field researcher, Bobonaro
Jaime Moises Tomas, Field researcher, Lautem	Rita Pinto, Field researcher, Liquiça
Armando dos Santos, Field researcher, Bobonaro	Anita Eka Martins Seran, Temporary Field Assistant, Muapitine
	Maria Rosantina de Jesus, Field researcher, Manufahi
MAF staff – regular participants	
Latino Coimbra, Researcher, Dili	
Celestino G Mali, Researcher, Dili	
Pedro de Deus, Researcher, Dili	
Domingos da S. Soares, Researcher, Dili	
Quintiliano Afonso Belo, Researcher, Dili	
Aristides Tavares, Livestock Technical Officer, Bobonaro	
Agustinho Araujo Nunes, District Livestock Officer, Liquiça	
MAF staff – occasional participants	
Casimero Mau, Veterinary Technical Officer, Bobonaro	Marta dos Santos, Veterinary Technical Officer (Coordinator of Barikafa Animal Production Centre), Lautem
Aleixo Soares, District Livestock Officer (Chief of Department), Bobonaro	Angelita dos Santos, Veterinary Technical Officer, Manufahi
Jose Baptista, (Coordinator of Extension Officer), Bobonaro	
Eduardo Baptista Belo, Veterinary Technical Officer, Lautem	
Gil Nunes, Veterinary Technical Officer, Lautem	
Rojelio Dias Trindade Sousa, Veterinary Technician Officer, Lautem	
Valeriano Julio de Jesus Araujo, Veterinary Technical Officer, Lautem	
Precioso Cota Alves, Sub District Vaccinator, Manufahi	
Agusto Fernandes, Livestock Technical Officer (Coordinator of Dotik Animal Production Centre), Manufahi	
Carlos Fernandes, Vaccinator/Veterinary Technical Officer, Manufahi	
Eduardo de Andrade Fernandes, Livestock Officer, Liquiça	
Almerio Marques, MAF Livestock Officer, Dili	
Domingos Soares da Silva , Field researcher at Loes Centre	

7.1.4.2 Outreach

The outreach strategy was the first real opportunity by the project to assess the impact of a range of cattle management interventions designed to improve the livelihoods of farmers. Five famers from each of the three project sites were recruited, with three recruited at Fatucahi and four at Muapitine. Farmers within sites met to discuss 'what were their primary problems with their cattle systems' as a way of setting priorities for interventions. The outcome of this was that each site indicated the largest problems were: free-ranging cattle; high calf mortality; and lack of feed and water, especially in the dry season.

In anticipation of this, each farmer was assisted with leucaena and sesbania planting (4,500 seedlings at an average of 215 (180-400) per farmer) as a feed source underpinning other interventions. This commenced at all sites under difficult seasonal conditions. At Aidabalaten, Guci and Fatucahi, approximately 90% of all farmer' seedlings survived, except for one Fatuchai farmer who lost all plants. Except for one Naimeco farmer, whose plant survival was high, it averaged approximately 35% at Naimeco and 60% at Muapitine. The forage crop failed for many in the absence of rainfall which came much later than usual, resulting in seedlings dying. At the Naimeco site, 4 of the 5 farmers lost leucaena through marauding cattle.

Two farmers at each of the Guico and Fatucahi sites, plus one each from the other sites had sufficient tree legume for cut and carry to wean and feed 5 calves and to pen feed 12 bulls and 2 cows. The farmers clearly appreciated that the planted forages underpinned their ability to supplement their calves' diets, thus enhancing increasing growth rates and their chances of survival.

All farmers who successfully implemented the full outreach program were very pleased with the outcome and have stated they will continue with the strategy. An example of the success was Mr Alberto of Fatucahi. Implementation of Outreach created a huge increase in control of his cattle which became much more tractable and easy to handle. He fed both weaned calves and bulls with leucaena. This resulted in much higher growth rates leading to lucrative sales. The calves grew at 0.45 kg/day, a rate he had never previously experienced. Mr Alberto regularly lost his previously-free-ranging cattle when they strayed into other farmers' gardens and were occasionally slaughtered because of this. The new feeding regime and improved control virtually eliminated this problem for him. The impact was very similar for all farmers who successfully implemented the Outreach strategy

Other farmers who witnessed the success of Mr Alberto and his compatriot Mr Francisco are very keen to adopt the system, but are so far limited by insufficient leucaena and sesbania. Farmers were seen to commence the practice of inter-rowing tree forage legumes with a range of food crops such as corn, cassava and papaya. As a result of the project, farmers at project sites are now using crop residues and tree legumes for cattle feed when previously this never occurred. Again, this outcome was replicated in each site.

The field researchers associated with the Outreach program also achieved substantial experience in assisting farmers to adopt better practices. The project manager witnessed the huge appreciation of farmers for their roles in improving the farmers' livelihoods when the two field researchers who were based at Fatucahi returned to a hero's welcome after a two-month absence at the end of the project.

7.1.4.3 Training of trainers

Training of trainers (ToT) for technicians and extension officers from selected project areas was conducted in December 2015. By sharing the research findings and introducing some principles and methods to facilitate improvements of the cattle production system of smallholder farmers, it was anticipated that the officers who had been marginally involved in the research activities could incorporate some of the innovations explored by the project in their daily interactions with farmers in their constituencies.

The ToT was implemented at Loes Research Station, allowing both in-class and practical field activities for the 26 participants from four districts (Liquiça, Bobonaro, Manufahi and Lautem). As the list of invitees was altered by MAF to include 18 Animal Health staff (including vaccinators), this unfortunately left out some of the major field collaborators and the ACIAR project team would need to reconnect with these officers in the follow-on project. The training sessions were facilitated by A/Prof. Elske van de Fliert (The University of Queensland), Mr Latino Coimbra, Mr Carlos Antunes and Mr Celestino G.T Mali from MAF, and Mr Adelino do Rego from UNTL. Mr Quintiliano Afonso Belo was in charge of the overall coordination. Topics included:

- A vision for cattle farming
- Live weight production of cattle
- Cattle control
- Estimating live weight of cattle
- Achieving high rates of pregnancy and calf survival
- Bull fattening
- Facilitation for sustainable development
- Forage production
- Group dynamics
- Business development and marketing

The participants received written support material as well as in-class and field experience. At the end of the training, participants proposed follow-up activities they thought might be supported by MAF: bull fattening demonstration; artificial insemination of cattle; vaccination of cattle; veterinary treatment of cattle. They did not have any experience working across departments to develop regional program activities that would serve farm families in a more holistic way, and presumably lead to better impact. This indicated a capacity development need.

The majority of participants were satisfied with and enjoyed the sessions (Figure 7.1.4.1).

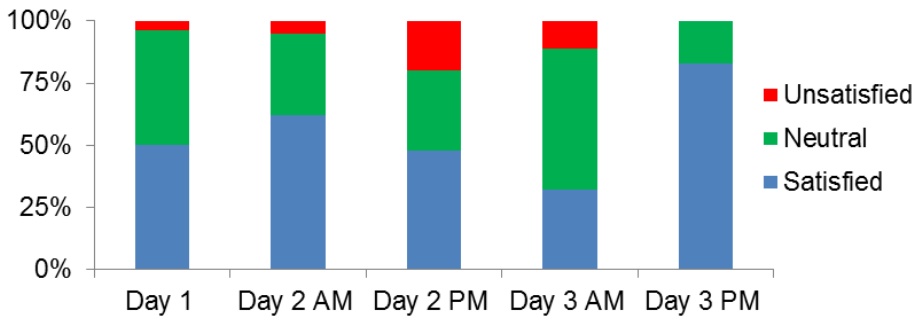

Figure 7.1.4.1 Participants' satisfaction with training sessions

Almost all training activities were given a good to very good assessment by the large majority of participants (81-97%), except for the session on cattle fattening that received a 60% good to very good review (Figure 7.1.4.2). The participants particularly appreciated sessions with practical and group activities.

Overall, the training provided an opportunity for district staff to share experiences with each other and project researchers, and learn some new concepts. Vice versa, the research team benefited from the interactions with the participants to receive input on the practical application of the innovations that are being tested, and the possible barriers to large scale implementation of the innovations. It will be of importance for the follow-on project to continue the dialogue with the district level officer and more actively engage them in the research activities.

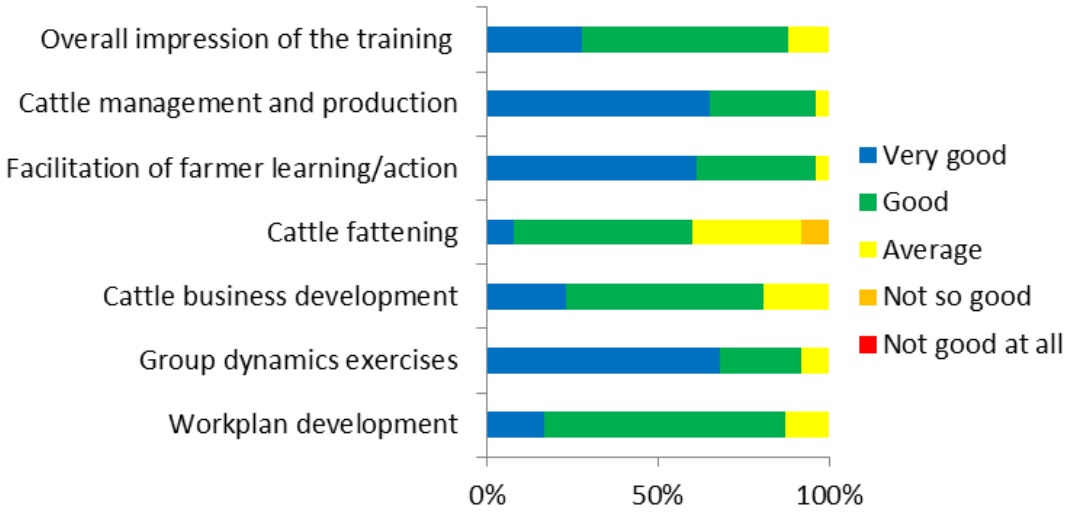

Figure 7.1.4.2 Perception of the value of the training by participants

Full details are presented in Appendix 7.

7.1.4.4 Post-graduate training

Three students were provided with scholarships by the project for studies towards post-graduate degrees. Two students completed their degrees and in the process developed considerable capacity in communications science, livestock production science, and biometrics, thus achieving the objectives of the strategy (Table 7.1.4.3). The third student, Walter Oliveira Soares, completed course work and participated in research for his dissertation but is unlikely to complete his dissertation.

Table 7.1.4.3 Post graduate degrees achieved by project-supported students

Student:	Pedro de Deus	Quintiliano Afonso Belo
Degree:	Master of Science	Master of Science
University:	Faculty of Animal Science, University of Mataram, Lombok, Indonesia	University of Gadja Mada, Jogjakarta, Indonesia
Period of study:	March 2013 to November 2015	September 2013 to June 2015
Thesis title:	Adaptability, production of biomass and nutrition values of legumes and superior grass in the arid areas of Timor-Leste	Exploration of collective learning and action as a dialogist extension model at Timor-Leste smallholder cattle project in Timor-Leste
Degree conferred:	23-Nov-15	29-Jul-15

7.2 Discussion

The major intervention that underpinned many of the successes in this project was the construction and use of cattle yards. Initially this was done to enable field researchers to take measurements of cattle during the systems monitoring. This created the opportunity to achieve control over cattle that most farmers had never previously experienced. The basic requirements of successful cattle systems are to provide cattle with adequate feed and water, and to have them under control. All three elements are vital. Prior to the project, the typical cattle farming system was to have ownership of cattle that roamed free. Restraint of cattle for health management or for slaughter was akin to a rodeo event. The introduction of yards with very basic crushes allowed farmers to catch animals very efficiently for transactions, whether it was for ceremonial purposes or sale to a trader. The yards could be used for weaning, which had not previously been practised. It also allowed fattening of bulls using cut and carry of the leucaena grown by the outreach farmers. A major consequence of handling cattle in yards, even when the specific practices were less than ideal, was that cattle became much more tractable and easier to handle. This resulted in safer and easier handling and substantial time savings. Farmers experience very high adult cattle "mortality" rates. A significant component of this is due to theft and to cattle being slaughtered by third parties when they damage other farmers' food crops. Improving cattle control has reported greatly reduced the incidence of this problem, which is another reason cattle owners have enthusiastically embraced this development.

Most farmers noted the advantages of cattle yards. At least one was built adjacent to project site yards by farmers who initially did not wish to join the project. The success of cattle yards was the reason for the introduction of an activity to improve the design late in the project. Further development is to be a central feature of operations in the next project. However, it should be noted that the broader concept under study is how to improve control of cattle, a significant part of which is cattle yard design.

7.2.1 Cattle production

There are challenges in the collection of cattle production data across Timor-Leste. These include the extensive cattle management systems, lack of appropriate infrastructure and/or animals and farmers' inexperience in the use of infrastructure and the limited experience and capacity of MAF staff and the next generation of researchers to conduct research with farmers within the farming systems. As a result the data set collected over the two years is limited and as such should be viewed with some caution. The collected data do however provide baseline data on production systems across a number of sucos from which recommendations for future management options can be identified, modelled (biological and economic) and tested under field conditions.

The much higher level of cattle ownership per household in the situation analysis than in the 2010 census data (11.2 *v* 2.4-5.9 cattle, respectively) for the study sites confirms that the census data tend to underrepresent actual ownership, presumably in particular for households with very large herds.

The productivity of cattle production systems in Timor-Leste is comparable to that of low-input systems in eastern Indonesia. Annual live weight production of male and female cattle in Timor-Leste was only half what appears to be achievable and associated with low live weight gain (0.1 to 0.3 kg/day), low calving rates (less than 50%) and high rates of calf (up to 27%) and cow (10%) mortality. The low productivity is largely a result of inadequate nutrition, which can be addressed through the introduction and integration of improved forage and feeding systems into the existing farming systems. Low cattle productivity was observed under these low-input systems with the exception of the higher rainfall and more fertile suco of Fatucahi on the south coast of Timor-Leste. Higher live weight gain and reproduction rates and lower calf mortality were reported for Fatucahi, and farmers in this site appeared to be more active in trading cattle for income generating purposes, demonstrating that there is the potential to increase productivity and profitability of cattle

enterprises in Timor-Leste, and hence move to more commercial production systems. While the low productivity across some sites is attributed to the quality and quantity of feed, water availability in the dry season was also raised by farmers as a major constraint to production. In both Guico and Naimeco farmers reported water shortages in the dry season which is likely to result in impaired growth, decreased milk production by lactating cows, increased dehydration of calves and increased mortality.

Calf birth weights were typical of Bali cattle under different production systems in Indonesia (Talib et al. 2003; Dahlanuddin et al. 2016). Calf mortality values are comparable to those reported elsewhere for Timor-Leste (De Almeida, 2012) and West Timor (Jelantik et al. 2008). A majority of mortalities are very likely to be associated with poor nutrition of cows that are unable to produce sufficient milk to keep the calf alive. However, the rates stated here are likely to be an underestimate as births and mortalities are likely to have occurred and never observed due to the extensive nature of the production systems and the low attendance of FRs in the sucos. Similarly, while abortions were recorded when observed this is also likely to be an underestimate as abortions are likely to have gone undetected under the extensive conditions.

Calving distribution was comparable to the 61% of calves born between May and October in a previous Timor-Leste study (De Almeida, 2012) and 88% of calves born in the same period in West Timor (Jelantik et al. 2010). This period of calving is a response to seasonal conditions with virtually no animal husbandry. It contrasts to cattle in northern Australia where targeted weaning is associated with peak calving in Oct-Jan, thus achieving synchronisation of lactation, which has high energy demands, with availability of the best quality and highest quantity of feed. The low body condition of cows, low calving rates and high mortality rates in calves and adults in Timor-Leste clearly indicates that weaning is a very high priority in any system that aims to increase productivity of breeding cattle in Timor-Leste. This strategy is likely to shift the calving pattern, even with no attempt to control mating, which is what occurs in northern Australian cattle systems.

The very low growth rates of Timor-Leste cattle are well below the achievable levels in Bali bulls of between 0.4 to 0.5 kg/day through improved feeding management, particularly through the strategic use of tree and herbaceous legumes and an energy source, such as rice bran (Dahlanuddin et al. 2014; Quigley et al. 2014). The absence of bulls >150 kg live weight in Aidabalaten reflected the drier conditions and limited supply of high quality feed available and higher rates of mortality in this suco. Increasing productivity will require management that uses a high proportion of available feed for production rather than maintenance. This demonstrates the need for the introduction of improved forages that persist through the dry season, weaning to remove lactation nutrient demands on cows and improved utilization of existing crop residues (e.g., rice straw).

Herd structure modelling using the above data plus situation analysis data (see Objective 1) and data from marketing research (see Objective 3) could not fully reconcile the cited rates and numbers. Despite this, the modelling indicated that annual live weight production (LWP) per beef animal averages ~25 kg, with a live weight production ratio (LWPR) of ~0.15. LWPR is a measure of efficiency and is calculated as net live weight produced / live weight of cattle that produced it, the denominator being a measure of feed intake. The low prevailing LWP and LWPR is less than half of an achievable level based on experience in northern Australia. Though annual growth of surviving juveniles is three times the average LWP, productivity is drastically reduced by high adult cattle and calf mortality rates. The model estimated annual calf mortality in Timor-Leste at >10,000 and close to calculated annual sustainable off-take from the national herd at current performance levels, highlighting a major production opportunity.

As discussed above, the developing cattle yard design for smallholders is showing considerable promise as a method for farmers to improve control of cattle, thus enabling administration of a range of management (e.g., weaning, loading) and husbandry practices (e.g., health treatments) that were previously very difficult. Progression to very effective design features that all stakeholders agree are suitable will take time as the perceptions of

what is needed and the experience of farmers need to evolve rather than jump forward from traditional practices.

It is expected that successful management strategies implemented in eastern Indonesia would have the same biological effects if implemented in Timor-Leste. Management practices that would increase the productivity of existing cattle systems in Timor-Leste include:

- integration of improved forages within the existing farming systems to increase live weight gain of fattening animals to above 0.4 kg/day; this may include cut and carry of legumes and crop residues, or rotational tethering within a secure grass-tree legume grazing area; trialling the response to phosphorus supplementation may be warranted during the wet season in some sucos.
- intensification of feeding systems for fattening animals to improve the efficiency of feed use, to allow more strategic use of scarce high quality feed resources and for the collection of organic fertilizer (urine and faeces) that can be applied to cropping land.
- weaning of calves at 6 months of age to remove the nutritional demands of lactation from cows, allowing them to maintain (or recover) body condition prior to the subsequent lactation and conception, thereby reducing the inter-calving interval.
- creep feeding of suckling calves during the dry season, to improve calf growth and survival (reducing the risk of mortality from inadequate nutrition, bull and dog attack, misadventure).
- improved access to drinking water for cattle.
- improved cattle handling infrastructure to assist with the implementation of the above management practices.

Survey data demonstrated the importance of (and constraints associated with) other livestock species to households across Timor-Leste. Opportunities to integrate improved nutritional management of all livestock species should be explored in the follow-on project.

It is recommended that implementation of any new management practices have higher priority for growth and fattening of cattle, rather than cow-calf systems. Responses to improved management, mainly nutrition, of growing and fattening animals will be more visible and immediate to farmers, which will help in building relationships and trust between researchers and farmers from which longer term strategies that focus on cow-calf systems can be implemented. However, in the absence of any significant market demand for cattle at present it is difficult to see where the financial (or other) incentives would come from for farmers to improve the productivity and profitability of the existing cattle production systems. The suitability of the above management practices to the social and cultural framework in Timor-Leste is largely unknown and the introduction of any recommended technologies should be developed through participatory activities with farmers to develop appropriate strategies for implementation.

It is recommended that future training of farmers, MAF staff and traders includes the use of girth to estimate live weight of Bali cattle. This may lead to higher values being accessed by farmers as butchers will pay higher rates (e.g., +$0.50/kg or more) on a per kg basis. A simple exercise used in preliminary training in Timor-Leste involved asking farmers to visually estimate the live weight of Bali cattle, then measure girth to estimate live weight from the prediction relationship and finally record the measured live weight of the animal, to demonstrate the accuracy of the different methods. Once the live weight of the animal is known/estimated then further demonstration of feed and water requirements and dosage rates can be conducted.

7.2.2 Forage options

The opportunity to grow forages is substantial but will take a significant shift in attitude for a majority of farmers in utilising rainfall and soils. Even the driest site in this project had an annual average rainfall of 1,000 mm which is double the amount of most of northern Australia where much higher pasture and animal productivity is achieved. For Timor-Leste farmers to improve systems' productivity, there must be a shift away from pasture over-utilisation which severely depresses subsequent forage production, and this requires reduced stocking rates.

Initially, it is most likely that browse legumes will form the backbone of improved forage supply systems, but as the benefits of integrating legumes into food cropping systems becomes more apparent, it is likely that annuals and perennial herbaceous species will also become important, supplying benefits to both cattle production and to the food cropping system.

On alkaline soils leucaena is the logical browse legume of choice, especially as it can be used in alley cropping with food crops. Sesbania and *Gliricidia sepium* are further options, but their adoption requires further research with farmers. The latter is particularly suitable on acid soils such as in Lautem.

Both *Lablab purpureus* and *Mucuna pruriens* are highly productive annuals on the alkaline soils across rainfall regions. Both species have large seeds which facilitate seed collection. These short-season plants are a logical choice when integrating legumes into food cropping systems. Of the perennial herbaceous legumes assessed, *Clitoria ternatea* and *Macroptilium bracteatum* are appropriate for grazing systems and for 'cut and carry', or can be part of a multi-seasonal rotational sequence or used as an intercrop with cereals. The seed of *Clitoria ternatea* is large and easily harvested whereas *Macroptilium bracteatum* seed is smaller and less easy to collect. *Stylosanthes* species were more difficult to establish and maintain and produced relatively low biomass, making them less attractive options. No herbaceous legumes tested thrive on acid soils.

While most of the grasses evaluated for the wetter, bi-modal environments of Muapitine, Lautem and Loes, Liquica produced significant quantities of biomass, *Brachiaria brizantha* was a stand-out across soil types. Despite its high stem to leaf ratio, King grass should not be discounted as farmers are familiar with it and there was some evidence it did persist under dry conditions such as in Oecusse.

It is recommended that a grass-legume mix be fed to livestock. The opportunity for producing and preserving hay with farmed forages is high with all recommended species. In any case, adoption of these opportunities relies on suitable fencing and tethering of livestock to control unwanted utilisation.

To sustain any farmed forage system, seed production must also occur. In the short term, the process initiated within this project will form the basis of new plantings and then expand when demand increases. Sustaining this will require on-going training of MAF and UNTL staff and students.

7.2.3 Business, markets and policy

The project has provided a rigorous, up-to-date and comprehensive account of structures and development issues in the Timor-Leste beef industry for industry stakeholders, including policy-makers, development agencies and researchers.

Farmers in Timor-Leste have traditionally kept buffalo for rice puddling and ceremonial purposes. Beef cattle were only recently introduced by Indonesia. Caution should be taken with statistics for grazing livestock as these animals are mostly managed using low-input extensive methods, thus limiting capacity to account for stock. Given a degree of accuracy in the statistics, the small herd today numbers about 160,000 with cattle being held by about 23% of households. Cattle are kept predominantly in low-input, low-output grazing systems, partly for ceremonial purposes, but more importantly as a source of "savings". Cattle provide one of the few sources of cash income for Timor-Leste farmers, and therefore play an important role in many areas. Cattle production is small-scale but commercialised in the west and the converse in the east. Addressing rural incomes and under-nutrition are priorities in a country with some of the lowest (non-oil) development indicators in the region.

Though traditional cattle ownership is biologically inefficient, it is not usually financially inefficient as associated costs are very low. However, it does expose the core to this project which was the substantial opportunity to improve both the biological and financial efficiency of smallholder beef cattle production in Timor-Leste.

As is the case for most areas in Timor-Leste, agricultural enterprises form the backbone of the livelihoods of the large majority of households studied. Families tend to cultivate crops and keep animals for home consumption as well as for cash income, although there is considerable variability in choices people make as to what enterprises to endeavour. This is related to variable capabilities that people face in their families in terms of knowledge/skills, labour availability and economic conditions, to name a few. It was reported that many families receive government allowances, a situation which tends to reduce the urgency for many people to engage in agricultural transformation. Another disincentive for agriculture development is the competition for labour with off-farm opportunities such as (road) construction activities, which seems to be more attractive to many young people, who consequently leave their villages.

Official (census) statistics record an annual off-take of about 12,000 cattle, but calculations in this report suggest an offtake of about 21,000. Cattle marketing systems have emerged to service the ceremony market (5,000 cattle), slaughtermen in the 13 districts (5,000), slaughtermen in Dili (5,000), and other higher value markets in Dili (1,000 animals to the Tibar abattoir, butchers, and Cooperativa Café Timor for Dili ceremonies). Dili is a rapidly developing market and focus should remain there. Also in this higher value market, Timor-Leste imported 160 tonnes of beef for the Dili supermarket and restaurant trade (equivalent of approximately 1,000 cattle) in 2014, while another 5,000 cattle were traded live across the border to Indonesia (although trade was disrupted in 2015). Based on these figures, beef consumption levels are low (1.66kg per person per year), but perhaps double this in Dili. Previous, widely-used consumption figures are highly over-stated. Consumption could be expected to increase with population growth and urbanisation, which bodes well for the industry.

The herd modelling described previously calculated annual sustainable off-take at 8,000 fewer cattle than has been recorded as annual off-take in recent years (13,000 *v* 21,000; see market research, Objective 3). This suggests the national herd is being slowly reduced by ~5% annually.

After independence in 2002, the government of Timor-Leste and donors have endeavoured to rebuild institutions from the ground up. This provided major challenges but also some scope for experimentation, especially in private sector development. On the upstream side of the chain, there were measures to build market-based animal health and extension systems, but effectiveness proved highly variable; e.g., government interventions for disease (brucellosis and haemorrhagic septicaemia) using vaccines are not achieving the

required uptake and farmers managing animal health independently. “Traditional” cattle management and production practices are resistant to change, but research in this project has identified high potential to increase productivity through improved feed and cattle management systems and support for more progressive farmers, including in the cattle fattening sector. Opportunities for farmers are limited by difficulty in accessing finance, but solutions are also emerging for this.

Much of the attention in recent years has been in the downstream sectors, where government with donor inputs have supported private sector development in the larger scale slaughter sector and more “modern” beef retail sector. This is valuable in kick-starting the diversification of supply chains, but stakeholders face challenges in expansion, increasing low capacity utilisation of the (subsidised) Tibar plant, and replacing imports in the supermarket and restaurant sector. Health and hygiene standards to expedite the process have been issued but are not yet enforced, which will be very challenging in Dili let alone the districts. The policy settings effectively represent an attempt to skip industry development paths of other south-east Asian countries (where centralised service slaughter plants predominate). While these “modern” structures are at fledgling stage, government is committed to this industry policy into the foreseeable future, but should also retain the flexibility to assess and revise the strategy where necessary.

“Traditional” supply chains where product flows through a hierarchy of spotters, traders and slaughtermen, are low cost, functional, and likely to predominate into the future. There is some scope to improve marketing systems (through measures such as cattle aggregation, transport and measurement) but gains will be incremental and vary from area to area. The “modern” chains contribute an additional sales channel for higher value product that could potentially deliver weight-price premiums and over-the-scales selling to producers if more direct linkages are established.

It appears that traditional ceremonial practices that utilise cattle are an important market as most cattle used are sold for this purpose. This is despite government policy against these practices.

The informal export of live cattle to Indonesia is very important to the cattle industry and livelihoods in the west and Oecusse. Disruption to the informal trade in 2014-5 provide a reason to restore formal trade and the measures required do not seem insurmountable, especially because of the mutual benefits and dialogue between the Timor-Leste and Indonesian governments on the issue. Restoring formal trade agreements will, however, require considerable investment and organisation on the Timor-Leste side to issue health certificates compliant with the WTO-SPS Agreement, and the integration with domestic animal health and vaccination programs. A detailed assessment of the costs, benefits and feasibility of meeting international protocols would be useful in developing incentives.

Staged introduction of many policies is helping to slowly deal with entrenched traditional practices, e.g., staged introduction of better standards to shift away from very poor slaughter and retail practices. This complements policy aimed at increasing focus on higher-value markets.

Maximising livestock numbers is a major policy target which concurs with prevailing householder objectives. This is very difficult to achieve, with the scale of the prevailing problem highlighted by less than 20% of the minimum requirements for dry matter intake by grazing livestock being produced on available grasslands. This problem is potentiated by the lack of individual tenure over a majority of land.

7.2.4 Communication

Traditional communication on cattle farming systems from government RD&E agencies in Timor-Leste has been through top-down, regulatory-type methods. This has achieved limited success in changing cattle systems. Traditional cattle management systems associated with limited farmer knowledge and marketing opportunities noted in the situation analysis indicate that farmers have not been offered adequate learning opportunities to help them work out how improved management practices, which implies a major systems change, will benefit them. Traditional RD&E agency advice appears to focus on aspects that have relatively-low impact (e.g., limited emphasis on nutritional management), and that direction given to farmers has not necessarily been validated for the Timor-Leste farming environment.

The research on forage and cattle production and on markets and policy settings in this project has identified a range of opportunities to improve cattle systems for the benefit for farming families' livelihoods. Pilot assessment of some of these opportunities using the Outreach strategy indicated the recommended practices were valid for Timor-Leste cattle farming systems, thus also validating the Outreach strategy as a valuable extension practice. This was demonstrated by the clear intention of farmers to continue with the practices, and the intention of many other farmers to adopt the new systems as resources (e.g., seed, yard construction materials) become available allowing them to do so.

A shift in farming practices requires support from technically-competent advisors. The project delivered a large amount of training to project staff and to participating MAF and UNTL staff. Most training was within Timor-Leste, with six people conducting international study tours. The training was reinforced by use of learnings in project research. The project team leadership witnessed a large transformation in skills and knowledge of team members during the project, which was also recognised in the self-assessment by these people (see Section 8.2). The most advanced training was for those sponsored to gain a Master of Science degree. Both of these people are clearly much more skilled in communications and in science methods, which will be of substantial benefit to MAF, their employer, whether it be within or outside the following project.

The benefits and success of advisor training was demonstrated through the successful implementation of the Outreach strategy by the field researchers with collaborating MAF and UNTL project team members. The culmination of training in the Train the Trainer workshop in December 2015 produced 3 project people and several MAF staff who will be key people in delivering training as part of research and application of its outcomes in the next project.

It emerged during the project that to achieve practice change in cattle farming systems, demonstration is the most powerful tool available. This involves both leading farmers and their advisors, all of whom must have a clear understanding of the biology and of the financial and social aspects of the systems they are demonstrating. The low level of literacy among cattle owners strongly indicates the need for agricultural extension methods that are adapted to the capacities of target farmers in future activities engaging them in improving their cattle production system. This further stresses the importance of demonstration as the key tool for achieving practice change.

8 Impacts

8.1 Scientific impacts – now and in 5 years

The primary scientific impact has been at UNTL, where under-graduate students at UNTL have participating in forage evaluation trials and cattle research on a regular basis under supervision of Yuliaty Brito and Neal Dalgliesh. The students were required to prepare reports. Through their participation in rigorous trials, they have developed better scientific methods skills and understanding than they were previously achieving. A similar outcome has occurred at Cairui (near Manatuto) where the suckling calf research conducted by Alipio de Almeida created final year study opportunities for 26 students and several UNTL staff.

Two Timor-Leste project staff (Latino Coimbra, Alipio de Almeida) have applied for and been granted a John Allwright fellowship as a result of this project. A third (Yuliaty) also applied but unfortunately was not successful in her application. These people are expected to make a substantial contribution to livestock RD&E in the near and long-term future in Timor-Leste, especially through research skills they have gained during the project and through their post-graduate studies.

In a similar vein, two MAF staff (Pedro de Deus, Quintiliano Afonso Belo) were supported to gain Master of Science degrees at Indonesian universities (Appendix 8). This was based on the acute lack of skills in both biometrics and communication science in the agricultural RD&E sector in Timor-Leste. Their training has positioned them very well as principal scientists within MAF in the future.

8.2 Capacity impacts – now and in 5 years

As discussed in previous sections, farmers collaborating in this project have attained considerable capacity. These farmers participated in many meetings with project staff where they learned about the new cattle systems. They participated in the monitoring of their cattle and businesses. Their capacity is demonstrated by successful implementation of the primary strategies that they previously never used and their commitment to continue even if the project discontinues, i.e., building and use of cattle yards, growing forages, weaning, feeding of forages to weaners and bulls, and selling based on live weight.

At the completion of the project, it withdrew from three of five research sites; the follow-on project will continue with some of the farmers in two of the sites. The success of the project is such that momentum for change in cattle systems within the farming community is large in all five sites. The livestock directorate within MAF recognised that substantial benefits will accrue if they initiate independent support for on-going development of the new cattle systems in four centres, including at least one of the project sites that was discontinued. This group is able to facilitate this through the broad capacity developed within MAF.

At the outset of the research, capacity amongst local MAF researchers in the activities to be undertaken was limited due to a lack of opportunity to participate in on-farm cattle production monitoring. Co-ordinating MAF staff (Mr Latino Coimbra and Mr Celestino Goncalves) quickly developed an understanding of the importance of the type of data to be collected and how it could be used in the future.

Project-employed field researchers who were UNTL graduates had limited capacity in all aspects of the work to be undertaken at the outset. Initially field researchers received training in field data collection and collation in simple Excel workbooks. Some field researchers had not previously used Excel prior to the project and the time spent training all staff on the use of Excel should not be understated, with training occurring on most visits by the Australian researcher involved in this activity. As can be expected, the capacity to develop these skills varied significantly with some field researchers clearly showing a greater capacity for the research focus of the project, while others demonstrated stronger

capacity for some of the more practical aspects of the project implementation (e.g., yard construction). As data collection and collation became more reliable, the capacity building transitioned to data interpretation (e.g. live weight gain, calving interval, mortality rates) and how the data can be used by farmers (e.g., weaning, feeding, culling unproductive animals, predicting sale live weight and price) and MAF policy makers in their decision making processes.

Because the project sites were geographically isolated, most training was conducted in Dili when the field researchers all returned for reporting at the start of each month coinciding with visits by Australian researchers. Most field researchers had their families in Dili, and the time lost in travel and not having their families where they were based had negative effects on the collection of data. In the final 8 months of the project two field researchers were located at Fatucahi, demonstrating that having two staff with complementary strengths improved project operations.

The substantial amount of training (Table 7.4.1) for the project staff, including MAF and UNTL employees was delivered by the Australian team members and the UNTL staff who had post-graduate degrees conferred in Australia. Through the training offered and participation in research, it was very pleasing to see gradual development of confidence and competence to reach adequate capacity of all participating staff by the end of the project. This was highlighted by the project staff delivering training at the Dec 15 “Train the trainer” workshop.

Of the eight field researchers employed by the project, two did not have contracts renewed mid-project and were replaced, three will be offered new contracts in the follow-on ACIAR project and three will not be offered new contracts in the follow-on project. To have three field researchers develop sufficient capacity to assist with implementation of the follow-on project is a significant outcome from the current project and will greatly facilitate the transition to a new project. It will be important to continue to build on the skills of the field researchers in the subsequent project and to increase the involvement of MAF suco staff in training activities.

Throughout the project, Timor-Leste project staff were asked to self-assess (10-point scale) on 53 skills and knowledge elements of beef cattle systems and RD&E that were grouped into six components: Cattle production; Forages for beef cattle; Cattle business; Research; Extension and Communication; Professional development. Primary outcomes were:

- Perceptions of their own skills and knowledge at the time of assessment, and a year prior to assessment, increased by 2 units over 3 years (Figure 8.2.1).
- In two of three years, knowledge and skills were rated higher at the time, than they were 12 months later (Figure 8.2.1).
- Perceptions of cattle and forage production knowledge and skills ranked highest.
- In general, specific skills and knowledge ranked highest were: identifying and feeding suitable water and forage to cattle, communicating as a team and with farmers.
- Business knowledge and skills consistently ranked 0.5 (field researchers) and 0.9 (MAF & UNTL staff) units below other categories.
- In general, specific skills and knowledge ranked lowest were: managing common diseases, business analysis, writing extension materials.

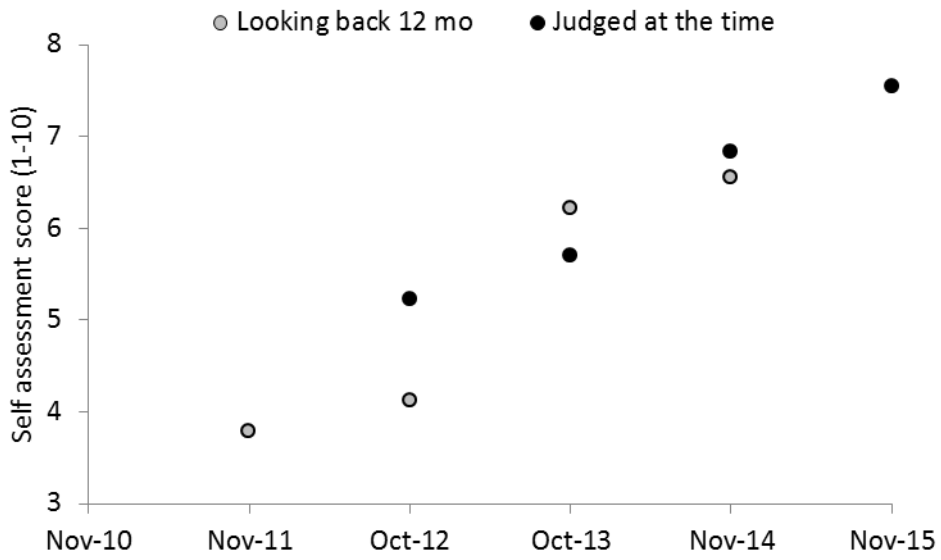

Figure 8.2.1 Self-assessment by five project staff who participated for the full project term on knowledge and skills relevant to beef cattle RD&E

This method clearly demonstrated the changing competency of the project participants which was evidenced in increasing ability to perform tasks required by the project, and ultimately in four (three field staff and the administration officer) being selected to participate in the follow-on project.

Having an in-country project manager in the latter stages of the project whose first language was English resulted in most staff achieving obvious large improvements in their language skills. This will be of great benefit to any research in which they are involved with in the future as it increases the chances of staff clearly understanding project and task requirements.

The Sep-14 north Queensland visit by UNTL project collaborator Yuliaty Brito focussed on increasing her skills in seed increase and forage production. While the exposure to modern methods of forage production has increased her capacity to service project needs it has also provided the opportunity for her to mentor UNTL undergraduate students. Twenty seven students have undertaken their final year research project at Loes Research Station investigating various aspects of grass and legume production. This training not only allowed them to meet their university obligations but also provided them with experience which should be attractive to prospective employers. These students have also been actively involved in servicing the technical requirements of the project as part of their university training including the support of Master students research (particularly Pedro de Deus), in managing tree legume nurseries for 2 projects and the increase of seed which is being used to supply project needs and outreach programs.

Three project staff applied for JAF scholarships. Alipio de Almedia was granted a JAF starting in mid-2015 with a University of Sydney group about to embark on an animal health research project in Timor-Leste and Indonesia. Latino Coimbra was granted a JAF and will study calf loss at the University of Queensland from mid-2016, a significant activity within the ensuing project. Having these staff able to apply and achieving a high level of success demonstrates the significant impact of the project on the development of both these scientists, especially in the case of Latino Coimbra who had not previously had access to education outside Timor-Leste and the Philippines.

8.3 Community impacts – now and in 5 years

This project did not aim to achieve significant community impact. Despite this, many instances emerged where impacts occurred beyond the project participants and scientific sphere and some of these are listed below.

The major intervention was construction and use of a cattle yard as discussed previously. The major advantages farmers experienced by having the cattle yard were noted by many farmers peripheral to the project. In at least three project sites, up to 5 farmers have either individually or collectively constructed additional cattle yards. These yards are creating major savings in time. For example, previously when a cattle owner wished to catch and animal for sale or slaughter, it would take a large team (e.g., 20-30) from the suco, each of whom is paid, up to two weeks to "corner" the animal that is captured using nooses or hunting equipment. Training animals to use the yards, even if it takes 1-2 hours each day, is a massive saving in time and creates a vast improvements in safety and animal welfare.

A further development is that farmers at one project site at which a new design was constructed realised they can alter the design based on what works, what does not work and what may work better in the future. For example, access to water was not provided, thus limiting the farmers' ability to lure cattle. The farmers used their own resources to construct a 1 km pipeline to provide water.

Farmers outside the project at all sites are also planting forage tree legumes as inter-rows in their gardens. They are using crop forages, especially rice straw and peanut hay, as cattle feeds added to tree legumes. The 2013-14 farmer demonstrations in Muapitine (Lautem) of the use of browse legumes (*Sesbania grandiflora*, *Leucaena leucocephala)* as alley crops resulted in individual farmers starting to feed the legumes to their cattle and to the intercropping of food crops. These included the growing of ground nuts and chillies with one farmer earning US$70/week (over a 6 month season) through chilli intercropping.

UNTL produces a large number of agricultural science graduates annually, many of whom are unable to secure employment related to their training. Our project has a developing profile, and some graduates are seeking unpaid work experience in their quest to develop experience in livestock and forage production science.

8.3.1 Economic impacts

The community impacts of farmers collaborating in the project at this stage are primarily in time and safety. Some farmers have already realised cattle sales that would not have occurred without the use of cattle yards, weaning, and feeding of forages. Some of this is due to increased cattle growth, in addition to the benefits of lower cattle mortality rates. As the tree legumes grow and animals grow to sale and slaughter weights, more widespread financial benefits will also be attained.

Weighing cattle during the project empowered farmers in their trading. Through the project, they became aware of being able to sell on a per kg of live weight basis. This enabled farmers to confidently negotiate fair prices for their sale cattle. Provision of scales, weighing platforms, and power to weigh cattle is not easy. Though girth tapes can accurately predict weight, it will take time before the farmers and traders learn to fully understand, accept and use the method. But this must occur as access to scales is not likely to be widespread for many years.

Advice from project personnel has been provided to senior administrators of MAF, thus the Minister for MAF, in considering several cattle industry developments (details not for public disclosure). It is hoped that this advice has assisted the Timor-Leste government to more astutely target investment, reduce unnecessary expenditure and improve returns from any major investments.

8.3.2 Social impacts

The new cattle systems have taken farmers from virtually no husbandry to a requirement for daily husbandry. The women are often charged with the extra work of handling the cattle. The field staff suggested they appear happy to do so as the advantages are as important to them as they are to the men.

At the beginning of the project, the team purposely selected an equal number of young men and women as Field Researchers for this project. Having women in field positions has not previously been the norm in Timor-Leste and we were advised this would not be a success. To the contrary, this strategy was highly successful. Though two of the three start-up female staff left the project, replacements were employed and at the end of the project, 4 of the 6 staff retained because of their excellence were female.

A very successful outcome was the placement of male and female field researchers together as a team in one site. This greatly enhanced communication with women in farming families and their active participation in project activities.

8.3.3 Environmental impacts

No significant environmental advantages have been noted by the project. Certainly no negative effects of the new cattle systems are apparent or conceived. If forage production systems are developed as recommended, these can have significant positive environmental effects through soil conditioning.

8.4 Communication and dissemination activities

The Outreach strategy was in effect the major dissemination activity in the latter stages of the project. This enabled Field Researchers, who by that time had developed sufficient capacity to support it, to assist many farmers outside the project to implement better cattle systems.

In late 2015 a video was produced that introduces cattle systems to farmers and advisors in Timor-Leste. This video has been used in initiating activities with new households and groups. It is expected to be a major asset in future projects.

During the project, an irregular newsletter, “Beefing up”, was produced as a means of communicating key project activities to stakeholders. This newsletter was very popular with consistent positive feedback.

ACIAR Communications under the leadership of Dr Sarah Vandermark brought a film crew to Timor-Leste in the week of 12 May 2014 to shoot an episode for *Food Bowl*, which had been contracted with the ABC’s Australia Network. The project team participated in a total of two days of filming activities. The episode went to air in December 2014.

During 2014 and 2015, many MAF offices were visited. Extra MAF staff also participated in annual project meetings. These meetings provided the opportunity to update MAF staff on project activities, outcomes and achievements.

9 Conclusions and recommendations

The project's research questions as follows were linked to the conclusions and recommendations.

RQ1: How do beef cattle contribute to smallholder livelihoods and what are the associated risks?

RQ2: Which low- or no-cost (financial and time) interventions can increase local beef production efficiency?

RQ3: What market opportunities exist to complement increased production and how can they be developed?

RQ4: What feasible mechanisms are required and will provide farmers with access to information and services that would effectively support them to integrate improved cattle management practices into their farming system?

9.1 Conclusions

RQ3: Cattle ownership and beef production and consumption are valued parts of Timor-Leste community and economy, and can contribute significantly to the non-oil GDP. Annual domestic cattle off-take and beef consumption were calculated at 21,000 and 1.66 kg per capita, which are much higher and lower, respectively, than previously thought. Beef consumption in Dili is probably double that in provincial areas, and is growing rapidly with the increasing population and increasing disposable income.

Modelling of data collected suggested that the herd may be reducing by ~5% annually as off-take appears to substantially exceed a level that sustains the herd size at current performance levels. No data were available to validate the size of the national beef cattle herd, which 2010 census data suggested was in the vicinity of 160,000.

RQ1: Low average calving rates (<50%) and growth rates (~0.2 kg/d for surviving juveniles) and very high mortality rates (10% for adults; up to 27% for calves) of all age classes are the primary contributors to low annual live weight production and low efficiency of Bali cattle systems in Timor-Leste, estimated at 25 kg and ~0.15 kg/kg cattle, respectively. Under-nutrition caused by lack of feed and water and almost no management or husbandry are the primary reasons for low cattle performance and productivity per animal at less than half of what is achievable.

RQ2: There is a range of intervention options available and acceptable to cattle owners in Timor-Leste to improve the financial benefits from cattle, thus livelihoods. The fundamental change that appears to underpin significant change in cattle farming systems in Timor-Leste is better control of feed, water and cattle, with cattle yards a key component. Use of grown forages and crop residues to increase growth of bulls and calves is a high-priority in the first-stage change to cattle systems. A range of forage tree legumes, herbaceous legumes and grasses was identified as suited to the variable conditions across potential cattle production areas in Timor-Leste. For cow management, good weaning practice is the primary husbandry that should be introduced. Selling based on live weight has also commenced and creates more equitable trading for both farmers and the beef supply chain.

RQ4: There has been substantial development of capacity in implementation and advising on cattle systems, especially within participating farming communities, and MAF and UNTL. This capacity had to be strengthened to form the basis of further research and scaling out.

To achieve change in cattle systems practices requires further capacity development and implementation of practices as part of systems that will be effective in Timor-Leste environments. There is limited advanced RD&E capacity servicing the beef cattle industry in Timor-Leste despite very large numbers of university graduates, and this limits appropriate development of livestock systems.

9.2 Recommendations

For supporting change in farming practices

RQ4: The strategy of flexibility in implementation of government policy should be retained to achieve success in introducing appropriate change to a resistant, traditional industry.

Involve farmers and traders in decisions about what problems and opportunities they have in directing research and adaptation of practice changes to Timor-Leste cattle farming systems.

In extension, use teams that include both women and men. Use demonstration of efficacious cattle systems as a key method of communicating options to farmers.

Map a structured system to develop capacity for cattle systems based on specific future requirements for Timor-Leste RD&E. A plan should include primary needs, such as skills and knowledge in business, marketing, communication, forage and cattle production systems, and research methods. The plan may include introducing national and international university training programs to produce graduates with much higher skills and knowledge than currently occurs.

To underpin appropriate supporting policy, identify methods to accurately, readily and cost-effectively measure domestic cattle populations, off-take and beef consumption.

For cattle productivity

RQ2: Use cattle yards as an entry point for improving cattle systems. Conduct research to improve the design of cattle yards to suit Timor-Leste cattle systems.

Assist farmer to increase live weight production and its efficiency in Bali cattle by:

- Using controlled production and utilisation of forages, initially with forage tree legumes and food crop residues, and progressing to other legumes and grasses.
- Using weaning as a primary husbandry practice, supporting by other husbandry such as creep feeding of calves, and improved access to drinking water.
- Having fewer cattle and other grazing animals where feed supply is limited to enable feed utilisation to be switched from maintenance to production.
- Better control and care for public grazing lands through strategies such as transition to private tenure.

RQ1: Elevate chances of farmers adopting better practice in cattle systems with high priority on using forages to increase growth of calves and bulls, and then progress to cow management.

Research is required to define better the reasons for high calf and adult cattle mortality rates, and to identify practical solutions

For cattle markets

RQ3: All current markets (ceremonial and other slaughter in Dili and provincial regions; border trade) are valuable and all are worthy of government support. As government is committed to cattle industry policy into the foreseeable future, it should also retain the flexibility to assess and revise the strategies where necessary.

More focus on the “modern” chains into Dili to establish direct linkages could contribute an additional sales channel for higher value product that could potentially deliver weight-price premiums and over-the-scales selling to producers.

Establish appropriate policy for traditional ceremonial practices that utilise cattle, a significant market. Most cattle used for this purpose are sold.

A detailed assessment of the costs, benefits and feasibility of meeting international protocols would be useful for the Government of Timor-Leste in developing a practical cost-effective way - with incentives - to formalise, and thus boost, the trade of live cattle to Indonesia.

Incorporate the use of girth measurement for cattle live weight estimation as part of systems monitoring and cattle transactions.

10 References

10.1 References cited in report

Anon (2007). Timor-Leste Household Income and Expenditure Survey 2007. National Statistics Directorate, Government of Timor-Leste, Dili.

Anon (2015). FAO Food Security Data, June 2015. http://knoema.com/FAOFSDD2015Jun/fao-food-security-data-june-2015?location=1002000-timor-leste

Dahlanuddin Mulik M, Sutaryono YA, Varela CdaC, Coimbra L, Supriyadi M, de Deus P (2014) Strategies for improving Bali cattle productivity in Timor-Leste. Final report, Project LPS/2011/044, ACIAR, Canberra.

Dahlanuddin, Yulian BT, Panjaitan T, Halliday MJ, van de Fliert E and Shelton M. 2014. Survey of Bali bull fattening practices in central Lombok, eastern Indonesia, based on feeding of Sesbania grandiflora. *Animal Production Science*. **54**, 1273-1277.

Dahlanuddin, Zaenuri L A, Sutaryono Y A, Hermansyah, Puspadi K, McDonald C, Williams L J, Corfield J P and van Wensveen M 2016. Scaling out integrated village management systems to improve Bali cattle productivity under small scale production systems in Lombok, Indonesia. *Livestock Research for Rural Development. Volume 28, Article #79.* http://www.lrrd.org/lrrd28/5/dahl28079.htm

De Almeida, A. 2012. *Cau*ses of low reproductive performance of Bali cattle *(Bos sondaicus)* in Timor-Leste and strategies to improve reproduction. M. Phil Thesis. The

Garcia, J.S. and Cardosa, J.C. (1978). Os solos de Timor. Lisboa: Junta de Investigacoes do Ultramar Mapas.

Jelantik IGN, Mullik ML, Leo Penu CLO, Jeremias J and Copland R. 2008. Improving calf survival and performance by supplementation in Bali cattle. *Australian Journal of Experimental Agriculture.* **48**, 954-956

Jelantik IGN, Mullik ML, Leo Penu CLO and Copland R. 2010. Factors affecting the response of Bali cattle (*Bos sondaicus*) calves to supplementation prior to weaning. *Animal Production Science.* **50**, 493-496

Lopes M and Nesbitt (2011). Improving food security in East Timor with higher yielding crop varieties. In: Food security in East Timor, Papua New Guinea and Pacific island countries and territories, ACIAR (Ed: D Templeton), Canberra. pp.12-26.

Quigley SP, Dahlanuddin, Marsetyo, Pamungkas D, Priyanti A, Saili T, McLennan SR and Poppi DP. 2014. Metabolisable energy requirements for maintenance of live weight of Bali (*Bos javanicus*) cattle. *Animal Production Science*. **54**, 1311-1316.

Talib C, Entwistle K, Siregar A, Budiarti-Turner S and Lindsay D. 2003. Survey of population and production dynamics of Bali cattle and existing breeding programs in Indonesia. In Strategies to improve Bali cattle in eastern Indonesia. Ed. Entwistle K and Lindsay DR. ACIAR Proceedings 110. Australian Centre for International Agricultural Research: Canberra, ACT.

UNDP (2012). Population below income poverty line (%), PPP $1.25 a day, 2002-2012. Multidimensional Poverty Index, Human Development Reports, United Nations Development Programme. http://hdr.undp.org/en/content/table-6-multidimensional-poverty-index-mpi

10.2 List of publications produced by project

Daos A, Seran AEM, Coimbra L, Pinto R, Dalgliesh N and Yuliaty (2014). The potential for herbaceous legumes and grasses as cattle feed in Timor-Leste. *In*: Proceedings of the 16th Asian Australasian Animal Production Congress, Yogyakarta, 10-14 November 2014.

Gusmão de Sousa JA, Coimbra L, de Deus P, Pinto R, Seran AEM, Daos A, Fernandes F, dos Santos J, van de Fliert E (2014). Cattle's Position within Smallholder Farming in Timor-Leste. *In*: Proceedings of the 16th Asian Australasian Animal Production Congress, Yogyakarta, 10-14 November 2014.

Mali CGT, Varela C, Daos A, dos Santos J, Fernandes F, Seran AEM, Pinto R and Coimbra L (2014). Body condition score of female Bali cattle in the dry and wet seasons in Timor-Leste. *In*: Proceedings of the 16th Asian Australasian Animal Production Congress, Yogyakarta, 10-14 November 2014.

Waldron S, Correia VdeP, Mulik M, de Rego A, Varela CdaC, Fordyce G, Thorne-George E, Dalgliesh N, Quigley S, van de Fliert E (2016). Sub-sector analysis of the Timor Leste beef Industry. Appendix of: ACIAR project LPS-2009-036, Enhancing smallholder beef production in Timor Leste, Australian Centre for International Agricultural Research, Canberra.

11 Appendixes

The following appendices were prepared as separate documents.

11.1 Appendix 1: Detailed report – Situation analysis

Prepared by: Elske van de Fliert

11.2 Appendix 2: Detailed report – Markets and policy analysis

Prepared by: Scott Waldron

11.3 Appendix 3: Detailed report – Forage production research

Prepared by: Neal Dalgliesh

11.4 Appendix 4: Detailed report – Productivity of Bali cattle

Prepared by: Simon Quigley

11.5 Appendix 5: Detailed report – Creep feeding

Prepared by: Simon Quigley, Alipio de Almeida

11.6 Appendix 6: Detailed report – Cattle handling infrastructure

Prepared by: Simon Quigley, Latino Coimbra

11.7 Appendix 7: Training of trainers Dec 15

Prepared by: Elske van de Fliert

11.8 Appendix 8: Master's students

Prepared by: Pedro de Deus, Quintiliano Afonso Belo