Australian Government

Australian Centre for International Agricultural Research

Final report

project **Small research and development activity**

Evaluating the opportunities for smallholder livestock keepers in Timor-Leste

project number	LS/2017/035
date published	23 December 2021
prepared by	Dominic Smith, Tarni Cooper
co-authors/ contributors/ collaborators	Joanita Jong, Abrao Pereira
approved by	Dr Anna Okello
final report number	FR2021-076
ISBN	978-1-922635-87-7
published by	ACIAR GPO Box 1571 Canberra ACT 2601 Australia

Contents

1 Acknowledgments

We would like to give our sincere thanks to ACIAR for supporting this study and especially to Anna Okello for giving us the opportunity to undertake this interesting and challenging assessment.

We would like to thank our colleagues in Timor-Leste, especially to our counterpart Joanita Jong and our working colleagues Abrao Pereira, Olavio Morais, Apolonia dos Santos Soares, Afriano Santos Cardoso and Deolindo Gusmao. We would also like to thank Tamsin Barnes for all her insights and support and we would also like to thank Richard Holloway, Alfons Urlings and the TOMAK team for their support in terms of logistics, but also in terms of information and knowledge sharing.

In West Timor we would like to thank our colleague Martin Mullik and all of the individuals and organizations who gave of their time so freely to support this research.

A special thanks also goes to all of the participants in the livestock roundtable of May 2020 and the beef sector discussion in June 2020. Also, thanks to Jenny-Ann Toribio and Cynthia Hunter for their advice regarding working with border-lying farming communities and to Robyn Alders who chaired and shared the findings from the Crawford roundtable on Strengthening Animal Health Service Policies in Timor-Leste.

Finally, we would like to thank all of the farmers and other stakeholders in Timor-Leste who gave their valuable time and shared their first-hand insights into smallholder livestock keeping in Timor-Leste.

2 Executive summary

The overall aim of the SRA was to further develop a vision and direction for ACIAR support to MAF in the sustainable development of the smallholder livestock sector in Timor-Leste over the coming 5-10 year period. This included evaluating the business case for ACIAR investment in support of smallholder pig production development in Timor-Leste with a focus on market and agribusiness aspects, identifying the current constraints and bottle-necks to formalizing cross-border trade between TL/NTT, and undertaking an analysis of the of key smallholder livestock sectors in TL considering policies, priorities, cross-border trade issues and the potential for impact on livelihoods.

The SRA used a range of methods to triangulate and maximise reliability of findings. The study was predominantly qualitative in nature, though included some semi-quantitative, participatory activities and quantitative analysis of secondary data. The study began with desk review and scoping in both West Timor and Timor-Leste, followed by study design and field research in five study sites in Timor-Leste. Findings were analysed and interpreted before they were presented to an online multi-stakeholder roundtable. Local and international leaders of other Timor-Leste livestock research and development projects also presented on their work at the roundtable and this information was also captured for inclusion in the SRA report.

The SRA research confirmed the vital importance of livestock to households, both in terms of socio-cultural significance and as a form of savings for regular and unanticipated expenses. While consumption levels of meat in Timor-Leste are generally low, over 178,000 of 204,000 (87%) of households kept livestock (RDTL, 2015), and the value of livestock to the people of Timor-Leste is extremely high.

Across all focus groups with both men and women, during ranking exercises participants consistently indicated that every livestock species is of high importance to their households. Poultry were seen as important for both ceremonial purposes and because they could be sold to meet immediate cash needs. Pigs were very important as ceremonial animals and also as a high value asset that could be sold in case of urgent need for a larger amount of cash. Cattle and buffalo were valued very highly for ceremonial purposes. In the mountainous areas, horses were ranked as extremely important for transportation purposes.

Livestock is of vital importance to households, both in terms of socio-cultural significance and as a form of savings for regular and unanticipated expenses. However, despite this importance, animal diseases are relatively uncontrolled in many parts of the country, and mass mortalities occur with regular seasonality, especially in pigs and chickens. This cyclical loss of animals wipes out household savings and creates significant stress in terms of needing to find alternative sources of livestock for ceremonies and cultural purposes.

The animal health sector continues to be faced with many challenges in terms of capacity building needs and resourcing from the Timor-Leste government and from donor agencies. Without systemic intervention and support for the animal health sector at a national level and across all municipalities, impactful and sustainable improvements to the system will be difficult to achieve.

Recommendations

Systemic and coordinated support for animal health and livestock sectors. The efforts of Government of Timor-Leste and donor agencies in support of the livestock and animal health sectors in Timor-Leste should be as coordinated and synergistic where possible, focusing on capacity building and also resourcing and supporting community relationship-building by veterinary and livestock technicians.

Cattle production systems should orient to the domestic market for cattle, rather than export. While there are relatively few physical barriers to trade between Timor-Leste and Indonesia, formal trade in cattle between Timor-Leste and West Timor will not be able to take place unless there is Brucellosis free status for all Timor Island.

In addition to the regulatory barriers to trade, there are significant economic barriers to trade. The strong appreciation of the USD against the Indonesian Rupiah over the past decade has seen Timor-Leste cattle exports become less competitive in Indonesia, while Indonesian poultry exports are becoming increasingly competitive in Timor-Leste.

The physical conditions for trade are in place, but until cattle exports from Timor-Leste to NTT become more economically attractive then it is unlikely that the significant remaining political and regulatory barriers to formalizing cattle exports can be overcome.

Pig Sector should be supported, but not with an orientation to supplying pork to Dili market. The vital cultural, social and economic role that pigs play for households in Timor-Leste has been noted in numerous studies ((Bettencourt et al., 2015; Hunter, 2019) and confirmed during the fieldwork for the current SRA. The current outbreak of ASF in the country has further highlighted the importance of pigs and the potential for pig disease to have serious implications for livelihoods across the country. These factors, combined with the widespread nature of pig raising across the country means that there is a very strong case for supporting household level pig rearing across the country as a means of supporting livelihoods and reducing vulnerability.

However, the lack of non-ceremonial demand for pork, the lack of value chains and slaughtering facilities, combined with the high price of domestic pigs and the extremely low price of imported pork products means that any strategy for supporting the smallholder pig raising sector in Timor-Leste should not be oriented towards producing pork for the market in Dili.

3 Background

Livestock are kept by the majority (87.2%) of households in Timor-Leste. Pigs are kept by a total of around 146,000 households with a national herd estimated at almost 420,000 (DNE, 2016). The most common pig production system is an extensive scavenging system, but some pigs are raised in confined smallholder semi-intensive and intensive systems. Around 3 percent of the pig rearing households (accounting for 3 percent of the total pig herd) reported rearing pigs mainly for sale, while 51 percent of households (53.5 percent of pigs) reared pigs mainly for home consumption and the remaining 46 percent (43.6 percent of pigs) kept pigs as part of minor agricultural activities (DNE, 2016).

Pigs are an important source of household cash income and are sold as piglets or retained as an investment for sale when funds are required. In general Timor-Leste people consume pork, but this is almost entirely at the time of various ceremonies. Very few Timor-Leste people consume pork outside of that which is consumed at ceremonies. The reasons for this are largely cultural, rather than a result of pork being highly priced. What limited demand there is for pork in the Dili market is also met by imports of around 1000 tons of relatively low-priced pork, possibly to mostly cater to expatriates and some restaurants.

While it would appear that interventions supporting smallholder farmers to fatten pigs for the (currently very small) pork market may not be useful in terms of generating sustainable livelihood improvements, there is a good case for analyzing interventions around smallholder pig production that could have potentially positive impacts on livelihoods. These include support to improved sow/piglet nutrition and management utilising locally available feedstuffs. There is a relatively strong demand for piglets (especially crossbred piglets) for households to raise for their own ceremonial purposes or for sale to other households for ceremonial purposes. The scale and sustainability of this demand for piglets will be what determines the business case for any project supporting improved sow and piglet nutrition and management for smallholders.

The governments of Timor-Leste and Indonesia have both expressed their commitment to greater cross-border cooperation and increased trade, especially between Timor-Leste and the Indonesian province of Nusa Tenggara Timur. Increased trade with Indonesia and greater cross-border cooperation supports the Timor-Leste Strategic Development Plan and the aspiration of the country to achieve membership of ASEAN. Asian Development Bank (ADB) is also prioritizing support for the two countries to develop collaboration in the form of trade, investment, and cooperative production as a means of addressing national inequality, diversifying economic growth, and importantly, reducing poverty in the border areas between the two countries (ADB, 2018).

Livestock trade has been highlighted as one of the first key areas of potential cooperation (ADB 2018). There is a strong case to be made for comparative analysis of potential livestock products for development support in terms of potential for sustainable livelihood improvements for smallholders, women's economic empowerment, health and nutrition and domestic and export market potential.

4 Objectives

The overall aim of the SRA is to further develop a vision and direction for ACIAR support to MAF in the sustainable development of the smallholder livestock sector in Timor-Leste over the coming 5-10 year period. More specifically the objectives are to:

i) Evaluate the business case for ACIAR investment in support of smallholder pig production development in Timor-Leste with a focus on market and agribusiness aspects, taking into account broader socio-economic and political factors

ii) Identify the current constraints and bottle-necks to progressive dialogue on formalizing cross-border trade issues between TL/NTT through a consultative process with DFAT, ACIAR and the governments of TL and Indonesia, and identifying opportunities for research contributions such as better understanding disease risks

iii) Comparative analysis of the of key smallholder livestock sectors in TL considering policies, priorities, cross-border trade issues and the potential for impact on livelihoods, together with a visioning process around the best use of ACIAR resources

5 Methodology

This small research activity used a range of methods (methodological pluralism) to triangulate and maximise reliability of findings. The study was predominantly qualitative in nature, though included some semi-quantitative, participatory activities and quantitative analysis of secondary data. The study began with desk review and scoping, followed by a process of study design. Following institutional human research ethics approval from The University of Queensland (approval number 2019001595), field research was conducted across five study sites. Findings were analysed and interpreted before they were presented to an online multi-stakeholder roundtable. Local and international leaders of other Timor-Leste livestock research and development projects also presented on their work at the roundtable and this information was also captured for inclusion in the SRA report.

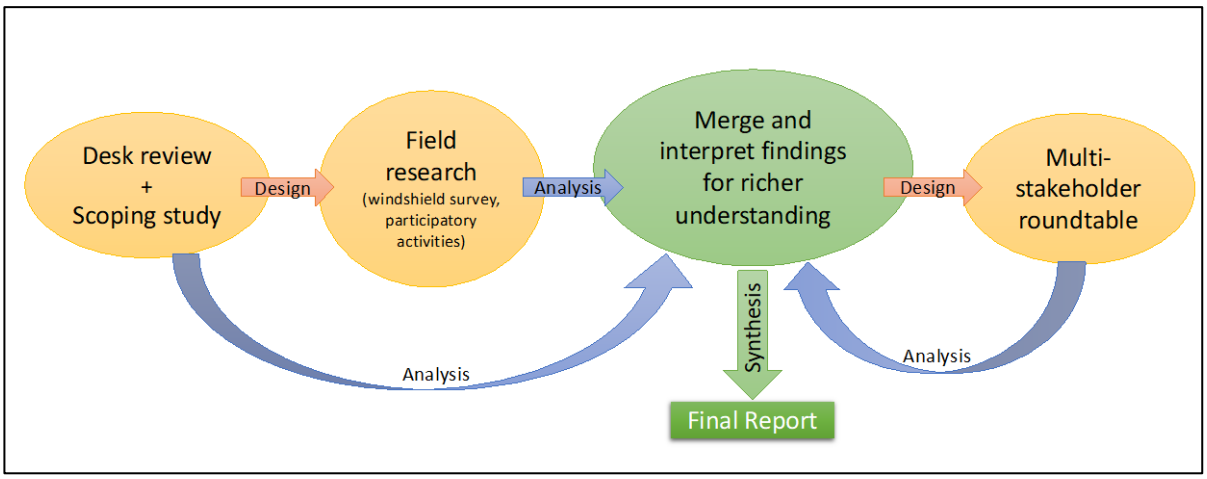


Figure 1 Schematic representation of the research process

Primary findings from field research were compared, contrasted and supplemented by secondary information. As well as peer-reviewed literature, reviewed documents included government documents from Timor-Leste and livestock research and publicly available development project reports from various institutions.

5.2 Analysis of secondary data

Data analysed were the most recent, available and relevant to the research questions. Timor-Leste's first dedicated livestock census took place during the period of the SRA, at the end of 2019 but data were not made available before the SRA closed. Accordingly, the following data sets were accessed, and descriptive analyses conducted:

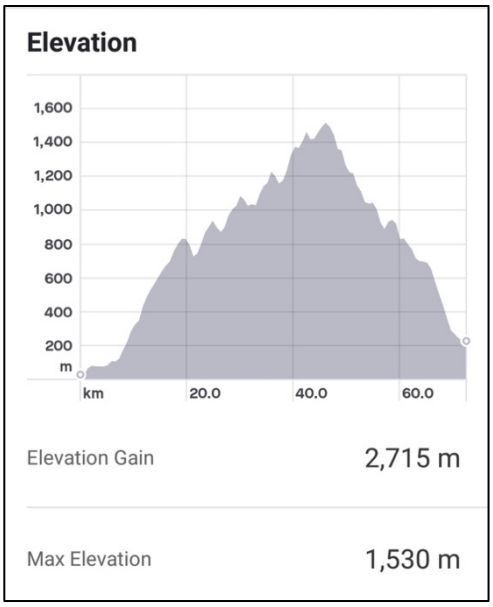
i. HIEC 2011 consumption data (urban vs. rural comparisons)
ii. HIEC 2011 income data from livestock production (need more detailed data as data in tables in report is not calculated correctly)
iii. Census 2011 and 2015 (population, livestock numbers)
iv. Import and export statistics (for formal trade)

5.3 Windshield survey

Windshield survey is a method of research where systematic observations are made from a moving vehicle. In contrast to a transect walk or walking survey, the method is useful for situations where large areas need to be covered in a short amount of time. The observations made are less in-depth than those that can be made on foot. Windshield survey is used to

observe features of communities such as accessibility, infrastructure, natural resources, and aspects of social and economic character. In the case of this study, windshield survey focused on (i) observations on the conditions for livestock raising and cross-border trade (considering fodder, crops, road quality, holding yards and so on) and (ii) informing the choice of study sites for further, in-depth study during subsequent field research.

During July 2019 the research team passed through the Indonesian checkpoint and border gate, Motamasin, entering Timor-Leste at Salele in Covalima municipality, in the far south-west of the country. After spending a night in Suai, the main city in Covalima, the team drove north along the border-most road. This northern route took the team from around sea level to the mountainous Lolotoe administrative post in Bobonaro municipality, reaching 1,530m above sea level (Figure 2).



The team then descended to Maliana, a low-lying administrative post in Bobonaro. Following a night in Maliana, meeting with government veterinary staff and visit to the local markets, the team drove to the Batugade-Motaain border gate in Balibo, Bobonaro and met with quarantine and customs staff before continuing along the northern, coastal route through Atabae and Liquica to Dili (see Figure 24 **Error! Bookmark not defined.**). The final leg of the windshield survey was driving to Cristo Rei administrative post in Dili municipality to visit intensive pig and broiler chicken production systems, and returning to Dili city.

5.4 Study site selection

All but one of our study sites was chosen during the windshield survey and stakeholder meetings. Alas was chosen as an additional study site following field activities in the existing sites due to an emerging theme. As we will describe in the findings section below, this was to further explore an emerging theme in the research findings.

The study sites chosen were five sucos in five administrative posts within four municipalities (Table 1). All participants came from a single aldeia (community) within a suco (village). The choice of municipalities was based on the appropriateness for answering our research questions and sucos within these were chosen during the first field visit, based on the windshield survey and conversations with local stakeholders. The first topic of discussion in each farmer focus group session was around what the community was known for and what species of livestock were owned by the group. These findings are included here, to give context to later sector-based sections.

Table 1 Sites selected for in-depth study (suco and aldeia names omitted to ensure anonymity)

• **Municipality** • **Administrative Post** → **Geography**	**Rationale for Selection**	**Features of the community, as described by farmers**
• Dili • Cristo Rei → Coastal	This site allows us to explore how the recent development of a local, commercial broiler farm, which imports day old chicks (DOC) from Indonesia has on smallholders. Also, looking at the barriers that a relatively small distance from Dili can present	*Our community is not known for anything special. We have challenges with livestock, especially disease and lack of water for livestock during the dry season. Most of the animal raising is for socio/cultural purposes, for example special ceremonies for clans and also for weddings, ceremonies, funeral and negotiation before marriage, etc. Some households do fishing, some doing livestock, some producing liquor for alcohol*
• Bobonaro • Maliana → Midlands	This suco borders Indonesia and is relatively close to a major border gate raising questions about opportunities to trade with Indonesia	*Famous for rice farming and secondly, for livestock raising in the traditional way (extensively). Some cattle are now tethered. Most people make the bulk of their livelihood on-farm. We have an annual community event where women and children chase and capture a flightless bird every August* (see section on wildlife)
• Bobonaro • Lolotoe → Highlands	The windshield survey revealed a very contrasting topography in the highlands of Bobonaro, where cattle and horses are raised in vast pastoral lands. This site will inform us about how a community addresses the challenges of remoteness and being connected to major markets only through challenging roads.	According to women - *In this community doing agriculture relating to cropping or livestock, the level of involvement of both men and women is equal. What men can do in cropping or livestock, women can do as well. This is a part of our culture, even in relation to other economic activities generating money women and men participate equally. This is a long-term cultural feature of this community, even from our grandparents' time.* *There are several ongoing development activities, by the government (roads rehabilitating the watershed and maintaining water supply) and World Vision (seedlings for forages and teak)* According to men - *This aldeia is about 1000m altitude and has about 150 households, 600 people. Get water from a spring (this is enough to supply all the people with water), have electricity since 2012. Road construction of the road between Maliana and Suai is ongoing. 3G here is excellent and fast (much better than Maliana) Close to border, have some cross-border activities like cockfighting on Sundays. This occurs on the Indonesia side so is not legal but accepted. The relations with Indonesia are good. The*

		main livelihood activity is livestock keeping but are also involved in cropping (corn, cassava) and forestry
• Cova Lima • Tilomar → Coastal	Far from Dili but close to the southern border gate, where formal cattle trade with Timor-Leste was once commonplace. Anecdotally, researchers have mentioned 'fat cattle' in this area, unlike other cattle they have seen throughout Timor-Leste	*The community is focused on agriculture including crops and livestock. There are two rainy seasons in this region, but December has the heaviest rains and this is when most animals get sick. Many vegetables are grown and sold in local markets. There are many cultural ceremonies in the dry season including Marian processions (Catholic ceremony).* *The community is famous for having a lot of agricultural assistance programs from non-government organisations (NGOs), which they put down to the community's enthusiasm in collaborating with NGOs. There is a famous bull here, the only successful offspring of an artificial insemination project. The bull is extremely large as it is a cross between local cattle and an exotic breed. People including politicians come to take photos with the bull.*
• Manufahi • Alas → Mountainous	This location allows the research to take a deeper look at challenges in government vaccination systems, a recurrent theme identified through field work in the previous locations. The Timor-Leste government previously implemented an improved vaccination program (cattle, chickens, pigs) in this location and through FGDs and interviews, we studied the local perceptions of this initiative.	*This aldeia is not well-known for anything. It is quite remote, not close to Dotik township. The road is hardly accessible during the rainy season. There are no bridges in the two rivers. Students live in Dotik for junior and senior high school. Common activities in this aldeia include rice farming. crop cultivation and livestock-raising. We have 'tebe-dai', 'dahur' which is commonly done at 'saubatar' (a ritual ceremony before harvesting the first corn in a year and other crops on the farm). This 'saubatar' normally takes place in March. Cultural activities commonly practiced in the community include construction of sacred house and inauguration (ceremony at conclusion of construction of a new sacred house, to 'open' it for use*

All participant farmers said they owned all animals they tended; they did not keep them for other people. In Cristo Rei, however they explained some people in their village did keep cattle for wealthy people in Dili but none of those present did. No cattle were kept for dairy production and no farmers kept ducks or rabbits.

Table 2 Proportion of participants in each farmer focus group who own each species of livestock (By location and gender of focus group)

	A-F	A-M	CR-M	L-F	L-M	M-F	M-M	T-F	T-M
Pigs	4/6	6/6	10/10	8/8	7/7	8/9	5/5	11/11	8/8
Chickens	6/6	6/6	10/10	7/8	7/7	9/9	5/5	11/11	8/8
Cattle (beef)	3/6	6/6	4/10	5/8	5/7	6/9	5/5	8/11	8/8
Buffalo	4/6	2/6	2/10	0	0	0	0	0	0
Goats	1/6	1/6	4/10	2/8	3/7	2/9	3/5	3/8	2/8
Horses	6/6	6/6	0	4/8	5/7	0	0	0	0
Dogs (meat)	6/6	6/6	0	7/8	7/7	7/9	0	11/11	8/8

A – Alas, CR – Cristo Rei, L – Lolotoe, M – Maliana, T – Tilomar

M- Male Focus Group, F – Female Focus Group

5.5 Farmer participatory group activities and discussions

Nine participatory group sessions were conducted with farmers across the five sucos. Separate male and female sessions were run in each suco except for in the Administrative Post of Cristo Rei, where logistical challenges prevented it. While discussion between participants was actively encouraged, the activities were heavily facilitated by researchers. Accordingly, some would label this research method 'participatory group interview'. The group sessions had six objectives. Discussion probes revolved around the personal and community-level benefits and costs of livestock keeping, challenges faced and questions the community wanted answered (potential future research questions).

Box 1: Farmer focus group discussion and activity guide

Objective 1: To gain a deeper understanding of family farming livelihoods in the community

Activity: Open discussion; Materials: toy animals as prompts

1. What is this village 'known' for?
   - Probes: crops, ceremonies, livestock, cultural events, main livelihood activities
2. How do livestock fit into people's lives?
3. What are the main livestock species kept in this village?
   - Why?

Objective 2: To understand how livestock contribute directly to food security

Activity: Proportional piling, matrix; Materials: beans, food cards, measuring jug, paper, pens

1. What proportion of your diet in the past year was made up of the following: meat, eggs, milk, fish, vegetables, fruit, rice, maize (and other categories identified by participants)
2. Of the meat, what proportion of each type (types identified by participants)
3. Of the animal-source foods (meat, eggs, milk), which do you get from your own farm?

Objective 3: To understand the relative value of each type of livestock, not just for consumption

Activity: Ranking and open discussion; Materials: toy animals

I. Which livestock brings the most *value* to a family?
   Probes: ceremony, social capital, draft power, emergency bank, manure, food, money
II. What prevents people from owning the most valuable livestock?
III. How might this change for your children?

Objective 4: To understand seasonal consumption of livestock and any patterns of livestock disease

Activity: Seasonal calendar; Materials: paper, pens

- *First build calendar (beginning, end, weather, major activities, crops, hunger)*

I. What are the ceremonies throughout the year where livestock are consumed?
II. Which ceremonies are fixed in time and which are not?
III. Of the ceremonies that change in timing, how do you decide when to hold them?
IV. Do you ever have a shortage of livestock for ceremonies? What happens then?
V. Does disease of livestock happen at different times of the year? Which and when?

Objective 5: To understand the challenges of livestock-keeping in the community

Activity: Open discussion and voting; Materials: Toys, cards, pens, stickers

1. What are the major challenges for raising livestock in this village? (write problems on cards and put beside toys)

- Probes: Disease, environment, feed, markets (e.g. competition from imports)

Objective 6: To determine what questions the community have and how they would prioritise them

Activity: Group sorting and ranking; Materials: cards, pens

I. Reflecting on the challenges you face in raising livestock, which ones do you know how to solve, and which ones raise questions? (sort into two piles)
   - Probes: How? Why? Who?...

II. What are the questions (prompt with each card in challenge pile and write questions on cards

III. If you could choose which questions were investigated first, which would you choose i.e. What are the most pressing questions for your village?
   -

In Timor-Leste, the overall adult literacy rate (15 years and older) is around 68 per cent. The rate is much higher in younger adults but in those over 65 years of age, it is much lower, 21 per cent among men and 9.5 per cent among women (UNESCO, 2020). Participants were all adults but otherwise not selected on age. Therefore, given this potential low literacy rate among participants, the use of visual (pictures, figurines) and verbal cues was maximised (Figure 3). In addition, where the primary language used in the community was not Tetum-Dili, the lead facilitator was supported by a translator. In Lolotoe, Bobonaro the community primarily spoke Bunak and in Tilomar, Covalima the community spoke Tetum-terik. The research team included research assistants fluent in these languages.

Figure 3 Use of animal figurines, local legumes and pictures for matrix activity during a farmer focus group, Timor-Leste

Participatory activities can be time-consuming, and the research team were aware of the risk of participant fatigue. Efforts were made to streamline activities where possible. For example, during proportional piling activities, the use of a measuring cup with a percentage scale, as first described by Tomaselli et al (2018), markedly reduced the time required for the traditional individual bean counting method.

5.6 Semi-structured interviews

A combination of purposive and snowball sampling was used to identify fifteen interview respondents. In each location the research team aimed to interview at least one government staff member and someone filling a different role in one or more livestock value chains. This was achieved in four of five study sites but in Alas, time constraints meant only government livestock and veterinary staff were interviewed (Table 3).

Table 3 Demographic details of semi-structured interview respondents across five study sites

Sex	Age	Employer	Occupation
M	53	Government	Livestock technician
M	54	Government	Head of Livestock and Veterinary Department
F	30	Government	Veterinary technician
M	50	Self	Livestock trader
M	50	Government/Self	Government livestock technician and livestock trader
M	38	Self	Livestock trader
M	34	Government	Livestock technician
M	49	Government	Head of Livestock and Veterinary Department
M	32	Government	Veterinary technician
M	38	Self	Slaughterer/butcher/meat seller/cattle trader
M	56	Government	Quarantine officer
M	54	Government	Second in charge of Livestock and Veterinary Department
M	33	Self	Cattle trader
M	31	Government	Veterinary technician
M	-	Government	Livestock technician

The objectives for interviews with government workers and other value chain actors varied slightly but both sought to understand more about the roles of respondents, their attitudes and nature of their interactions with smallholder livestock keepers. All interviews then led into discussing the challenges respondents and those in similar roles faced and the role for research and development in addressing these. Finally, interviews sought to understand the way respondents would prioritise suggested research and development interventions.

Box 2: Objectives for semi-structured interview of government workers

The following were used as the basis of a checklist for interview of veterinary and livestock technicians and their heads of department.

Objective 1: To gain an understanding of the participant's background and role (break ice and contextualise ensuing discussion, walk around workplace if appropriate)

Objective 2: To understand how the government values smallholders and sees their role changing over time

Objective 3: To understand the way the government interacts with/serves smallholder livestock-keepers and barriers faced (compared to larger farms)

Objective 4: To determine aspirations for the future (regarding work) and the need for research, in context of other needs, to achieve these

Objective 5: To determine what questions the participant has with respect to livestock and which they would want prioritised first

Box 3: Objectives for semi-structured interview of non-government livestock value chain actors

The following were used as the basis for an interview checklist used when interviewing non-government value chain actors

Objective 1: To gain an understanding of the participant's role (break ice and contextualise ensuing discussion, walk around workplace if appropriate)

Objective 2: To understand the respondent interacts with/serves smallholder livestock-keepers and barriers faced (compared to larger farms)

Objective 3: To understand how the respondent sees their role changing over time (past and future)

Objective 4: To understand the challenges faced by the livestock value chain and perceived solutions

Objective 5: To determine what questions the participant has with respect to livestock and which they would want prioritised first

5.7 Stakeholder meetings in Indonesia and Timor-Leste

In July 2019, the research team spent two weeks touring Timor Island, starting in Kupang, West Timor, Nusa Tenggara Timur, Indonesia and finishing in Dili, Timor-Leste. Six nights were spent in West Timor and 7 nights in Timor-Leste with around 800km driven (see Figure 24 **Error! Bookmark not defined.**) and 23 stakeholder meetings conducted in West Timor. In West Timor, all of the regencies and all active border gates between Indonesia and Timor-Leste were visited. The border gates included Napan (bordering Oecusse), Motamasin (southern crossing bordering Suai) and Motaain (northern crossing bordering Batugade). When in Timor-Leste, the Batugade post at the norther border crossing was also visited (Figure 5).

Figure 4 Route of land travel (approximate) during West Timor consultations and Timor-Leste windshield survey, July 2019

Figure 5 Meetings with Quarantine Officers at Mota'ain, Indonesia (left) and Batugade, Timor-Leste (right) border posts on either side of the northern land-border crossing

The windshield survey component of this mission, conducted in Timor-Leste, was previously described (*see* Section 5.3). In addition to this survey, in Timor-Leste the research team met with livestock and veterinary technicians and Heads of Department in Covalima, Bobonaro and Dili, staff from the National Veterinary Laboratory, and Tomak and Market Development Facility (Australian Government-funded initiatives), and a commercial broiler day old chick (DOC) importer who also directs a national farmer association.

5.8 Online multi-stakeholder Roundtable

In preparation for the Online Roundtable on Supporting MAF Timor-Leste in the Development of the Livestock Sector, an online survey was conducted, to capture core details of recent and current bilateral and multilateral livestock projects and programs in Timor-Leste. The research team employed purposive and snowball sampling in an effort to reach out to as many recent and current initiatives as possible. Twenty-one projects and programs were reached and responded to an online survey and all were invited to present a short summary of their research at the roundtable. Forty-four people attended the 4-hour online roundtable held on May 19th, 2020. The roundtable first included presentation of the

data contained in this report, to seek feedback, followed by the presentations from participants.

6 Achievements against activities and outputs/milestones

Objective 1: To evaluate the business case for ACIAR investment in support of smallholder pig production development in Timor-Leste with a focus on market and agribusiness aspects, taking into account broader socio-economic and political factors

no.	activity	outputs/ milestones	completion date	comments
1.1	Desk review of existing project/program outputs, census information, household expenditure and income survey and data gathered during scoping visit	Scoping Visit Trip Report Information incorporated into final report	15/4/1029 31/12/2020	Integrated into overall report on livestock trade and development in Timor-Leste
1.2	Set of key informant interviews/semi-structured interviews with farming households in Maliana and Baucau to collect information on livestock raising and overall livelihoods	Trip Report for Field Visit in September 2019	15/10/2019	Key informant interviews and focus group discussions were held in 1. Sukaer Laran, Hera, Cristo Rei, Dili 2. Tapo Memo, Maliana, Bobonaro 3. Lebos, Lolotoe, Bobonaro 4. Salele, Lalawa, Tilomar, Covalima 5. Dotic, Manufahi
1.3	Preparation of report outlining conclusions around the business case for support of smallholder pork production.	Preliminary Report Final report on business case for support of smallholder pork production	31/12/2020	Preliminary report prepared after scoping visit and discussions with key stakeholders. Final report integrated into overall report on livestock trade and development in Timor-Leste

Objective 2: To identify the current constraints and bottle-necks to progressive dialogue on formalising cross-border trade issues between TL/NTT through a consultative process with DFAT, ACIAR and the governments of TL and Indonesia

no.	activity	outputs/ milestones	completion date	comments
2.1	Desktop review of ADB project material and other project/program information relating to cross-border trade between T-L and NTT.	July 2019 Visit Trip Report Information incorporated into final report	15/08/2029 31/12/2020	Integrated into overall report on livestock trade and development in Timor-Leste
2.2	Field visit to NTT to discuss cross-border trade issues	Field report from visit to NTT	31/7/2019	Field visit to NTT combined with field visit to Timor-Leste during July 2019.

2.3	Continued discussion with ADB regarding upcoming pilot, and linkages to ACIAR, DAWR and DFAT activities currently being undertaken in Timor-Leste	Information incorporated into final report	31/12/2020	Consultative meeting held in Canberra. Working with ADB key consultant Martin Mullik during fieldwork in NTT ADB participation in Livestock Options Roundtable meeting in May 2020 and Beef and Trade online discussion.
2.4	Preparation of report outlining conclusions around the issues relating to formalization of trade.	Final report on issues relating to formalization of trade	31/12/2020	Final report integrated into overall report on livestock trade and development in Timor-Leste

Objective 3: To undertake a comparative analysis of key smallholder livestock sectors in TL considering policies, priorities, cross-border trade issues and the potential for impact on livelihoods, together with a visioning process around the best use of ACIAR resources

no.	activity	outputs/ milestones	completion date	comments
3.1	Continued desk review of existing project/program outputs (especially those of LPS/2014/038 and antecedents, census information, household expenditure and income survey and data gathered during scoping visit	Scoping Visit Trip Report Information incorporated into final report	15/4/1029 31/12/2020	Integrated into overall report on livestock trade and development in Timor-Leste
3.2	Consultative meetings in Canberra with ACIAR, DAWR and DFAT, including identification of opportunities for collaboration and alignment of activities in Timor-Leste's livestock sector	Presentations and discussion notes	12 June 2019	Consultative meeting held in Canberra.

3.3	Consultative workshop in Timor-Leste with MAF, TOMAK, MDF and other programs/projects relating to livestock to discuss and share ideas, and identify key livestock research priorities for MAF in the next 5 years	Workshop presentations and proceedings	19th May 2020	Due to Covid19, this workshop was not able to be held in a face to face modality. The roundtable was held as an online event on 19th May 2020, including presentations on preliminary findings from the field research and presentations from other projects and programs on their activities. In addition to the consultative workshop, the SRA facilitated an online Beef and Trade Discussion on June 3rd 2020.
3.4	Preparation of report outlining conclusions around issues relating to ACIAR support to the smallholder livestock sector in Timor-Leste moving forward.	Final report on issues relating to ACIAR support of smallholder livestock sector moving forward.	31/12/2020	Final report integrated into overall report on livestock trade and development in Timor-Leste

7 Key results and discussion

7.1 Overview of the livestock sector in Timor-Leste

7.1.1 Number and characteristics of farming households and livestock population sizes

According to the most recent (2015) National Population and Housing Census, 89.8% of households in Timor-Leste are involved in agriculture and of these households, 84.5% are male-headed and 15.5% are female-headed. More specifically, over 178,000 of 204,000 (87%) of households kept livestock, with 84.7% of these male-headed and 15.3% female-headed (RDTL, 2015).

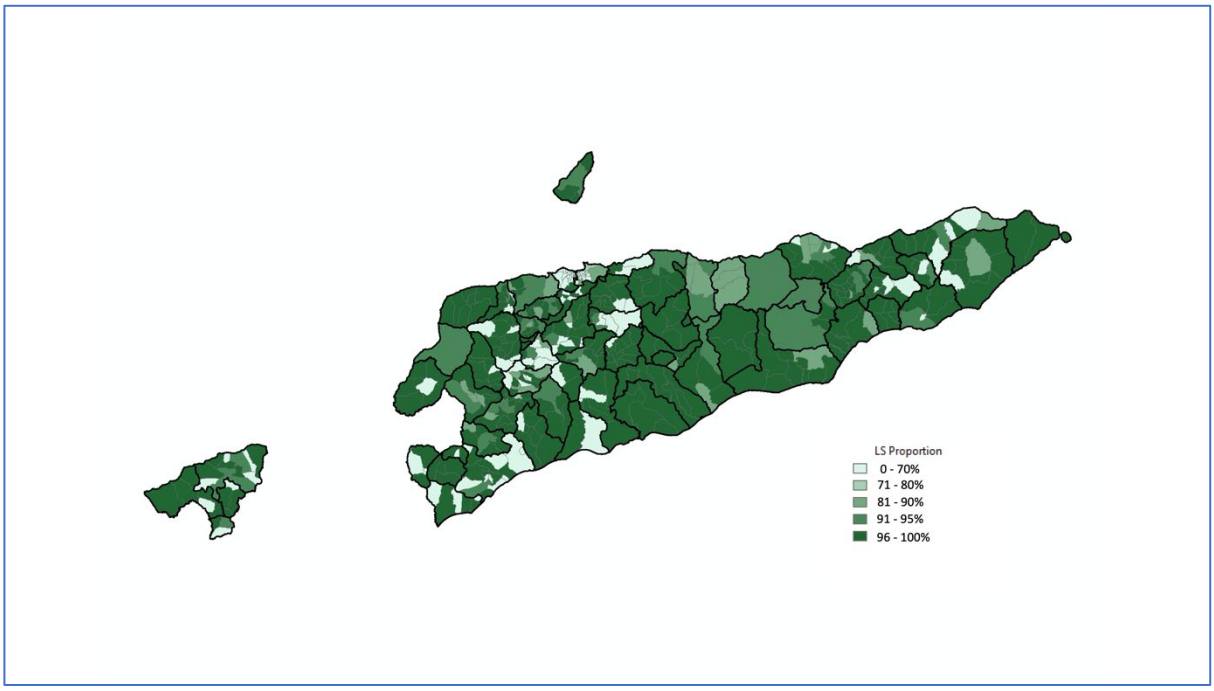


Figure 6 Proportion of total households keeping livestock by suco, based on 2015 National Population and Housing Census

Livestock-keeping is multi-purpose; The census found that 99.5 percent of households were rearing livestock for their own use and 98.1 percent were rearing them to sell. The number of households keeping each species of livestock and the national livestock population sizes are below.

Table 4 Households keeping each type of livestock and the national livestock population sizes as recorded in the Timor-Leste national census (RDTL, 2015)

Livestock species	Number of households (% total households)	Livestock population size
Chickens	146,158 (71%)	928,806
Pigs	146,449 (72%)	419,169

Cattle	52,864 (26%)	221,767
Goats	46,154 (23%)	158,467
Buffalo	26,324 (13%)	128,262
Horses	27,339 (13%)	50,751
Sheep	40,498 (4%)	40,498
Other	46,818 (23%)	121,069

7.1.2 Importance of livestock in overall economy and in agricultural sector

In 2017 the GDP (current prices) of Timor-Leste was USD2.487 billion, and the non-oil GDP (current prices) was USD1.592 billion. (GDS, 2019) and its non-oil GDP per capita was USD1228.50. Timor-Leste is the 182nd largest export economy in the world.

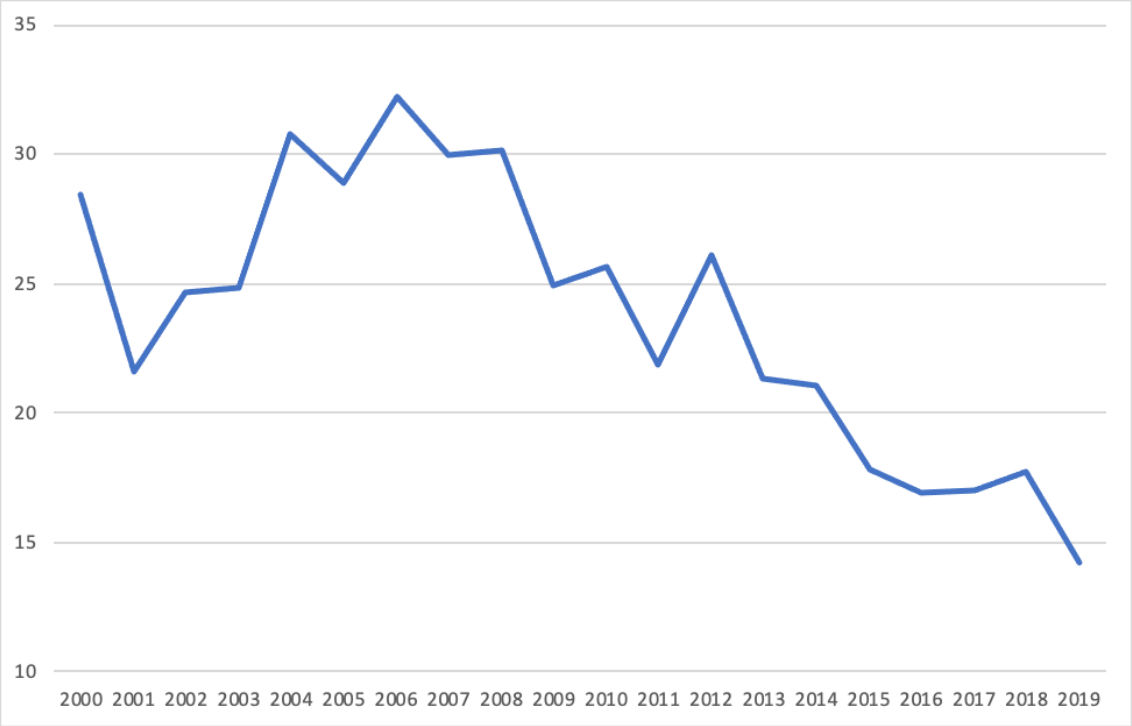


Figure 7: Timor-Leste Agriculture, forestry, and fishing, value added (% of non-oil GDP), by year

Source: World Bank national accounts data

In 2019, agriculture accounted for around 14.2 percent of the total non-oil GDP of Timor-Leste (Figure 7) and this proportion has had a declining trend since 2006. The national accounts in 2017 did not decompose the GDP composition of the agriculture sector, but the national accounts 2004-2010 (Ministry of Finance of Timor-Leste (2012), *Timor-Leste's National Accounts 2004- 2010)* listed livestock as contributing around 16 percent of total agriculture GDP in 2010.

If we assume that this proportion has not changed significantly since 2010, then we can estimate that livestock contributes around 2.27 percent to national non-oil GDP, with a current exchange rate value of USD56.45 million.

In 2017, Timor-Leste exported goods and services valued at USD108million and imported goods and services valued at USD651 million, resulting in a negative trade balance of

USD543M. In 2017, total official exports of livestock products had a value of USD 825,000. All of this was fish, of which USD 495,000 is fresh/chilled (55% to China and 45% to Hong Kong) and USD 330,000 was frozen whole fish (100% to Hong Kong).

Official imports of livestock products in 2017 totalled USD 38.9 million. Of this, a total of 51 percent (USD 19.9 million) was poultry meat (USD10.2 million from Brazil, USD4.96 million from US and USD4.54 million from Singapore. Pig meat imports were USD2.56 million in 2017, dominated by imports from Netherlands (USD2.19 million) and New Zealand (USD234,000). Imports of bovine meat (frozen) totalled USD917,000, with USD471,000 being from New Zealand and USD295,000 being imported from Singapore. In addition, USD21,400 of fresh/chilled bovine meat was imported from Singapore, China, Australia, New Zealand and the Netherlands. Dairy products, including concentrated milk, fermented milk products, UHT milk, cheese and butter accounted for 20.9 percent (USD8.14 million) of livestock product imports in 2017.

7.1.3 Importance of animal source foods

National consumption data revealed that for beef, buffalo, chicken and pork, expenditure on meat was 1.3 to 2.5 times greater in urban than rural areas (Table 5). It should be noted here though, expenditure does not equal consumption and families in rural areas may raise more of their own animals or use non-monetary means to acquire them.

Table 5 Urban versus rural expenditure on four types of meat (US dollars). Source: Timor-Leste Household Income and Expenditure Survey 2011 (RDTL, 2011a)

Meat Type	Urban expenditure ($ per household per week)	Rural expenditure ($ per household per week)	Ratio of Urban to Rural Consumption expenditure
Beef	$1.66	$0.73	2.27
Buffalo	$1.05	$0.50	2.12
Chicken	$2.36	$0.96	2.46
Pork	$0.94	$0.69	1.36

During proportional piling activities (Figure 8) with nine groups of farmers, meat was consistently estimated to constitute around eight percent of household diets, except in the highland area of Lolotoe where it was only eaten once per week to fortnight and estimated to make up only three percent of the diet. Fish consumption was greatest (15 percent of the diet) in Cristo Rei where most people fish themselves. While Tilomar is also coastal, the community in which the research took place was actually a resettled community of families from other, more inland places with no tradition of fishing. Also, they explained that the waves on this part of the coast made fishing treacherous. Therefore, they only consumed fish bought from ailebas selling fish from their motorbikes and therefore depends on their finances. These farmers estimated fish made up seven percent of their diet.

Figure 8 Female farmers estimate the proportions of foodstuffs making up the diet of an average household in their community, using proportional piling

Dairy hardly featured in the diets of participant communities. While no desire to consume more milk was identified in this study, in a previous multi-year, mixed methods study in Aileu, Bobonaro, and Lautem municipalities by Wong et. al. (2018), farmers expressed a desire to consume milk, which was understood to be good for health, but cost was seen as the barrier. This contrast highlights the limitation of small sample sizes in a country where attitudes to animal-source foods are diverse and vary significantly by ethnic group and community.

Egg consumption was estimated to constitute five percent of diets or less. Farmers gave reasons for their choice to eat or abstain from eating eggs and these are described on page 34.

The staple food in each study site, rice constituted 15-25 percent of household diets. Imported rice was said to be cheaper than local rice so in places where rice could not be grown, such as Lolotoe and Tilomar, imported rice, not local rice was bought from the market. In Maliana, farmers mentioned they have problems with livestock destroying alternative staples such as maize, cassava and taro.

Of all the meats, chicken was the most consumed at 24 percent, followed by beef then pork (Figure 9).

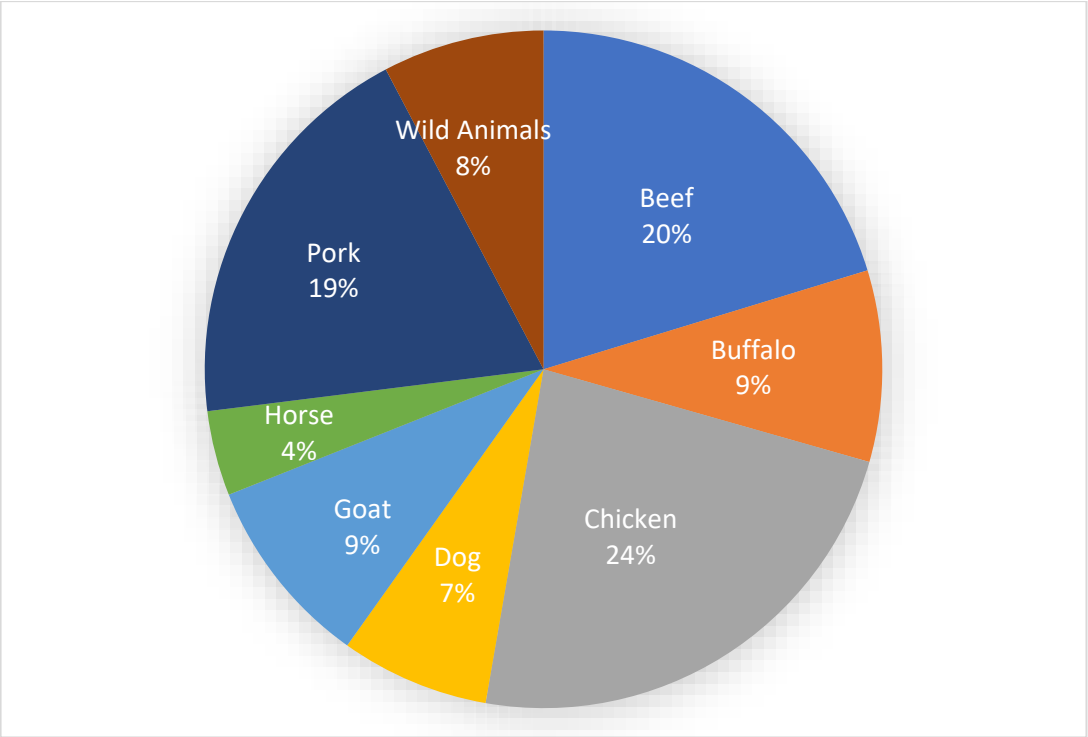


Figure 9 Proportions of meat consumed in five communities as estimated by nine farmer groups

Some seasonality to meat consumption was described. For example, farmers in Maliana, Lolotoe and Alas explained, as meat was eaten during ceremonies, and most ceremonies occurred in the dry season, they consumed more meat in the dry season. In the wet season they needed to buy meat if they wanted to eat meat.

In Maliana and Alas, farmers explained that they also ate the family's free-range, local breed chickens during the wet season when there were fewer ceremonies. In this way, chickens served as a nutritional buffer.

Farmer groups in Tilomar and Maliana said that even if they had the opportunity, they would not change the proportions of foodstuffs in their diets, they were satisfied with their diet, which was similar to what they ate when they were children.

Conversely, in Lolotoe, the men said that into the future, their diet will probably remain the same as income will remain the same and this is what they can afford. They used multiple, starchy staple foods to have enough food to eat at any one time. If they had increased income, they would increase their meat and fish consumption and eat less cassava and corn (i.e. more protein and less carbohydrates).

There was, however, lots of laughter at this prospect as it was seen as a lofty dream. Similarly, farmers in Alas would change their diet if they had higher incomes. These latter attitudes of desiring to change are consistent with the study by Wong et. al. (2018), which found that farmers did desire to consume more animal-source foods but experienced barriers to doing so including insufficient or unstable income, high levels of small livestock morbidity and mortality (so the need to reserve animals for reproduction) and the need to save animals for sale and ceremonial purposes.

The topic of taboos was never brought up by study participants but taboos are known to be widespread throughout Timor-Leste, placing restrictions on who can eat which sort of foodstuffs. A taboo around eating crocodile is widespread. Taboos follow particular lineages of people (uma-lisan) but temporary prohibitions (tara bandu) can also be placed on foods (Castro, 2013).

7.1.4 Broader importance of smallholder livestock keeping

The immense sociocultural importance of livestock in Timor-Leste has been detailed in previous research (Bettencourt et al., 2015; Castro, 2013; Hunter, 2019; Wong et al., 2018). The people of Timor-Leste hold both animist beliefs, passed down from their ancestors and Roman Catholic beliefs adopted during Portuguese times and often practise rituals from both, side by side. Livestock rituals, slaughter and consumption are all involved in many and varied spiritual ceremonies, as well as community celebrations and social activities. Consumption of meat is so linked to these rituals and events that in this study, farmers reported seasonality to their meat consumption; most weddings, celebrations and communal activities such as construction of buildings occur during the dry season. These events precipitate increased overall consumption of meat during the dry season. Some events where meat is consumed, such as funerals are not seasonal. According to farmers, the least meat is consumed during the forty days of Lent observed each year.

As mentioned previously, livestock also serve as 'banks' for households and can be an important income source, both regular and irregular, during emergency situations requiring fast cash. Most groups struggled to rank the livestock by importance, explaining they all had important and varied roles:

> *Depending on the scale of cultural activity and the role that they play, the people will bring different types of livestock. Different ceremonies/roles need different animals. Also, for selling in times of household needs/financial difficulties it depends on the scale of difficulty/need; If we need a small amount of money then sell small animals such as chicken. If we need more money, we might sell a bigger one – Female farmers, Tilomar*

In Cristo Rei, farmers discussed how livestock raising might change for future generations. The farmers explained, livestock will always be important because there will be cultural needs in the future, and these should not be abandoned. They hope their children will continue to value cultural ceremonies and therefore livestock. The main reason for keeping livestock in Cristo Rei is socio-cultural. The farmers would like to keep livestock for regular income but there is a big demand for livestock for socio-cultural activities so according to them, there are not enough animals for raising for other (non-cultural) purposes. They pondered, maybe in the future if the need for livestock for cultural purposes declines then the next generation will be able to raise for non-cultural as well as cultural purposes.

In Tilomar farmers had mixed opinions about how important livestock will be for future generations. Some believed that as the generations become more educated, the cultural activities will become less important, but others disagreed and believed the activities are too central to their culture.

7.1.5 Production system characteristics

Timor-Leste livestock keeping is overwhelmingly characterised by smallholder, family farming, subsistence systems and small enterprises. Most livestock are still extensively raised but semi-intensification is increasing:

> *Cattle raising here is tethered, in the night we tether in pens and in the day we tether outside. This is because we are worried about thieves and the cattle destroying crops. Pigs are also kept inside pens generally. This is for the same reasons... Some goats are kept tethered and some are extensive. Chickens are all free range (except on the broiler farm present in this suco) – Female farmers, Tilomar*

> *The most significant change over the past years is now some male cattle are tethered. This is because if we tether the male cattle, they don't wander*

around looking for females to mate with and it is easy to cut and carry [feed to the cattle]. This tethered raising is only a small proportion of cattle at the moment. The livestock systems are still mostly extensive raising – Male farmers, Maliana

In farmer focus groups, no participants indicated they tended livestock that they did not own. There was mention in Cristo Rei however, of some community members keeping cattle for wealthier people in Dili.

7.2 Pig subsector

The national pig herd size is around 420,000 with around 147,000 households (more than 70 percent of the national total) keeping pigs in 2015 (República Democrática de Timor-Leste (RDTL), 2015).As shown in Figure 10 the proportion of households keeping pigs across the country is relatively high, with most sucos recording more than 60 percent of households keeping pigs.

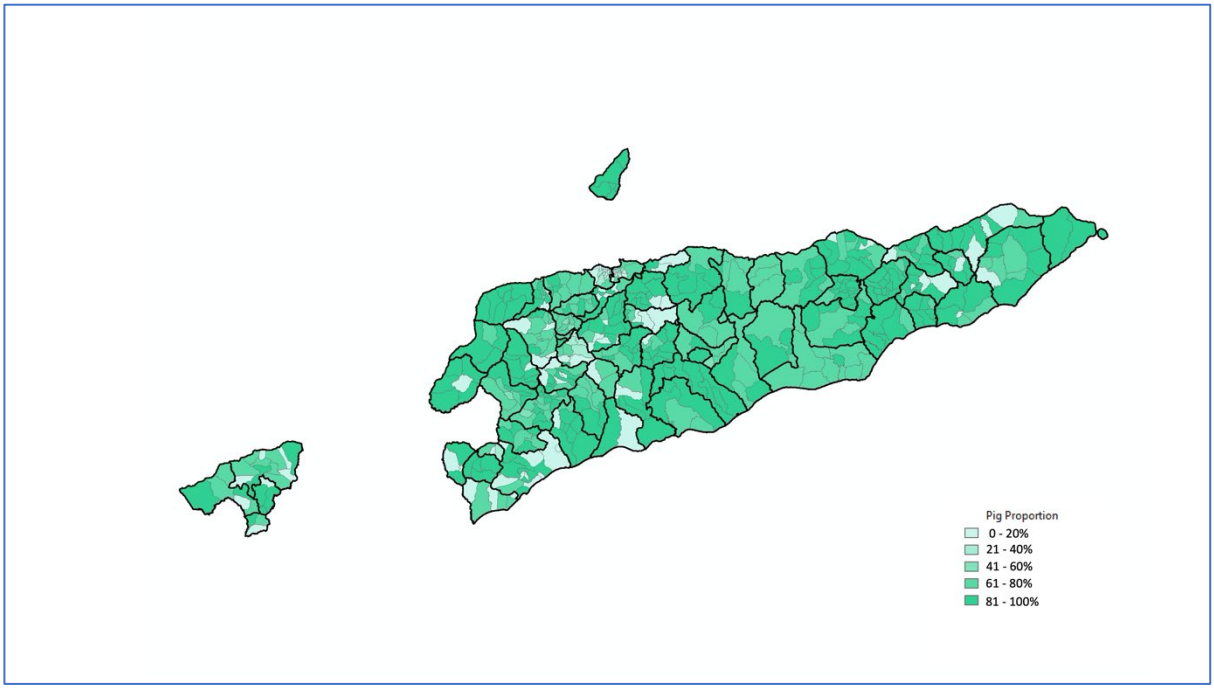


Figure 10: Proportion of households keeping pigs by suco, based on 2015 National Population and Housing Census

As shown in Figure 11, the herd size per pig keeping household is relatively higher in more remote lowland and midland sucos. This may possibly indicate a higher proportion of sow/piglet production systems in those locations.

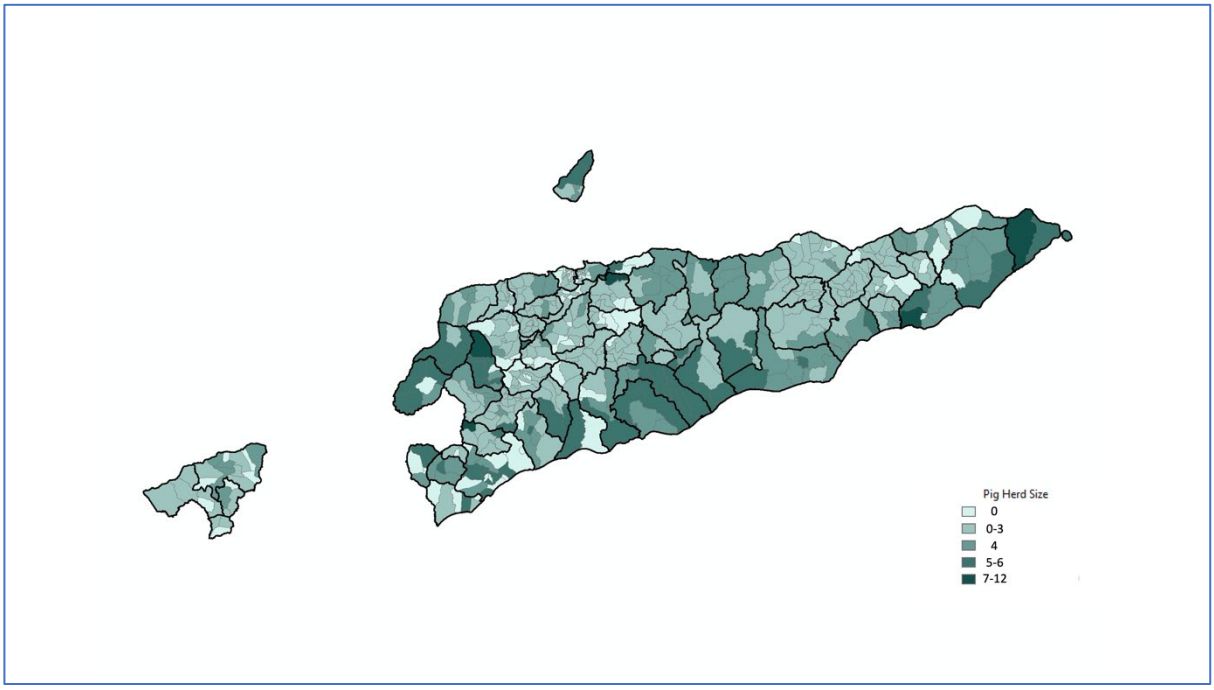


Figure 11: Average household pig herd size by suco, based on 2015 National Population and Housing Census

7.2.1 Household contributions of pigs

Importance of pigs in overall livelihood strategies

Pork is a regarded a desirable meat in Timor-Leste. According to farmer estimations, it constituted just under 20 percent of meat consumed in the five communities, on average. Pork, like other meats is not usually eaten in everyday situations. Focus groups estimated on average that 63 (40-75) per cent of pork consumed in their communities occurred during ceremonies and celebrations. These events included sacred house construction, funerals, inauguration, Marian processions and more. In Alas, pigs were described as important for dowry. A higher rate of non-ceremonial pork is eaten in Maliana, which has a large wet market.

When participants were asked to rank livestock species by their importance to their lives and livelihoods, one group ranked them first, seven groups ranked them second and one group ranked them fifth. Of 70 farmer participants across the nine focus groups, 67 owned pigs. Farmers keep pigs for their own cultural use and importantly, to sell. In Alas, pigs were described as a ‘living bank’ and in all locations, farmers emphasised the importance of having pigs to sell; pigs are always in demand, fetch a good to ‘very high’ price and have a lot of piglets in each litter so can repopulate easily.

During a visit to Maliana market the research team observed live pigs on sale. Some pigs were sold by farmers themselves and some by middlemen (traders) who had purchased them from surrounding communities and brought them to the market. The size of pigs on sale varied from small piglets to an impressive looking 60-70kg pig. The pig sellers explained that pigs were sold per head but works out about $10 per kg liveweight. Farmers in Maliana said there was always a market for their pigs, even sick and deceased pigs.

Pigs are also of substantially more value than chickens so can be sold in emergencies, such as when a family member is unwell. In Tilomar pigs were described as being too large and valuable to slaughter for home consumption so they were only used for cultural events or sold. The majority of pork was sourced from the village or surrounding villages. Farmers explained that this was overwhelmingly as part of cultural celebrations and ceremonies in theirs and neighbouring villages.

There was some discrepancy between male and female responses in Alas and Lolotoe, regarding sources of meat. When this was queried with local veterinary staff they said they were not sure but tended to trust he women's responses more as "they are the ones who prepare meals so they know best". Women farmers in Lolotoe explained the market is very far and transport is expensive so very little pork is sourced there.

Farmers in Cristo Rei buy frozen pork from the supermarket at times, including for community events, on occasion. No other community buys pork from a supermarket. However, frozen pork was observed for sale in Maliana supermarket.

Animal health and production issues

This field research took place in the month preceding the emergence of African Swine Fever (ASF) in Timor-Leste. As this section reveals, even before ASF, pig disease was a major concern for all participant farmers except the male group in Lolotoe. Six farmer groups reported seasonality in the clinical signs they observed. Below are descriptions of these conditions by location, combining descriptions by male and female groups only where they are very similar.

In Tilomar, farmers described sickness they observed during the heavy rains (March to May). It can spread between farms rapidly. Clinical signs include coughing, laboured breathing, shivering and then fever, anorexia, and for smaller ones have dry eye discharge. Pigs sometimes die in 3-5 days. Affects all ages and sizes of pig. When they observe the disease at the start they will give traditional medicine and then if it is not helping they will call the livestock technician and they give medicine. If treatment is unsuccessful and the animal dies, the farmers bury it because they do not want to consume animals that have been given medicine. Mortality rate ranges but can be up to 100 percent. Recently had a case where all of the pigs on a farm died. In addition, during the dry season there is a lack of feed.

In Maliana, men reported that a common disease occurs during the dry season (August to October): Pigs coughing, 3 days to a week to die. Mortality rate is 100 percent and gradually moving from one animal to another, this happens every year. They don't know what causes it but use some traditional medicine (leaves, bark etc.) but that does not really work. Normally go to government office when animals are sick and ask for help. So only go to government office when animals are really sick so the treatment by government does not work as expected and this in turn, reduces confidence in veterinary service. They don't ask government to come when animals not sick and they don't have regular vaccinations. The women in Maliana said there was no particular seasonal pattern of disease. There is one predominant disease of pigs, the symptoms are as follows - in the morning give feed, then if go back in the afternoon and did not eat food then they know is sick. The farmers have used some traditional medicine to treat the pigs in this case – not too sure about the success rate of the traditional treatment. The traditional treatment is used to bring back their appetite**.**

In Alas, women said sick pigs often show clinical signs such as difficulty in breathing, bloody discharges from body orifices, shivering. The disease occurs from May to September inclusive, which covers the second half of the wet season and first half of the dry. The morbidity and mortality rate are around 80-100%. The disease often spreads from house to house and normally within at least 24 hours to less than a week. They often try traditional medicines but when it does not help pig to recover, they would call vet tech or livestock tech. The success rate for traditional medicines is reported to be 50%. Men described a condition of coughing raised hair, difficulty in breathing. The disease often occurs in July to August. Within 24 hours it dies. The mortality is high from 90-100%. It spreads from house to house. They call vet when the pig is sick. Their pigs are vaccinated by MAF staff on the ground.

In Cristo Rei, during the hot, dry season (August and September) a disease affects all pigs (male, female, any age). The clinical signs include piloerection, anorexia, including not drinking water and death within 4 days. Have normal faeces. On autopsy, find anaemic

tissues. The pigs are not routinely vaccinated. The only time vets visit is when the farmers call them during outbreak. Communication is not really good. There is often a delay for a few days or a week and in the meantime, the outbreak is much worse and many deaths. Their vaccines come too late and are not successful, so this discourages the farmers from dealing with the municipal office. The overall herd mortality rate in the community is around 90 percent.

In Lolotoe, women farmers described three conditions of pruritus, diarrhoea and swollen head. These conditions occur at different times. For the “swollen head disease”, sometimes they recover, but mostly they die. In some cases, they call the livestock technician to come and administer an injectable medicine, which is largely successful. “Swollen head disease” can occur at any time of the year, but the participants mentioned January. The male group in Lolotoe said that no particular diseases affect their pigs.

The government vaccination campaigns for pigs target Classical Swine Fever only. Classical Swine Fever emerged on Timor Island around Dili in 1997 and rapidly spread across the island. The disease-causing agent, a *Pestivirus* is highly transmissible and can present as an acute, subacute or chronic disease, causing morbidity and mortality to differing degrees. A study exploring seroprevalence and risk factors for infection of pigs in Timor-Leste found widely varied seroprevalence across three districts (Sawford et al., 2015). There remain significant barriers to implementation and the coverage of these programs is suboptimal. The study above also found levels of herd immunity were inadequate for disease control and outlined some of the likely causes for this, all linked to resourcing of the vaccination program (Sawford et al., 2015).

In late September 2019, just as the field research for this ACIAR-SRA drew to a close, reports of rapid, mass pig mortalities reached the MAF office in Dili. Field investigation followed by diagnostic testing in Australia confirmed the presence of African Swine Fever (ASF), which had been rapidly spreading through Asia since August 2018 and was determined to have first broken out in Dili on September 9th 2019 (OIE, 2019, 2020). In response, the authors of this report used the fresh primary data collected during September 2019 to make an estimation of the potential cost, both economic and non-economic of un unchecked ASF epidemic. As previously mentioned here, the value of the national pig herd was estimated to be USD 160 million, or around USD 1000 per pig-keeping household. In addition, the authors described the immense sociocultural importance of these animals (Dominic Smith et al., 2019). The emergence of ASF in Timor-Leste has necessitated and effected a shift in focus for research and development activities pertaining to pigs.

Pig diseases were the first concern of farmers, all other challenges were secondary. Growth rates of pigs were never mentioned as a concern. Selling pigs was also regarded as easy and prices were good. In Maliana, farmers even explicitly mentioned the sale of pork from sick or dead pigs explaining that consumers readily buy the meat. The majority of pigs in Timor-Leste are still raised in free-range scavenger systems. As was found by Cargill (2017), the intensive pig production system visited by the research team in Dili municipality was facing challenges; the pigs had clear signs of emaciation and mixed skin pathology and sheds and pens had not been maintained. The base feed was not observed but pigs were being supplemented with chocolate flavoured milk (from piles of snack-size containers). There had been previous plans to create a feed processing plant on-site, but these had not come to fruition. It is easy to imagine the many roadblocks the producer would have faced, not in the least, a lack of affordable inputs. As previously mentioned, even in West Timor, there is acknowledgement that there is insufficient foodstuffs on the island for commercial feed production.

In the Tilomar community pigs are generally kept inside pens due to the risk of them being stolen stealing or destroying other farmers’ crops. In Maliana, the trend to confine pigs is also increasing but farmers complained about the time required to prepare feed and manage diseases. They said pigs in general are the most resource-intensive as they still have to feed free-roaming pigs at least once per day to ensure they return, don’t run away permanently. In Maliana as well as in Lolotoe, farmers were not concerned about finding

feeds for their pigs, saying they could source them locally. During the dry season was feed was scarcer, farmers in Lolotoe fed pigs alternative crops such as cassava.

In reality, it has been noted that pigs are only fed protein-poor foods in times of food shortages as the scarce protein-rich feeds are consumed by humans (FAO, 2010). This is consistent with the finding that farmers are not significantly concerned about pig growth rates.

7.2.2 International Trade and trade potential

Frozen pigmeat imports to Timor-Leste have generally trended upward over the last decade, with the value of imports reaching almost $2.6 million in 2017. From 2011-2014, Singapore was the main supplier of pork to Timor-Leste. Since that time the Netherlands has dominated. It is most likely that both Singapore and Netherlands are actually re-exporting pork from other origin countries to Timor-Leste, rather than being the original source of the pork themselves.

Comtrade statistics for 2019 indicate an average CIF unit value for imported products at around $1.88/kg, a total import volume (including offal) of around 919 tons and import value of around $1.73 million. This value is less than that reported through the OEC MIT database, but this is likely due to the OEC database also including prepared and dried pork products. On either measure it appears that imports likely dwarf the supply of domestic fresh pork (for non-ceremonial purposes) supplied to the Dili market.

There are currently no formal trade arrangements for pigs between Timor-Leste and Indonesia. A degree of trade occurred informally but the quantities are far less than in cattle or chickens. ASF is currently present in both Timor-Leste and West Timor and having significant impacts on both sides of the border (Simarmata et al., 2020). This also has a significant dampening effect on trade.

According to Dinas Peternakan (DP) NTT, there is potential to export pigs to Timor-Leste, but the volumes and values would be relatively small. The Dili market is supplied by very cheap imports of pork and in the border districts of Timor-Leste (Covalima and Bobonaro) there is demand for pigs for ceremonies and for piglets, but the population is very small, and the volumes of product traded would be too small to justify the paperwork and procedures involved.

Indicative of how quickly trade development can occur, we also heard from both sides of the border that a shipment of 500 pigs was due for export from West Timor to Timor-Leste across the Mota'ain/Batugade border gate in August 2019. We heard differing reports about whether these will be pigs for slaughter or breeding animals. Reportedly the outbreak of ASF in September 2019 meant that this transaction did not proceed.

7.2.3 Rationale for potential support of smallholder pig production

The importance of pigs in Timor-Leste for sociocultural activities, social capital and financial security is beyond question. While consumption of pork in everyday situations is not high and there is little prospect of pigs or pork being produced for export, it is extremely important the national pig herd is maintained. With no significant commercial pig-raising industry, smallholders will have a large role to play into the foreseeable future. Overall, the major concern for smallholder pig-keepers as identified during this research is disease; farmers want to know the cause of pig diseases and want technicians to be equipped to vaccinate against, diagnose and treat them.

As explained above, ASF will be a major limiting factor in pig production while it persists in the population. Following the emergence of ASF in Timor-Leste, the Australian Centre for International Agricultural Research supported three research and development initiatives targeting the disease. Two were existing projects that were reimagined, and one was developed in direct response to the threat of ASF:

i. *Identifying husbandry options for smallholder pig farmers in Timor-Leste* was a few months out from completion but in late 2019 it pivoted to address the new need for identifying interventions to reduce the spread and increase public awareness of ASF. The research revealed how some simple biosecurity measures such as confining pigs in basic pens showed promise for controlling ASF (T. Barnes, 2020; T. S. Barnes et al., 2020). The sample size for this study was small and the period of time the farms were followed was short, so it is suggested that this study be scaled in geographic location and time to better assess intervention effectiveness. Also worth exploring will be the degree to which support and incentives will be required for wider adoption, i.e. the role for development. This suggestion is based on the fact that:
    - Farmers from the five communities in this Report complained about the increased labour and feeding requirements for confined pigs and some, about food shortages at certain times of the year
    - The farms in this *husbandry options* study were part of a larger development project which to some degree supplied materials and labour to farmers free of charge

ii. *Improved animal health surveillance in Timor-Leste*, which had been designed but not yet launched in September now includes ASF in its objectives. It is due to be completed in March 2022. The objectives are to introduce and build capacity in diagnostic tests, improve detection of pig diseases and passive surveillance and to determine the relative importance of different pig diseases. This project is very well-matched to the needs expressed by pig farmers in this study, thus this research and capacity-building is likely to be well-received. However, given ongoing budget freezes and administrative changes within the Timor-Leste government, without further intervention, it is anticipated any surveillance and diagnostic processes developed are unlikely to scale. As explained in previous and upcoming sections on the animal health system, there is a need for greater financial, human and physical resourcing across the sector. Again, effective institutionalization of any interventions arising from this research will involve a development component.

iii. *Developing a Regional African Swine Fever socioeconomic and livelihood impact assessment (ASF-SELIA) framework* was a new activity which ran from February to September 2020. This project was led by the Project Leader of this report and sought to enable more accurate measurement and modelling of the tangible and intangible impacts of ASF and its control on smallholders and associated value chains, for more effective decision-making by governments and donors. The SELIA framework was piloted in Timor-Leste and findings are pending publication both in an ACIAR Final Report and peer-reviewed journal.

In addition to ACIAR's research and development activities, the Australian Government Department of Agriculture, Water and Environment (DAWE) have long-standing relationships with MAF in Timor-Leste in capacity building and surveillance work. DAWE continued to support the Ministry through 2021.

7.3 Poultry subsector

The national chicken flock size is around 929,000 with around 177,000 households (more than 80 percent of the national total) keeping chickens in 2015 (República Democrática de Timor-Leste (RDTL), 2015). The proportion of households keeping chickens across the country is very high, with most sucos recording more than 80 percent of households keeping chickens.

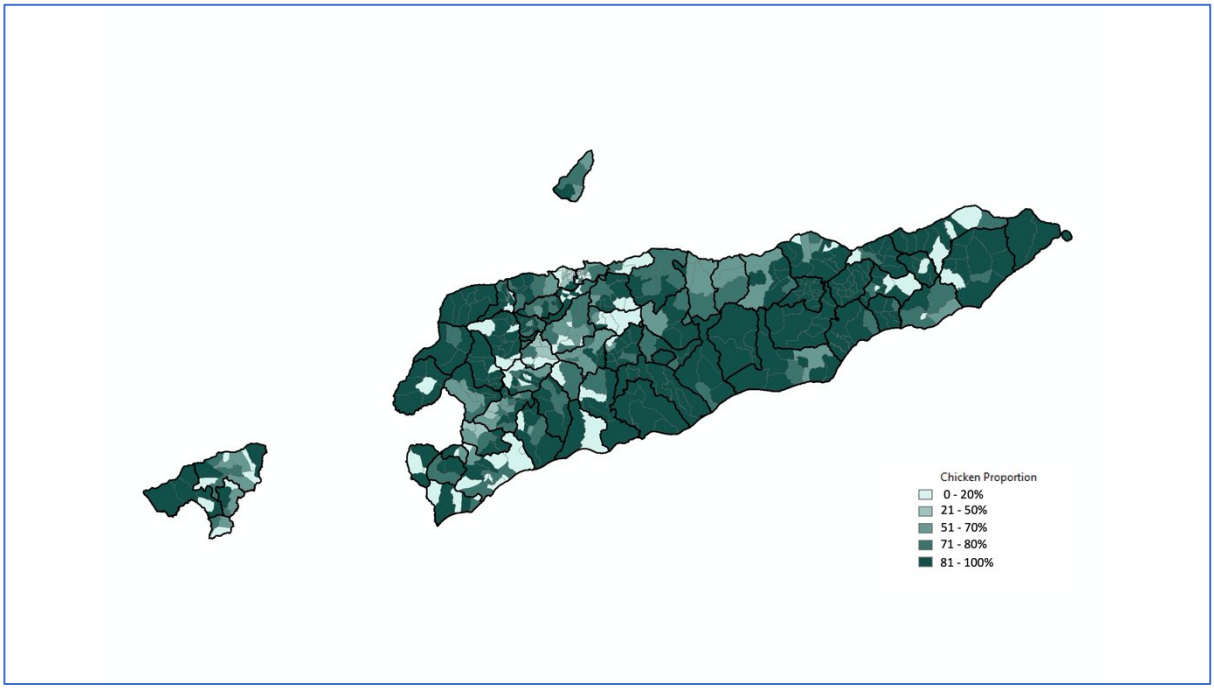


Figure 12: Proportion of households keeping Chickens by suco, based on 2015 National Population and Housing Census

7.3.1 Household contributions of poultry

Importance of poultry in overall livelihood strategies

Chickens are highly adaptable to varied and harsh environments; they are ubiquitous across farming communities in Timor-Leste. Sixty-nine of seventy focus group participants kept chickens and they were constituted the largest proportion of meat consumed, at 23 percent. All were extensively raised (scavenger) chickens. During participatory ranking activities with farmers, chickens were only ranked first by two groups. This was influenced by the fact they are the smallest and cheapest livestock to buy, it was not reflective of the many important roles they were described to play in farmer livelihoods.

Starting with the reasons two groups gave for ranking them first in importance, female farmers in Alas and male farmers in Tilomar explained that chickens were easy to sell any time a household needed cash for everyday household needs. The Tilomar farmers also explained are the easiest livestock to keep and feed and they lay many eggs so reproduce quickly.

All groups mentioned the importance of chickens for cultural ceremonies. In all study sites, farmers explained how local chickens were indispensable for certain ceremonies. In Tilomar, when farmers go to their sacred house, every member of the family needs to bring a local chicken for slaughter, even the young members, adding up to a large number of chickens. If they do not have enough chickens at home, they have to buy local chickens from others.

If there are many visitors coming to their house, farmers will sometimes buy frozen broiler meat from the kios and loja. Broiler meat was mentioned by most farmer groups as an easy ‘filler’ for feeding large numbers of people.

On average, farmer focus groups reported that broiler meat represented 29 percent of chicken consumed and 57% of this broiler meat was consumed during cultural ceremonies and celebrations. Local chicken meat made up the other 71 percent of chicken consumed and 47 percent of this was consumed during ceremonies and celebrations (Figure 13).

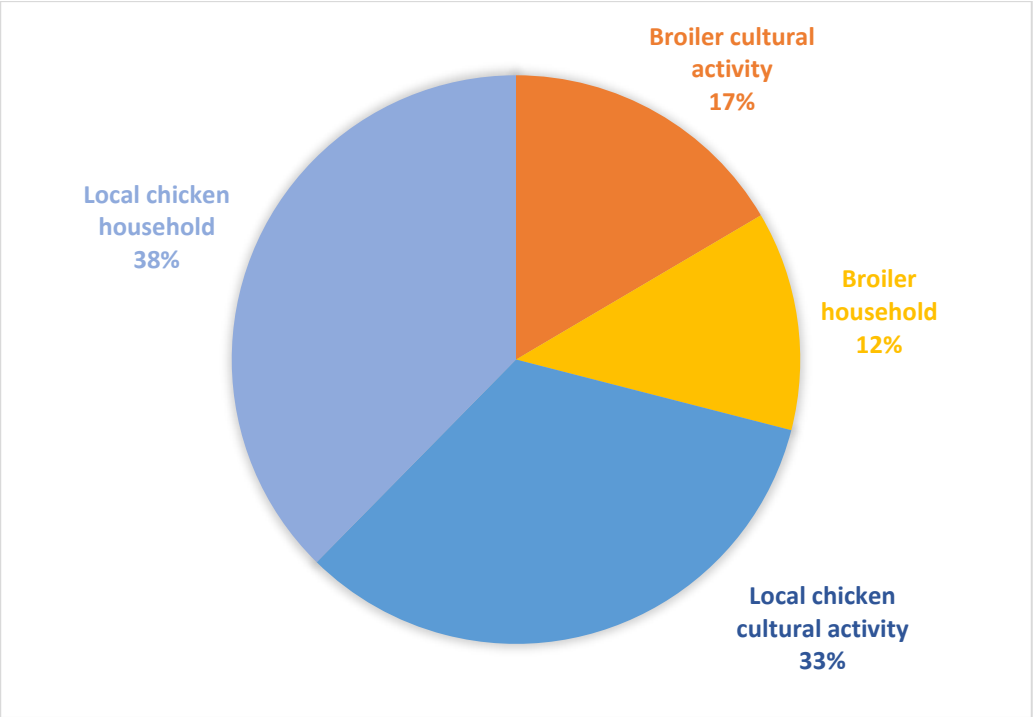


Figure 13 Average proportions of chicken consumption among farming communities as estimated during proportional piling activities

During the wet season when there are fewer ceremonies and so less meat is being consumed, female farmers in Maliana explained that they fill this deficit by eating their family (local) chickens and therefore chicken is their most highly consumed meat.

In Lolotoe, female farmers unanimously said they preferred the taste of local chicken. They never ate broiler meat at home, if they ran out of their own chickens, they would buy local chickens from neighbours. If needed, they sourced chickens for raising from Maliana market. They were also concerned that broilers were given medicines ('some injections etc') that could impact on human health. They mentioned a concern about increasing their blood pressure, as an example. In Lolotoe, live broilers have been available for purchase from ailebas since 2010 both coming by motorbike and on foot. Farmers said these chickens could come from Maliana market or "other places", which was interpreted as informal trade from West Timor. This practice has increased in terms of volumes of chickens and the number of people doing it over the years. They farmers said it was a positive change because it gave them some options for income generation. For example, they could buy a broiler chicken from an aileba for US$7.50 and then sell it in another suco for US$10**.**

Commercial farms were only present in two of the five study sites, Cristo Rei and Tilomar. In Tilomar, women explained that broilers were still a novelty and so people liked to buy them for something new and also, because they were fatter than local chickens. Broilers could be sourced from three commercial farms in the area (US$5), from the aileba on motorbike (US$6) or from the market (US$7). However, because the commercial farms have contracts with big buyers it is not often that they will allow households to buy one or two chickens. Frozen broilers can be purchased from the kios, loja and supermarket.

Roosters had multiple functions and could fetch prices of up to US$25 if large and attractive. Female farmers in Lolotoe mentioned the popularity of cockfighting. The research team also heard rumours there was a cross-border tradition of cockfighting which was illegal but accepted. Roosters were important to male farmers in Alas as they served as alarm clocks to get them up early in the morning.

The research team conducted observational research in Maliana market on a Saturday morning in September. There were four sellers of live broilers from Indonesia, each one sells around 20 head per week in the Maliana market. They come once per week to sell (on Saturdays) – price is US$6.50 for smaller ones and US$7.50 for larger ones. Numerous other sellers were in the same area selling local chickens. They were charging around $8-10 per local hen, depending on size. Roosters sold for up to $25 if large and impressive.

Farmers recalled that the price for broiler chickens was the same, whether carcasses from the commercial farm in Ermera or live chickens from across the border (Indonesia). The main difference was, there was a consistent supply of broilers from across the border, available in Maliana market every Saturday whereas the supply from Ermera was only sporadically available, depending on when they conducted slaughtering. Maliana farmers mentioned local chickens can be up to US$14 so even though they prefer the taste and think the meat is safer (fewer chemicals) they still buy broilers.

Eggs were on sale at the market for US $4.00 per 30 for Timor-Leste produced eggs and US $4.50 per 30 for eggs imported from Malaysia. These were also sold in nearby shops. According to our research assistant who was raised in Maliana, local eggs cost $0.50/egg and you buy directly from local farms. Her family never buys eggs, they eat their own.

In Tilomar, farmers said they normally consume eggs from their own chickens but when they have festivities like weddings/birthdays and need a lot of eggs for cakes, they don't have enough from their own chickens so purchase them. In Lolotoe, farmers said that despite there being many egg-laying chickens in their community, they did not tend to consume eggs, they hatched them to raise the chicks. They could also sell eggs to other families within the village for US$0.25 per egg.

In Alas, the women's group indicated that they bought the majority of their chicken at the market but explained this was local chicken, which is why the finding was different for the men's group. The market in Alas is an important weekly event, it starts on Wednesday night and finishes off at around 10 am on Thursday. People travel from distant places to arrive on Wednesday night and stay overnight in the market. Transactions normally start at dawn and finish at around 10 am. According to farmer participants about a third of their chicken, pig and wild meat is bought there. On non-market days, only two shops sell broiler chicken meat. In Alas, women explained broiler meat was never consumed in everyday situations, only when there were large gatherings (when they require a large volume of cheap meat). For this, they would go to acquire broiler meat in lojas outside of their community. While ducks are raised in Timor-Leste, they were not kept in any of the communities studied.

Animal health and production issues

When asked what challenges farmers faced in chicken-raising, the descriptions of disease in each of the study sites were very similar. A seasonal, highly lethal and infectious disease. The information is presented in a table for easy comparison

Table 6 Descriptions of clinical chicken disease in five communities

Location	Seasonality	Age/sex affected	Disease duration Morbidity Mortality	Spread	Clinical signs
Cristo Rei	Dry (when hot)	All	24h 100% 100%	Rapidly, farm to farm	Comb deep red Anorexia
Lolotoe	Wet	All	24h		Head turns dark

			~100% ~100%		
Maliana	End of dry (one person said start of wet season)	All	24h-4days 100% 100%	Sometimes wipes out entire poultry population in community	Blue comb Anorexia Not moving Cannot raise head Flufffed feathers Runny nose
Tilomar	Start of wet season		24h-2days 80-90% 100%	Takes 1-2 weeks to spread through entire community	Dark comb Watery diarrhoea Nasal/oral discharge Ocular discharge
Alas	Dry	Farmers said many diseases occurred during this time but did not detail them			

While the clinical signs associated with Newcastle disease are highly variable, the descriptions above could potentially place an acute (highly virulent) form of fowl cholera (Pasteurellosis, caused by *Pasteurella multocida*) higher on the differential diagnosis list. There are two additional pieces of information that support a suspicion of fowl cholera. The first was the reported ineffectiveness of the Newcastle Disease vaccine against this disease in Maliana. The second was the presence of predatory cats in Lolotoe. A study describing the occurrence of *Pasteurella multocida* in village free ranging chickens and their animal contacts in Tanzania (Muhairwa et al., 2001) and another studying the epidemiology of fowl cholera in free-range broilers (Singh et al., 2013) both implicated in-contact, feral and free-roaming cats in spread of the disease. In both studies cats were found to be carrying viable the same subspecies of *P. multocida* as the chickens and in the study of broilers and cats, the specific strains matched. Also, increased predation of chickens by cats was observed before outbreaks. More recently, a book titled Backyard Poultry Medicine and Surgery described cat and rat bites as risk factors for introduction of infection as they carry *P. multocida* as commensal organisms in their oral cavities. Once in the flock, the disease can be spread through body secretions and cannibalism (Fulton, 2015). In addition to cats, pigs are another species that have been shown to carry isolates of *P. multocida* that are consistently pathogenic to chickens (Singh et al., 2013). Pigs and chickens are the two most ubiquitous species of livestock in Timor-Leste.

Farmers in Maliana explained that this was the only time when they could not sell meat from dead animals. They said the meat from chickens affected by this disease doesn't taste nice. For other species, meat from diseased animals usually just fetches a lower price. The men said they ate the meat if they slaughtered the animal before it died but it was often too rapidly fatal. The disease outbreaks were so rapid, they put pressure on an already strained animal health service.

Notably, men's groups in Alas and Lolotoe did not express a concern about chicken diseases or mention vaccination. In Alas, farmers had heard of a government chicken vaccination program but had never been offered it. When chickens get sick, they use traditional medicines.

In Maliana, some women clearly recalled the government vaccination schedule for chickens, while others were unaware. The women explained, chickens should be vaccinated for Newcastle disease (ND) with an eye drop three times a year, but there are only a limited number of technicians in the office, so they don't come often enough. Technicians should come in March, June and October. For the vaccinations, the household are responsible for catching and confining the chickens. The farmers explained that they are not given any warning and so they are not able to catch all of the chickens in time. They were frustrated by this because it means only some of their flock usually gets vaccinated. All farmers desired for their flocks to be vaccinated. Farmers do not pay for vaccination.

Lolotoe was the only location where chicken production problems other than disease were listed. As previously mentioned, women said wild predator cats are a problem. In addition, males said thieves steal all livestock species including chickens. They come during the night and while the farmers had suspicions of where they come from but are not willing to say. Our research assistants believe they were inferring Indonesia but did not press them for more detail.

The research team observed a commercial broiler enterprise in Cristo Rei during the windshield survey. The commercial farm had recently received a shipment of day old chicks from Indonesia and they appeared in good health. The sheds were raised and secure, with plenty of commercial feed and water. The animal health and husbandry standard of these farms compared to the intensive pig shed was stark.

7.3.2 International Trade and trade potential

Poultry meat imports to Timor-Leste are dominated by imports of frozen chicken, mainly for consumption in Dili and surrounding areas. The frozen chicken imports are mainly whole frozen broilers, with a small quantity of frozen pieces being imported.

The value of frozen chicken imports has been rising in recent years and experienced a sudden surge in 2017, followed by a return to normal trend levels. The main exporting country is Brazil, follows in most years by Singapore. As was the case with pork imports, Singapore is unlikely to be the origin country for the frozen chicken, but rather is servings as a location for import and consolidation for subsequent exports.

Table 7: Value of Poultry Meat Imports of Timor-Leste by exporting country (2014-2018) (USD)

	2014	2015	2016	2017	2018
Singapore	4,583,991	2,786,956	3,336,223	4,538,890	4,630,209
Portugal	2,357	21,698	19,832	45,603	7,619
Australia	9,280	7,825	5,709	2,127	5,002
Brazil	3,860,666	4,774,386	5,892,821	10,170,407	6,383,451
Denmark		31,233			
United States		586,114		4,963,835	
China				7,030	
Malaysia				68,967	1,304
Netherlands				116,217	
Indonesia					29,117
Total	8,456,294	8,208,212	9,254,585	19,913,077	11,056,702

Source: OEC MIT based on UN Comtrade

Prior to 2018 relatively small volumes of chickens (predominately day old chicks) were imported to Timor-Leste from Malaysia. Formal imports of day-old chicks (DOC) from

Indonesia to Timor-Leste commenced in 2018. This was possible because though Indonesia is not avian influenza (AI) free, in 2018 Timor-Leste agreed to recognise AI-free compartments and zones within Indonesia. Currently there are 53 AI-free compartments (companies) and 3 AI-free zones in Indonesia. West Timor's aim is to export 50,000 DOC per month. We were able to secure export data from the Customs Office in Atambua, which revealed, as at July 19th, the monthly target had almost been reached (see Figure 25 **Error! Bookmark not defined.**). All DOC exported from West Timor to Timor-Leste are broilers; layer DOC come from other islands.

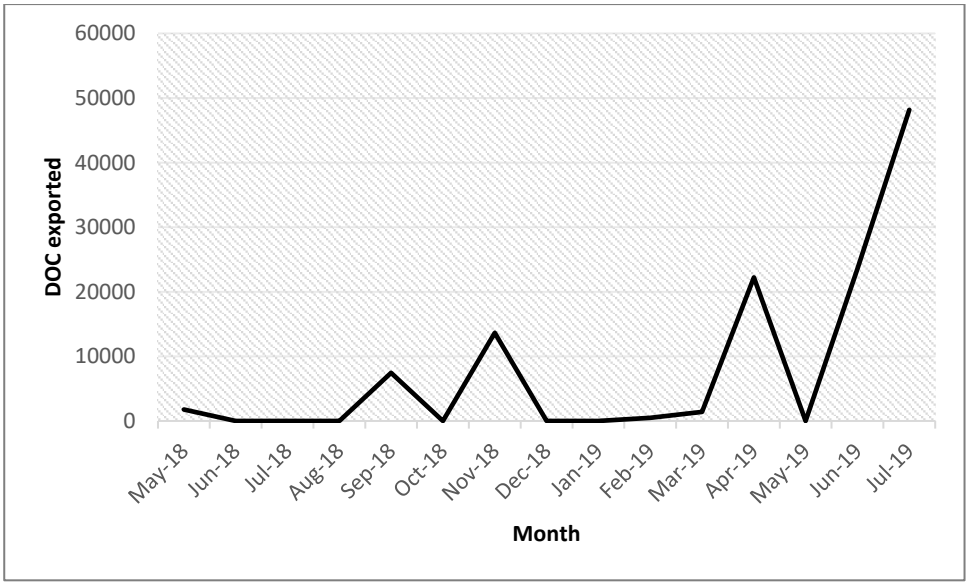


Figure 14 Exports of Day-Old Chicks (DOC) from West Timor to Timor-Leste

The recipients of formal exports of broiler DOC, layer DOC and poultry meat from West Timor to Timor-Leste (until March 2019) were 13 companies, including cooperatives. Of these, 5 companies/cooperatives were receiving broiler DOC. Most DOC exports from West Timor exit via the northern, Mota'ain-Batugade border gate. We heard of good relationships between leaders of the quarantine stations on both sides of the border, but some ongoing problems with consistency of paperwork and processing times.

A fairly new initiative in Timor-Leste, Movimentu Asaun Ekonomia Komunitaria (MAEKOM) led by a private businessman, is responsible for a large proportion of the current imports of DOC from Indonesia. MAEKOM describes itself as an agricultural cooperative association. Established in 2018, by July 2019 MAEKOM included 33 companies in 9 municipalities (see Figure 27 **Error! Bookmark not defined.**) but they had plans to expand to all municipalities. Some of the companies included young seasonal workers, working in Australia, who wished to contribute to food security and development in Timor-Leste and had set up businesses for their return home. There were also some pig farms in the association, but this was not expanding at the same rate.

Until all of West Timor is declared an AI-free zone, only compartments (larger companies) within West Timor can export chickens. At present, only CP Kupang are recognized as an AI-free compartment within West Timor. In reality, no cases of AI have been recorded on Timor Island (either side). Just before we visited, the new governor of NTT had written to Jakarta to ask them to conduct the necessary surveillance and procedures to declare the island AI-free according to OIE requirements. The main constraint to actioning this is that the local government budget has to pay for the special commission from Jakarta and Bali. This process will be facilitated by ADB.

Once this status is achieved, another constraint is funding the required ongoing monitoring by Bali, to retain it. Once West Timor is declared as an AI-free zone, it is believed medium-sized companies will be able to commence export of live chickens from West Timor to Timor-Leste.

As previously mentioned, some frustration was expressed by different stakeholders on both sides of the border about processing times and shipments not being accompanied by the correct paperwork. In one case, coupled with an inexperienced driver, this led to the deaths of an entire shipment of DOC at the border.

While the problems associated with that case have been addressed, it is agreed processes can still be further improved. For example, customs officers in West Timor expressed a desire to integrate both sides of the border to allow for “One submission, two countries”, to improve processing times. Although Timor-Leste is a member of the World Customs Organisation (WCO), according to Indonesian customs officials there is still insufficient harmonisation of procedures between the two services. It should also be noted that the other two countries that share land borders with Indonesia (PNG and Malaysia) are both members of WCO, and there is still not yet an integrated customs processing system between Indonesia and either country.

7.4 Cattle subsector

The national cattle herd size is around 221,000 with around 53,000 households (around 27 percent of the national total) keeping cattle in 2015 (República Democrática de Timor-Leste (RDTL), 2015).As shown in Figure 15 the proportion of households keeping cattle in sucos close to the Indonesian border in Bobonaro and Covalima is relatively high, with sucos recording more than 60 percent of households keeping cattle.

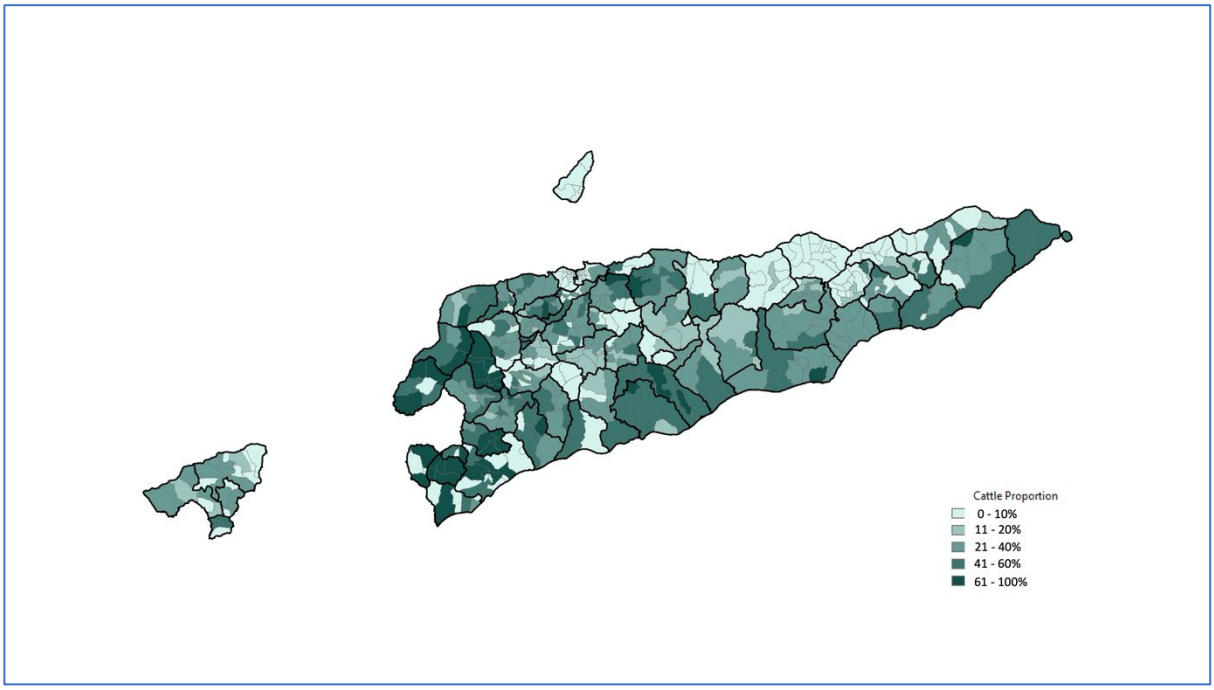


Figure 15: Proportion of Households keeping Cattle by suco, based on 2015 National Population and Housing Census

The average herd size per household keeping cattle is relatively higher in the east of the country, where cattle keeping households in many sucos have an average herd size of more than 6 head (Figure 16).

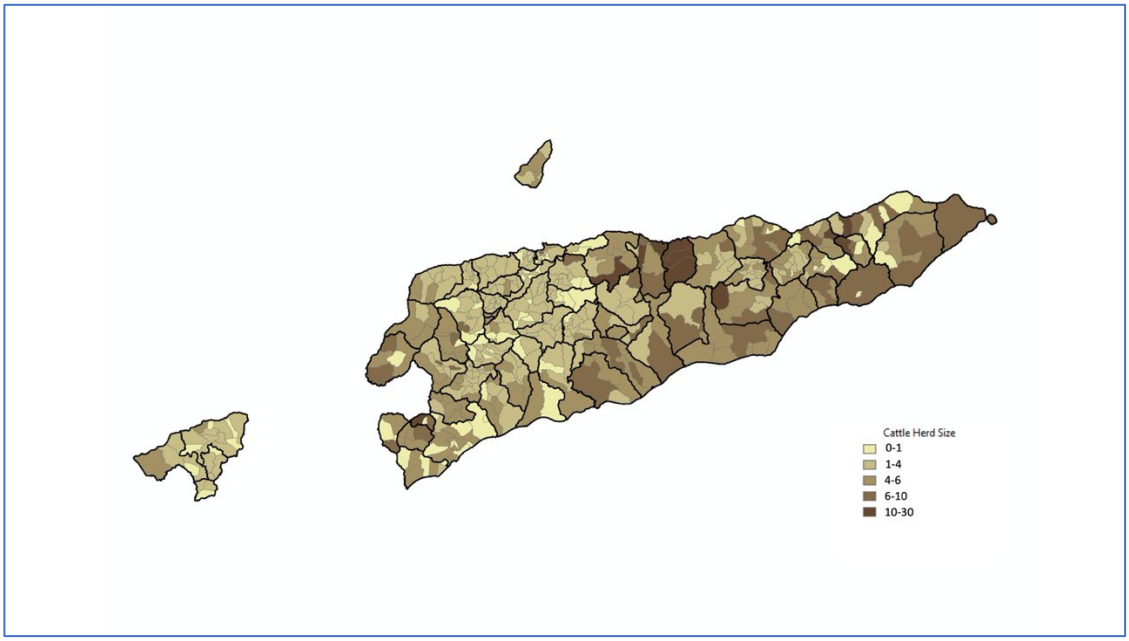


Figure 16: Average cattle herd size per household by suco, based on 2015 National Population and Housing Census

7.4.1 Household contributions of cattle

Importance of cattle in overall livelihood strategies

Cattle are a valuable animal and hence many farmers engaged in this research could not afford to own them. However, across Timor-Leste, whether people own cattle themselves or not, they are viewed as an extremely important species. In the participatory ranking exercise with farmers, five of nine groups ranked cattle as the most important species in the community. Only fifty of seventy farmer participants owned cattle, far fewer than chickens or pigs.

As with pigs and chickens, cattle are very important for cultural needs. On average, 65 percent of beef was estimated to be eaten as part of cultural ceremonies and events (ranging from 32.5 percent in Maliana to 82.5 percent in Alas). Unlike chickens, cattle are generally not slaughtered for home consumption or for casual gatherings of groups of friends, family and workers, they are reserved for more important events where large number of people need to be fed, such as weddings, sacred house construction, inaugurations and funerals. The only time most communities would eat cattle outside of ceremonies is if an animal dies. In Cristo Rei and Tilomar, farmers sold and slaughtered cattle for meat, which was sold in the local market.

Because of their size and value, cattle are a significant source of income for families who can afford to raise them. Their sale supports larger expenses such as their children's tuition (mentioned by farmers in all study sites), building construction and larger cultural expenses.

In Lolotoe, where cattle were ranked as most important the farmers explained that the largest proportion of meat in their diet was from beef and this is because there are many ceremonies in their village and surrounding villages requiring meat. As mentioned in the windshield survey, many cattle were seen being extensively grazed in the Bobonaro highlands. If cattle die in the highlands, they are sold to ailebas who process them and sell the meat. They do not go to the market often because it is a long distance to Maliana from Lolotoe. Ailebas selling beef are also common in Maliana.

In Tilomar, the environment is well-suited to cattle; cattle eat forages readily available in the area. A cattle trader was interviewed and had a successful business finishing cattle before sending them for slaughter. Female farmers estimated that on average, they sell 4-5 large animals per year. This is for various household needs including money for school expenses.

They don't slaughter cattle for their own consumption because they are too large and valuable, but they do buy beef in the market and make some purchases from the aileba.

In one study site a cattle slaughterer and beef seller had an important trade relationship with a school feeding program. This was usually a major source of revenue for him involving 4-5 head of cattle per week but without warning, over the previous 3-4 months the money for buying rice and meat had dried up and no orders were made by the cooks.

Animal health and production issues

Cattle diseases were raised as a concern in all five communities. There was some similarity in clinical signs associated with seasonal disease (Table 8).

Table 8 Descriptions of clinical cattle disease in five communities

Location	Seasonality	Age/sex affected	Disease duration Morbidity Mortality	Spread	Clinical signs
Cristo Rei	Dry (when hot)		Some recover, about 20% die in 7 days		Anorexia Self-isolation
Lolotoe	Wet (mostly heavy wet, sometimes dry)	All	Some recover, about 25% die in 1-2 days	Starts with one animal, spreads to in-contact animals	Anorexia Diarrhoea – some blood Swollen cheeks/neck Drooped ears Tongue protrusion
Maliana	Start of wet season				Diarrhoea
Tilomar	Wettest season	All	10-20% die		Diarrhoea Hypersalivation Drooped ears Nasal discharge Dry mucous Weight loss
Alas	Dry				Diarrhoea Abortion Inflamed, necrotic liver on necropsy

While government animal health technicians mostly suspected the disease targeted by MAF with vaccinations, haemorrhagic septicaemia (*Pasteurella multocida*), this would be unlikely to explain all of the clinical signs described by farmers nor the lower mortality in the short-

term. For example, for 'swollen face and neck' (bottle jaw), Johne's disease (*Mycobacterium avium subsp. paratuberculosis*) would be on the differential diagnosis list. Also, Salmonella Dublin, especially owing to the mortalities and seasonality of disease.

In Lolotoe, when the seasonal disease appears, they will call the veterinary and livestock technicians. They don't kill animal, wait until it dies, hoping it will recover. They don't consume meat from these animals as they are concerned about their health, they bury them. In Tilomar the technicians are also called for the seasonal disease but sometimes they are too sick and die despite being administered medicine. This is often because the animals are free ranging, and once farmers notice that they are not well, it is too late for treatment or saving the animal.

In Alas, the farmers speculate the seasonal disease is due to a lack of vaccination in their community. Vaccinations are also a challenge in Lolotoe. There are several non-seasonal diseases too: In Maliana farmers noted, cattle can get eye disease at any time. In addition, any group that was probed on abortion said that their cattle experienced abortions all throughout the year. There was some cultural sensitivity in discussing this at times. In Tilomar farmers said that when a cow has an abortion, she is weak.

In Maliana, there is no problem with the market, lots of people come looking for cattle. Cattle are bought and slaughtered in Maliana. If cattle die, they sell the meat for a lower price.

While feed was consistently available in Alas, water was not, attracting significant labour costs during the dry season. Also, in Alas unsealed roads and lack of bridges over rivers made livestock trade outside the township impossible during the wet season.

In Lolotoe theft was a significant and increasing problem. Farmers said it was most prevalent in the dry season when there are a lot of ceremonies. Men explained that despite branding their cattle, thieves still came in the night and stole them. They reported to police but they could not do anything because they did not have details of the thieves. The farmers have to pen animals and keep watch. Cattle becoming feral and being hard to catch is also a problem in Lolotoe.

In Maliana feed scarcity during the dry season, from July or August until the rains come was a yearly problem. Cattle became emaciated and farmers had to get forage from the bush. Farmers think it would be good to develop forage grasses and legumes but the farmers mentioned the main difficulty is that there is a lack of water especially in the dry season, so it is very hard to grow forages.

7.4.2 International Trade and trade potential

Primary data gathered through the windshield survey in July 2019 provided important contextual information. Before live cattle trade was banned in 2010 the Salele-Motamasin gate (where the survey started) served as a key point of passage for cattle from Timor-Leste to Indonesia. The windshield survey coupled with conversations with local veterinary staff revealed government-owned cattle pens and holding yards not far from the border gate in Salele, intended as quarantine facilities for export cattle. Cattle would have to be transported by truck between the yards and the border checkpoint. However, the pens were situated off the road and the path to them was overgrown, which was consistent with local reports that they had so-far never been used for holding cattle. A near-identical facility, also not in use, was present at the Northern border gate in Batugarde (checkpoint on Indonesian side is Motaain) but this facility was easily accessible by foot from the border checkpoint.

Though formally banned since 2010, cross-border trade still features heavily in the local cattle economy of the border regions. The windshield survey and focus group discussions revealed many drivers to this informal trade and barriers to smallholders partaking in formal trade, should it be reopened:

- Existing trade relationships: As described above, cross-border trade has a long history on the island of Timor. Long-standing social and trade networks support informal trade.

- Ease of access to Indonesian markets driving informal trade: Driving along the roads bordering Indonesia in both highland and lowlands during windshield survey, it was apparent that for the most part, there were no fences or clear demarcations between the countries. Asking local residents where the border was located, they pointed to natural landmarks clear to them but less obvious to the research team. Cattle could move freely to graze on either side of the border. In the highlands there was a simple police post on the Timor-Leste side as the road passed close to the border though no police were seen.
- Road conditions make cattle transport from parts of the highlands to formal border gates challenging: It was observed that the road between Lolotoe (highland Bobonaro) and Salele border gate in Covalima was very rough and though it was the dry season during windshield survey, it seemed substantial sections would not have been accessible without a 4WD vehicle. Reportedly, some sections are unpassable during the wet season. Very few vehicles were observed on the road.

However, there were two major drivers towards formal trade. Firstly, cattle producers favoured legal means of trade, so as not to risk coming into trouble with the law. Secondly, the smallholders in Timor-Leste were vulnerable to dishonest practices and theft. In addition to the risk of not being paid for cattle, they were also at risk of becoming sick or dying in transit.

The ocean-bordered region of Covalima municipality experiences two rainy seasons per year and is seen by MAF and others as a high-potential location for cattle fattening. On the Koba Lima (Indonesia side), recent leadership has seen the community take full advantage of these two seasons and a rapid reduction in human malnutrition over the past five years. Covalima is widely known as a source of ‘fat cattle’ and before the closure of the border to cattle in 2010, was the site of significant export to West Timor. MAF speak of the potential for a ‘southern cattle corridor’ from as far as the major cattle hub of Lospalos. The personal relationships that existed between traders either side of the border when cattle trade was legal still exist in some cases.

The governor of NTT views cattle as a great priority; DP of NTT wish to significantly increase the cattle population of the province from the current level of 1.2 million head to two million head within 5 years. There is a policy in place that that no breeding-age females from NTT can be slaughtered within the province or sent for slaughter in other parts of Indonesia.

For cattle leaving the eastern part of the island, owing to its naturally deep waters, Wini seaport, rather than Atapupu is used. Geographically, Wini has potential for expansion. However, there is currently lack of agreement between local government and the port’s administration, currently located in Atapupu (Belu Regency). The TTU Regency government wants the port management to be handed over to them before they undertake investment and land purchase for the expansion of the port.

There are two phytosanitary barriers to that are currently constraining the formal import of cattle from Timor-Leste into Indonesia: brucellosis and FMD.

Brucellosis: According to DP NTT, there are two rounds of active surveillance for brucellosis per year, by both the national lab in Bali (larger sample size) and the local lab (because local government likes some independence). The prevalence of brucellosis differs east to west: the border districts of TTU, Belu and Malaka have around 2%, whereas Kota Kupang, Kupang Regency and TTS have a prevalence of 1% (see approximate location of the boundary between these zones in Figure 17 on page 45.

DP NTT described strong and effective restrictions to cattle movement from the east to western part of West Timor. Producers cannot bring cattle across the brucellosis line from East to West. Each Regency border has an inspection post and all cattle need certification to move past. This means all cattle from the east are either consumed locally or sent for slaughter in other parts of Indonesia.

According to DP NTT, the vaccination rate is 20% of national herd (age 1 year or under), using ring vaccination based on an annual seroprevalence survey.

Sumba Island has been declared brucellosis-free. Now government wants to achieve this status for West Timor. They believe Timor-Leste is crucial for this - they are aiming for Brucellosis-free Timor Island. In reality, this would be difficult to achieve; the vaccination rate would have to be increased to 70% and a test and slaughter system put in place, with compensation for farmers, which would be very expensive. Indonesia wants a thorough seroprevalence study in Timor-Leste as they feel (and previous, small studies have shown) there is a higher prevalence there. ADB is planning the design of a joint surveillance strategy for brucellosis.

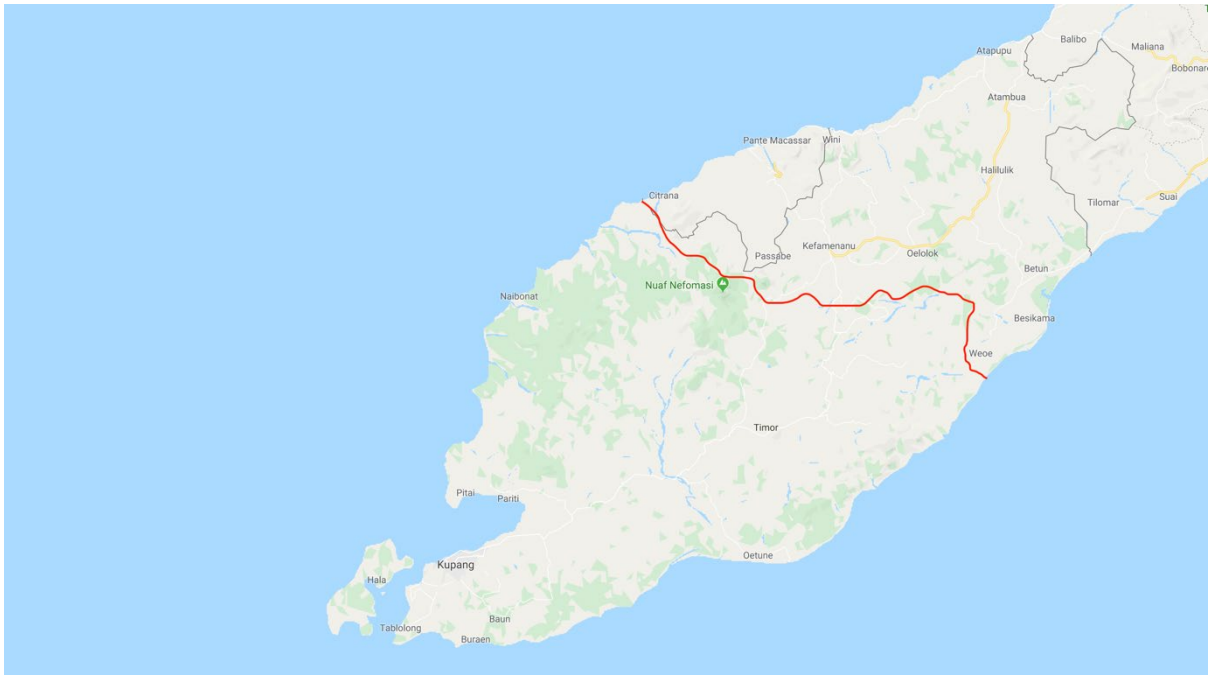


Figure 17 Approximate location of "brucellosis line" in West Timor, as at July 2019

The cost concerns for brucellosis surveillance and vaccination are substantial in Timor-Leste. Timely procurement and implementation are ongoing concerns for the National Vet Lab also, as test kits can be unavailable or go out of date waiting. Despite this, with support from the Australian Government Department of Agriculture Pre-Borders team, a recent serological survey of goats and cattle was conducted in Timor-Leste. Joint, peer-reviewed publication of these data is planned.

FMD: FMD does not weigh heavily on the minds of the stakeholders we spoke to as they feel there is a clear path to Timor-Leste's freedom declaration. The Indonesian government has expressed clear support, saying they will write letters, etc. and offer historical data.

Economic Challenges

The strong appreciation of the USD against the Indonesian Rupiah over the past decade (see Figure 18) has seen Timor-Leste exports become less competitive in Indonesia, while Indonesian exports are becoming increasingly competitive in Timor-Leste. In the livestock sector this has led to a decrease in competitiveness of Timor-Leste cattle for export.

Figure 18: USD to IDR exchange rate 2011-2021

Timor-Leste cattle are impacted by an increasingly interlinked set of beef and cattle value chains spanning from Australia across South East Asia, India and China and are also impacted by cattle development policies in Indonesia.

The current exchange rate situation and the entry of Indian Buffalo Meat and increases in the NTT herd pose significant challenges to trade. The physical conditions for trade are in place, and many of the regulatory barriers are being overcome. It is likely that once the trade becomes more economically attractive then the remaining political/regulatory barriers can be overcome.

7.4.3 Rationale for potential support of smallholder cattle production

The disease syndromes described by farmers during group activities warrant further investigation, given the similarities across locations and lack of similarity to the only disease currently targeted in the national cattle vaccination campaign, haemorrhagic septicaemia. In addition, one municipal animal health worker explained they were not given resources for basic deworming campaigns despite the high value of cattle and they did not feel their request had been taken seriously.

Farmers in Lolotoe also expressed a desire for future research and development programs to focus on cattle health above other species due to their relative value. What these farmers did not mention as a problem but was observed during windshield survey was erosion. A full study of the health of highland soils would be an important step towards improving productivity of cattle production.

In Maliana, feed availability for cattle was ranked number one in priority problems to address. This lack of forage availability, along with water scarcity, also presented a challenge for cut and carry systems across locations. Cut and carry systems were supported by farmers in multiple locations as a way to reduce theft, if the other constraints could be overcome.

The region showing the most promise for forage development, owing to its dual wet seasons was Covalima. A national-level forage development program is being implemented there but not in all administrative posts. The selection criteria for a specific location, according to government staff are as follows: (1) should have road access so national level experts can have access to bring materials etc.; (2) should be along main road and visible so it can attract other farmers passing by; (3) should have water; (4) should be community owned land. According to staff, after identifying the location they socialise the program in the community and try to attract men and women to participate (in a gender sensitive way). So far, no farmers beyond the pilot sites have adopted the changes but the staff feel it is early days and see further support of this program as an important initiative. Adjacent to Covalima, in Kobalima, Indonesia cut and carry systems and greater forage development were observed by the project team. This could serve as a useful model.

Farmers were interested in artificial insemination (AI). In Salele, despite there being only one successful outcome (a farmer in the group activity had produced a very large, now celebrity bull) the farmers all wanted the program to be run again. A trader in Lolotoe also suggested AI programs with exotic genetics.

7.5 Buffalo

As shown in Figure 19 in many parts of the country households keep buffalos for both ceremonial and labor purposes. The proportion of households keeping buffalo are particularly large in the central areas of the country and in Oecusse.

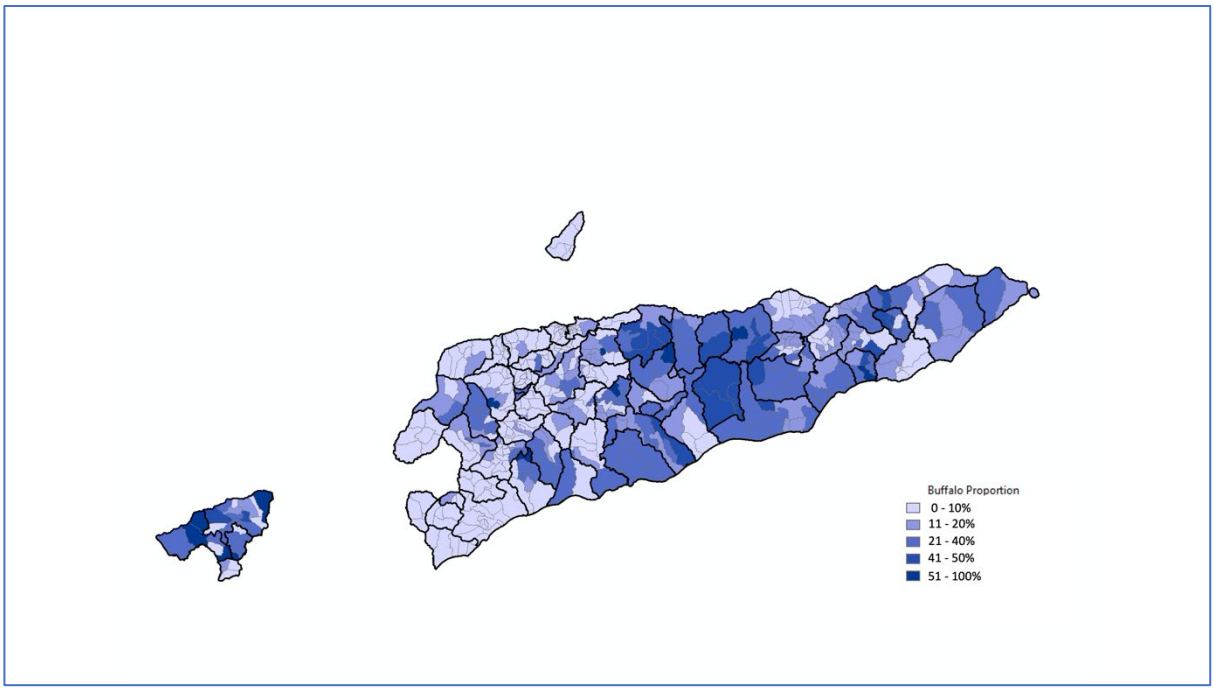


Figure 19: Proportion of Households Keeping Buffalo by suco, based on 2015 National Population and Housing Census

7.5.1 Importance of buffalo in overall livelihood strategies

Buffalo were owned by only eight of seventy farmers participating in this study. Barriers to owning buffalo included their great expense and need for a swampy area as well as their relatively slow growth rate compared to cattle. In terms of money, buffalo are the most valuable livestock in Timor-Leste. A very cheap buffalo is US$700 but the prices usually range between $1000-$1500. Farmers in Lolotoe said their ancestors owned buffalo but now none of the farmers in their community did due to the expense. They calculate that for an equivalent animal to a $1000 buffalo they could spend $500 on cattle.

One participant in Lolotoe emphasised the point that buffalo are still important despite their not owning them. For example, when they construct a big Sacred House they need buffalo horns. As they do not own them, they need to source and buy buffalo for this. Also, if there are particular activities in the wife's family then need to bring along buffalo for that. They buy buffalo from Suai, Maliana, Bobonaro. These farmers said it is possible to transport buffalo along the border road between Lolotoe and Suai in Covalima, which seemed very challenging during the windshield survey.

Men in Maliana gave an explanation as to why the prices were so high:

> *It is not the meat quality but rather the cultural value of the live buffalo. While the people here are Bunak and they do not need buffalo for their ceremonies, they can sell to other ethnic groups. In some particular cultural ceremonies*

such as dowry negotiation, a girl's family will particularly demand buffalo, not cattle. Since the supply of buffalo is limited, the price tends to be more expensive as compared to cattle

Beyond financial and ceremonial value, buffalo can be used for draught power in rice farming, which was the case in Alas. Male farmers in Alas ranked buffalo as the most important livestock species for a variety of reasons including using as draught power for rice paddies, cultural ceremonies, and selling to get cash for household needs.

In Tilomar, buffalo horns are only needed for ceremony every 3-5 years on average. Live cattle are bought from the market and slaughtered in the village. Consumption within the community is all associated with cultural purposes. The average ceremonial consumption of buffalo across all nine focus groups was 84 percent. Ceremonies include sacred house construction, inaugurations and funerals and dowry ceremonies. Large animals in general are rarely slaughtered for home consumption. There are no kiosk or lojas selling buffalo meat.

7.5.2 Animal health and production issues and opportunities

Farmers reported that the diseases in buffalo were similar to cattle and buffalo too had a hungry season where pasture was scarce. Were cattle disease investigation to be enhanced, buffalo disease should also be investigated as many diseases are shared. Forage and pasture development will enhance buffalo production along with other grazing animals.

7.6 Goat subsector

The national goat herd size is around 158,000 with around 46,000 keeping goats in 2015 (República Democrática de Timor-Leste (RDTL), 2015).As shown in Figure 20 the proportion of households keeping goats in sucos close to the Indonesian border in Bobonaro and in the North east of the country is relatively high, with some sucos in those areas recording more than 50 percent of households keeping goats.

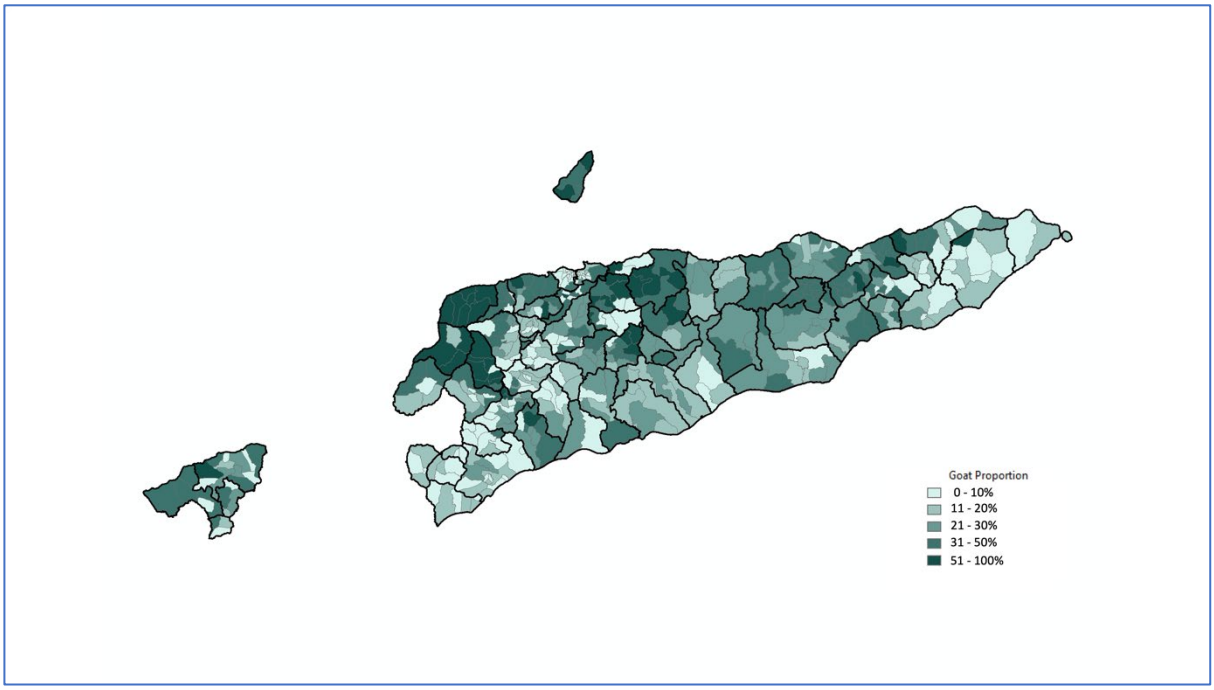


Figure 20: Proportion of households keeping goats by suco, based on 2015 National Population and Housing Census

7.6.1 Household contributions of goats

Importance of goats in overall livelihood strategies

Goat is a less desirable meat than pork, chicken and beef. On average it was estimated to make up nine percent (ranging from 0-15%) of meat consumed. Despite this, almost as many households in Timor-Leste keep goats as cattle. Goats are fairly easy to keep, they fend for themselves.

In all communities, goats were used for ceremonies and overall, 57 percent of goat meat was consumed during ceremonies and celebrations. The regularity of this ranged from rarely (in Alas) to very commonly. In Alas, goats were sometimes used to feed groups of workers during coffee harvesting. The farmers explained that even though they are a less important species or them culturally, they still keep them because they are a source of fast cash when in need of money. This was similar in Tilomar, they are seen as easy money. They usually sell the big male goats in the local market for US$150-200 per head. According to the farmers it is easy to bring goats to the market. There is a strong demand for goats from people in Bobonaro and Ermera who come to Tilomar looking for big goats. Price is about Goats eaten for Cultural activities inside and outside the village. In Alas, women noted that goat was so rarely eaten, during the last year it was not eaten at all.

Animal health and production issues

Goat diseases were not of great concern to farmers. In Maliana, goats can become lame early in the wet season, especially if it is muddy. In Alas, a seasonal diarrhoea and nasal discharge condition is seen during the heaviest part of the rainy season. If goats die, they can sell the meat.

In Tilomar farmers said it is very rare to see diseases of goats, sometimes they get diarrhoea and inappetence. When asked about abortion they said they have never observed it but as they spend so much time in the forest, it is possible it goes undetected.

In Maliana, the top two challenges for goat-keeping are the tendency for goats to go and destroy crops of other farmers and then the other farmers kill them (and presumably eat them). Secondly, they are prone to lameness in the muddy season.

In Lolotoe where theft of livestock is a major challenge, goats are normally not stolen. However, they have a problem with dogs killing goats all through the year.

7.6.2 International Trade and trade potential

There seems to be little potential for import-export of goats on Timor Island. The only recorded official trade figures for live animals are recorded in 2014 and 2015. Each year around USD3,000 worth of goats were imported from Indonesia into Timor-Leste. Both sides of the border report large herd sizes and little cultural preference for their meat; In Indonesia, they were described as having ‘the status of vegetables at parties’ but paradoxically, because people like goat satay as a snack food, they are missed if not there. In general, goat is consumed outside the home, rather than goat meat being purchased in the market and cooked at home. The price of goats does also increase during Haj. Goats are sent from West Timor to South Sulawesi and NTB but they easily fill this demand without need in to import from Timor-Leste. We did not hear rumours of informal trade of goats either. The only potential for market growth is thought to be feeding of workers by big companies, but even this demand could be filled with goats from NTT without needing to import from Timor-Leste. Goats are not vaccinated against brucellosis in either half of the island.

7.7 Horses

As shown in Figure 21 the horse population is concentrated in the high altitude sucos along the central spine of the country. In these sucos the proportion of households keeping horses is frequently between 60 and 100 percent.

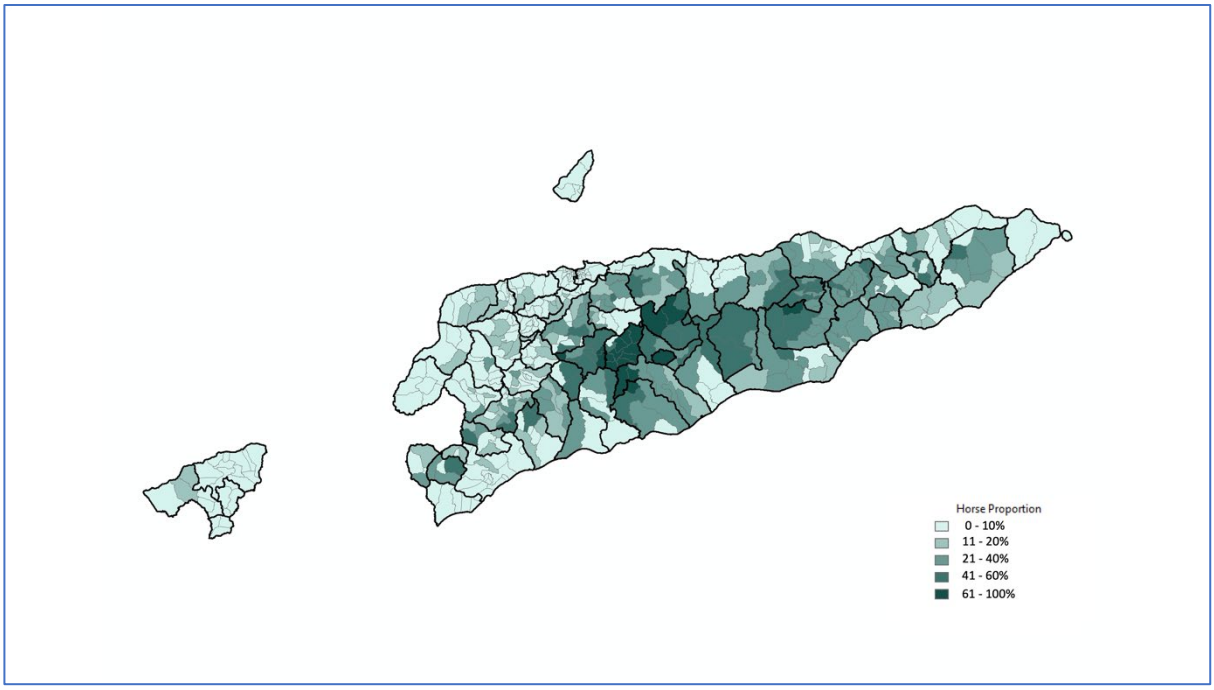


Figure 21: Proportion of households keeping horses by suco, based on 2015 National Population and Housing Census

7.7.1 Importance of horses in overall livelihood strategies

Horses have deep cultural value in Timor-Leste as they were heavily relied upon to traverse mountainous terrain (Silva, 1954) and in the wars between various kingdoms and the Portuguese colonialists. Horses also were vital during the time of resistance against Indonesian occupation. Today, horses are still used for horse racing in special events and transport in places where roads are challenging or non-existent (Miranda, 2011).

In Alas, people described close relationships with their horses and said every household in the community owned them. They relied on them for transport as over poor roads, especially in the rainy season. Horses were also used for dowry and they sold some for income. Buyers regularly came from places as far as Bobonaro to buy horses. An adult male horse was sold for US$200 while adult females were sold at US$150. If horses in Alas died, they buried them. Horse meat was never consumed there.

In all other study sites, horse meat was consumed but only opportunistically, when a horse died. In Cristo Rei farmers recalled one horse from a neighbouring community dying in the past year so the community bought some of that meat. In Maliana, men and women estimated consumption very differently with men saying they consumed three percent horse meat and women saying they consumed fourteen percent. This could be reflective of the opportunistic nature of that consumption. Women said horse meat could not be reliably sourced from the market, so consumption depended on when horses died. Maliana was the only community where horse meat was consumed during cultural events. In Tilomar and Lolotoe, sometimes an aileba would sell the meat from horses that had died.

Farmers in Tilomar did not keep horses themselves but used them for transporting heavy goods so they needed to pay someone else with a horse to provide services. In Lolotoe horses cost US$350-400 and all men in the community know how to train horses. These trained horses are used to travel to distant farms and to transport goods across the border.

7.7.2 Animal health and production issues and opportunities

Only one horse disease was described by farmers and that occurred in Alas. The horses exhibited clinical signs such as swollen chest and neck, and inappetence. The mortality rate was high and it took around a month for them to die. One farmer said he had 20 horses but they all died. The major concern for farmers in Lolotoe was theft.

There has been little attention paid by research and development initiatives to horses in Timor-Leste, though they hold great emotional and practical value to smallholders. There may be potential for further support of horse research and breeding in Timor-Leste.

7.8 Dogs

7.8.1 Importance of dogs in overall livelihood strategies

Dogs play many and varied roles in the lives of Timor-Leste communities. Across the five study sites, the relationships to dogs seem to vary from almost a pet-like relationship (in Alas) to a regular and cheap food source for bulk food provision (in Maliana and Tilomar). Despite this, they were not listed with the other livestock in the Timor-Leste Strategic Development Plan 2011-20 (RDTL, 2011b).

Dog meat was eaten in all nine communities and overall, almost as much dog meat was eaten as goat meat (seven and nine percent of meat consumed, respectively). In Maliana and Lolotoe (both within Bobonaro municipality), women estimated a much higher rate of dog meat consumption than men, by a factor of more than two and three times, respectively. In Maliana, men said they ate more beef and in Lolotoe more chicken. Local guides said women tended to have a much better overview of family consumption patterns than men as they prepare the meals. The most common situation in which dog meat was consumed was when partaking in physical group labour activities.

In Tilomar, lots of people laughed when discussing dog meat. Our local facilitator laughed along and said, “just mention ‘RW’ and everyone knows what you mean! This is likely because there is still some degree of taboo surrounding dog meat; while Timor-Leste is considered a Catholic country, many Muslims also reside there, and dog is haram in Islamic culture. RW is an Indonesian code term for dog meat. All but one very vocal, elderly farmer in Cristo Rei was reluctant to admit eating dog meat too. This reluctance may well have skewed the data collected during proportional piling exercises and a more accurate reading may be that dog meat is eaten more than goat meat. In Tilomar, dogs are normally slaughtered as adults.

In Lolotoe, dog meat was used for a variety of cultural purposes including christenings as well as group labour activities. Women noted there was also an aileba selling cooked dog meat balls. One ball or portion costs one US dollar. They used this as a part of their normal meal.

Dog meat was considered easy to source. In Maliana almost everyone owns dogs and they start to slaughter them from three to five months of age. They slaughter them for both home consumption and to feed workers. There is also some dog meat sold in the market. A couple of farmers said they kept their dogs purely for guardianship.

The importance of dogs for protection of people, property, crops and livestock was mentioned across the five sites to different degrees. In Alas and Lolotoe dogs are important for companionship, protection and labour during hunting trips. One farmer described the dog as a guardian angel. Farmers in Alas explained that where they grow crops on distant farms, they often leave their dog there or have them leashed there to take care of the crops particularly protecting them from monkeys which otherwise raid their produce. Dog meat is rarely eaten by this community, only on occasion, during large group gatherings such as during manual activities (construction and coffee harvesting) or small gatherings with family and friends such as at Christmas.

7.8.2 Animal health and production issues and opportunities

In Alas as well as Tilomar, common dog diseases include scabies and coughing. The mortality rate of the coughing disease is low. In Tilomar, diarrhoea is also observed at times. In Alas, farmers have recently been concerned about a seemingly new disease. Women farmers estimated population mortality at 60 percent and noted that the disease is occurring all year. Based on these descriptions, infectious diseases such as viral infectious canine hepatitis and canine distemper would be on the differential diagnosis list. There were no current national dog health programs or international projects identified.

7.9 The Animal Health System

7.9.1 Overview of the animal health system in Timor-Leste

The Ministry of Agriculture and Fisheries (MAF) is the Government department responsible for the design, implementation, coordination and evaluation of the policy, defined and approved by the Council of Ministers, for the areas of agriculture, forests, fisheries and livestock, and is responsible for proposing the policy and preparing the draft legislation and regulations necessary for its areas of protection.

MAF has wide-ranging responsibilities including ensuring the continuity of rural development programs, managing technical agricultural education, technical support centres for farmers, quarantine services, promoting agrarian research, and promoting and supervising animal health. The General Directorate of Livestock and Veterinary Services sits within MAF.

There are a total of eight veterinarians within the government in Timor-Leste, who are all based in Dili, including two people who are directors within the Directorate (RDTL, 2020). There will soon be a number of government-supported graduates of veterinary medicine who are conducting their studies in Indonesia but a challenge will be providing these graduates with secure contracts and equipping them to work effectively. Senior government staff explained that if graduates did not receive adequate pay and conditions, they may be drawn to work for international teams instead of the government.

Each municipality has a Livestock and Veterinary Department with a Head of Department and under their leadership, veterinary technicians and livestock technicians form the frontline of animal health services. The first cohort of Veterinary technicians graduated from UNTL with a Diploma 3 in Animal Health (3 years of study) Health in 2013 and the course has been run each year since. In addition to veterinary technicians, livestock technicians form part of the frontline of animal health services.

In contrast to Veterinary Technicians, Livestock Technicians generally do not have Diploma level education. Livestock technicians have rudimentary training and are employed by MAF at Administrative Post Level, with one Livestock Technician will responsible for one Administrative Post, and covering all villages down to hamlet level.

There are three nationally funded vaccination campaigns led by the government, to control Newcastle Disease in chickens, Classical Swine Fever in pigs and Haemorrhagic Septicaemia in cattle. There is one veterinary laboratory in Timor-Leste. The Diagnostic Laboratory of MAF was inaugurated by the President of the Republic of Timor-Leste in August 2011. Located in Dili city, this is the only dedicated veterinary laboratory in Timor-Leste. Establishment of the laboratory was supported by the Australian Government (AusAID, at the time) and the Australian government continues to support capacity building to this day.

The laboratory is rated as Biosafety Level Two (BSL-2); it is licensed to handle pathogens of moderate potential hazard to personnel and the environment, which can cause only mild disease to humans and/or are not easily transmitted via aerosol.

7.9.2 Barriers and opportunities for an improved animal health system: findings from the field

Human Resources

Historically, there have been many several animal health programs and models in Timor-Leste. Agente Pecuaria do Suco (APS) or Village Livestock Worker funded by the World Bank East Timor-Agricultural Rehabilitation Project II (2002-2008) and subsequently supported by FAO (2008-2009) trained livestock technicians in Hera, Dili for a short period (a total of 100 hours that composed of 60% animal health and 40% animal production) before providing them with a medical kit and sending them to sucos. The quantity of medicines provided by FAO depended on the livestock population data in the area. The project allowed livestock technicians to charge for their services. One technician said he used to charge $5 for treating cattle and $2.50 for treating smaller animals such as chickens or goats. They did not charge the farmers for vaccination, because the government provided them free to the farmers. The APS got paid by the government for doing the vaccinations, 15cents per cattle, 15cents per pig and 4cents per chicken. This model persisted until 2012 when some of the APS staff were absorbed by MAF as livestock technicians.

As the primary 'boots on the ground', livestock technicians across locations reported being stretched beyond their capacity. There was a suggestion from a livestock technician of returning to the APS model with a livestock technician in every suco but another former APS noted that the income from MAF, a salary, rather than fee for service, is more stable, allowing them to take out small loans (being sure they can repay them).

Opinions on different animal health projects and models varied. A senior animal health respondent felt that the model introduced by the Ausaid-funded Biosecurity Strengthening Project, where MAF extensionists, who are based in each suco, report cases to livestock technicians is effective. He said this model of communication has persisted until now.

Income stability for the most part, though is short-term. A major personal challenge for government animal health staff was the contractual basis under which the majority were employed. Younger employees were stressed by their lack of job security and older employees who were approaching retirement explained they would not be eligible for retirement benefits. Each year they signed a new contract, which was stressful. The salary was also considered inadequate (USD272/month for veterinary technicians and USD170/month for livestock technicians).. One livestock technician emphasised that this large pay gap does not seem fair as they are working so hard and covering such a large area, however the discrepancy in salary is due to different levels within the public service in addition to different educational levels.

Continuing education was not mentioned beyond specific training from international projects. Many livestock technicians had only received one month of training as part of the Agente Pecuaria do Suco (APS) or Village Livestock Worker program financed by World Bank East Timor-Agricultural Rehabilitation Project II. One technician believed that whenever opportunities for training in or outside the country arose, staff from the national office in Dili would always be chosen. Regional technicians suggested that MAF should conduct more training to build their capacity, either through giving them more opportunities or at least ensuring national office staff shared their learning after attending training. MAF has allocated funding for capacity building down to local level and this will continue to be implemented based on the stability of government budget.

The need for more livestock and veterinary technicians to better service large areas was mentioned at all locations and by different levels of seniority.

Physical Resources

At the time of observation, the Diagnostic Laboratory of MAF was equipped with dedicated sterilising, microbiology and serology rooms, biosafety cabinet, a number of refrigeration and freezer units, troughs, computers and more. A main and ongoing challenge as reported by the staff was consistent procurement of reagents and other consumables necessary for

the functioning of the laboratory. Largely, consumables were linked to particular projects and donors and were not available on an as-needed basis. On tour of the facility, expired reagents were observed. Since the laboratory was toured two new projects have begun, which are building the capacity of the laboratory staff and supporting it with equipment and consumables. For long-term institutionalism and sustainability of gains made during these projects, the issue of procurement will need to be addressed.

The kit supplied to a mobile livestock technician (Figure 22) included two tools for restraint, nose pliers (for cattle) and an animal catch pole used to restrain a variety of animals. This equipment was reported by farmers and technicians as often being insufficient for restraint of livestock for treatment and vaccination. This was a limitation when animal health workers were trying to achieve good vaccination coverage in villages. The need for livestock crushes and pens was repeatedly mentioned by farmers and other key informants. The medicines carried by the technician included injectable antiparasiticides, antimicrobials and vitamins and a topical antiparasitic spray for screw worm fly, which killed larvae, repelled flies and disinfected lesions. Syringes were reusable.

Figure 22 Animal healthcare kit carried by a livestock technician in Bobonaro

In all locations, technicians struggled with insufficient pharmaceuticals to meet the demands of their livestock cases. Technicians talked warmly about training they had received from Australian government staff and Australian government-funded projects but explained that it is often difficult to utilise their new skills when they have no diagnostic consumables or medicines. A need for more syringes was mentioned. In the study sites close to the border, farmers reportedly travelled to Indonesia to buy medicines such as antimicrobials. Technicians were concerned farmers did not have the necessary knowledge so were using them inappropriately. In Cristo Rei, farmers said they travelled to Dili city to buy human medicines for their animals because there are no veterinary medicine shops.

The Australian-funded, FAO implemented Biosecurity Strengthening Project (BSP) (2007-2011) took a broad development approach to prepare for the possible occurrence of Highly Pathogenic Avian Influenza (HPAI) and H5N1 in Timor-Leste. This included building capacity within MAF for border quarantine, disease surveillance, investigation and diagnosis, and control and eradication activities (FAO, 2011). According to leaders in the municipalities, the MAF supplied refrigerators based on the recommendations of the Village Poultry Health and Biosecurity project and some are still functional. In one location, the ‘cold chain’ referred to was project-supplied refrigerators in the residences of animal health technicians in each administrative post as there is no MAF office. In some locations, where refrigeration was still available, refrigerators were empty. In these same locations, power outages were common and one technician said they did not have a generator or an alternative storage location for their vaccines and other heat-sensitive pharmaceuticals.

According to respondents, the BSP provided medicines and vaccines; during the years of the project, MAF did not procure their own. BSP also provided pulsa (mobile phone currency) and fuel for livestock technicians and extensionists. This all ended at the

conclusion of the project but as mentioned under Human Resources, above, the communication channel between extensionists and technicians was reported by one municipal leader to continue today.

Another program mentioned, which according to municipal animal health leaders supplied vaccines, medicines fuel and pulsa for its duration and employed vaccinators in each suco was the European Commission-funded Rural Development Programme Phase III (RDP III), which ran from 2009-2013. The overall objective of the program was to alleviate poverty and contribute to the socioeconomic development of Timor-Leste, particularly poorer rural areas (European Commission and Ministry of Agriculture and Fisheries (MAF) Timor-Leste, 2009). According to municipal staff large numbers of buffalo, cattle and pigs were vaccinated under the program and those vaccinators covering the largest number of animals, along with the most supportive suco leaders were given cash prizes.

In addition to vaccine and medicine procurement being a barrier to utilising skills, it was also a barrier to capitalising on improved farmer knowledge. An example was given, of a project involving a public awareness campaign for Newcastle Disease vaccination. The vaccine needs to be given triennially and communities were educated through posters and other means. The campaign was very effective but in recent times (since project completion), had been accompanied by additional stress for the animal health and livestock department; three times per year, staff were inundated with calls to their mobile phones asking for the Newcastle Disease vaccines but they had none to give. Animal health workers explained they put together requests to MAF for vaccination campaigns but due to lack of availability, they turn to development groups and projects to partner with them in supply.

One office described how they are only given medicines and vaccines once per year and there is a gatekeeper at the main office who prevents them from accessing the medicines and vaccines as needed, and they are so under-resourced. In addition to insufficient medicines and vaccines, technicians were lacking basic equipment such as stethoscopes and thermometers. One livestock technician said that for the last three years he has been unable to carry out vaccinations due to his not having a cool-box and the refrigerated vaccines being a long distance away. Another constraint mentioned was the lack of livestock restraints such as crushes and pens. Farmers sometimes tell government livestock workers to ‘go and catch the (free-ranging) chickens themselves’ if they want to vaccinate them. An additional problem mentioned by a senior animal health worker is that vaccination vials treat 100 chickens so they need to gather together this many to release a vial of vaccine.

A senior animal health worker explained that they believe financial limitations are closely linked to financial instability. For example, in 2017 no vaccinations were given at all:

> *In 2017 there was only state budget for some very key agencies. In fact, there was only budget to sustain the departments and staff, not actually to implement anything. If have good plans, but no money then it is impossible to implement activities effectively – Senior government animal health worker*

Technicians also lacked personal protective equipment such as boots, raincoats and overalls. They explained that disposal overalls they were left by an international project were inappropriate for field work because they tore.

Motorbikes for government animal health staff were few. In April 2017, 68 motorcycles were delivered by the government to ‘meet the everyday needs of technical assistants in Livestock and Veterinary Medicine and supports their work implementing the programmes and activities of the General Directorate’ (RDTL, 2017). Those who had received them were very grateful. Others had to use their own, walk on foot or rely on being driven by other staff. One livestock technician had received a motorbike from a project, Rural Development Program 3 (RDP3), which they were able to continue to use for MAF work beyond the project but if they needed the assistance of a veterinary technician he had to drive to pick her up as she had no transport.

Allowances for motorbike fuel were considered inadequate by regional technicians. One technician said they received US$30-40 per year in fuel coupons but one year received none. Another said they received five of fuel litres per month. As with training opportunities (see human resources, above), regional animal health workers said they felt the national staff and municipal technicians were treated unequally with respect to work travel.

Farmer trust and confidence in animal health services

Farmers across locations saw animal health as a top priority for future research and development initiatives. The faith farmers have in animal health technicians was diminished when the technicians lacked medicines, equipment and training to treat diseases effectively and when they could not respond in a timely manner.

In addition, a veterinary technician described a repeat problem they experienced in managing relationships between themselves, farmers and international project teams. International teams would ask technicians to assist in recruiting participants, but they did not always know the purpose and the participants received no benefits so lost trust in the technicians.

In Alas, both men and women prioritised access to veterinary and livestock technicians; both men and women felt more technicians were needed to better serve the community 'on the ground'. The men suggested that the vet and livestock technicians come to their village to give farmers some training on key livestock diseases. They explained, this knowledge would help them to manage the diseases in coordination with the MAF technicians. The men also explained that technicians needed better access to medicines because sometimes they would call for their assistance, but they didn't attend as they had nothing to treat with. They also called for more research on livestock diseases, questioning "why don't wild animals get disease but livestock do?"

In Cristo Rei, disease was the top-ranking challenge according to farmers, followed closely by a lack of water in the dry season. Solutions to disease problems proposed by farmers include going to a human medicine shop and buy to treat animals, but the medicine shop is in Dili. Farmers requested more support from government to help them overcome livestock disease.

In Lolotoe, women prioritised a focus on disease (of all animals) and building up the animal health system to support them. A key problem identified is that when the farmers call the technician he runs out of drugs and supplies to do treatment and so cannot effectively treat. Sometimes inform him, but he could be far away or attending another case so then he doesn't come and then the animals die.

In Tilomar, women saw the most important focus for support to be for government to focus more on treating disease of large animals (including cattle). Other participants said that should concentrate on diseases of all of the different type of animal. Should also ensure the supply of medicines for vet workers also should ensure supply of vaccines.

8 Impacts

As this was an SRA with a short timeframe and relatively modest budget the expectations for significant impact at present should be somewhat tempered. The main potential impacts from the research will only be realised through improved decisions by MAF and donors around coordination of support for the livestock and animal health sector in Timor-Leste in the coming years.

8.1 Scientific impacts – now and in 5 years

A key part of the pathway to scientific impact is publishing project results in peer-reviewed journal articles. The article “Counting the cost: The potential impact of African Swine Fever on smallholders in Timor-Leste” based on field observations under the current SRA has 8 citations in leading journals as of January 2021 as well as more than 80 shares on social media and 32 tweets.

An area where there is potential for scientific impact within 5 years is related to the fieldwork methodology developed for the SRA. The methodology contains some novel elements- including the integration of nutritional information collection into a broader analysis of production systems and value chains. This enhances the ability of researchers to build up a picture of overall food systems in a developing country context where livestock have a high socio-cultural value. This has high potential to be adopted by researchers beyond the SRA.

8.2 Capacity impacts – now and in 5 years

The main capacity impacts of the SRA have been with the young researchers that we have worked with in Timor-Leste as a result of their active participation in collaborative research activities of the SRA.

The Timor-Leste team were involved in conducting pilot activities, recruiting and obtaining free and informed consent from participants, conducting Focus Group Discussions and Key Informant Interviews. Prior to this SRA, the Timpr-Leste research colleagues had experience in undertaking surveys for gathering quantitative information but did not have experience in facilitating participatory activities or collecting qualitative data for analysis.

Capacity of Timor-Leste partners was built through training activities and piloting exercises prior to the focus group discussions and key informant interviews being undertaken.

8.3 Community impacts – now and in 5 years

8.3.1 Economic impacts

Currently there are no significant positive or negative economic impacts of the SRA. The main pathway to delivery of economic impacts of the SRA within 5 years is that the results are used to inform improved decision making by MAF and donor agencies around support for the livestock and animal health sector in Timor-Leste, which in turn will result in improved government support for smallholder livelihoods and mitigate some of the negative impacts of disease on livelihoods.

Some idea of the potential scale of benefits of more effective disease control can be gained from looking at the case of ASF. D Smith et al. (2019) estimate that ASF could cause a potential economic loss of more than USD160 million for smallholders in Timor-Leste. If improved operations of livestock and animal health agencies under MAF as a result of more coordinated support from Timor-Leste government and donor agencies resulted in a reduction in losses from ASF of only 10 percent, then this would mean avoiding around USD16 million of losses.

8.3.2 Social impacts

Currently there are no significant positive or negative social impacts of the SRA. The main pathway to delivery of social impacts of the SRA within 5 years is that results are used to inform improved decision making by MAF and donor agencies around support for the livestock and animal health sector in Timor-Leste.

8.3.3 Environmental impacts

Limited impacts expected from this research.

8.4 Communication and dissemination activities

In addition to ongoing consultation and discussion between implementing partners and other key stakeholders, the following key communication and dissemination activities around the SRA activities and results were undertaken.

Initial Canberra workshop June 2019

Online Briefing Sep 2019

Livestock Options Roundtable May 2020

Focus Group Meeting on Cattle and Trade June 2020

Presentation on value of livestock to smallholders in Timor-Leste December 2020

9 Conclusions and recommendations

The current SRA has taken an overview of the livestock sector in Timor-Leste, including the importance of the sector in livelihoods of smallholders and also the existing and potential future trade patterns of livestock and livestock products. This overview has been informed by a mixed methods methodology, including analysis of secondary data, stakeholder meetings, key informant interviews and participatory information gathering through focus group discussions. Based on the SRA activities and results, a number of key conclusions and recommendations can be made.

9.1 Conclusions

The consumption levels of animal-source foods in Timor-Leste are relatively low across most income groups and there are only small differences in consumption levels between urban and rural residents. While consumption levels are low, the vast majority of households keep at least one type of livestock, and the value of livestock to the people of Timor-Leste is extremely high.

Across all focus groups with both men and women, during ranking exercises participants consistently indicated that every livestock species is of high importance to their households. Poultry were seen as important for both ceremonial purposes and because they could be sold to meet immediate cash needs. Pigs were very important as ceremonial animals and also as a high value asset that could be sold in case of urgent need for a larger amount of cash. Cattle and buffalo were valued very highly for ceremonial purposes. In the mountainous areas, horses were ranked as extremely important for transportation purposes.

Across all regions and livestock types, ceremonial and cultural uses of livestock predominate, and this leads to high selling prices of live animals. The price of live chickens, pigs, cattle, buffalo and goats are all significantly higher in Timor-Leste than in West Timor. Imported pork, beef and chicken meat are all significantly cheaper than locally produced meats. In the last 2 years the imports of broiler chickens from West Timor have increased dramatically, adding another potential source of inexpensive protein for the population of Timor-Leste.

Imported frozen beef, pork and chicken meat and the meat produced from imported broilers should not be considered to be direct substitutes for the mainly rural and peri-urban demand livestock produced on smallholder farms in Timor-Leste. As livestock are predominately utilised for ceremonial and cultural purposes, live “local” type animals are needed. However, in the urban consumer market in Dili locally produced pork and beef are at a price disadvantage to frozen imported meats.

Livestock is of vital importance to households, both in terms of socio-cultural significance and as a form of savings for regular and unanticipated expenses. However, despite this importance, animal diseases are relatively uncontrolled in many parts of the country, and mass mortalities occur with regular seasonality, especially in pigs and chickens. This cyclical loss of animals wipes out household savings and creates significant stress in terms of needing to find alternative sources of livestock for ceremonies and cultural purposes.

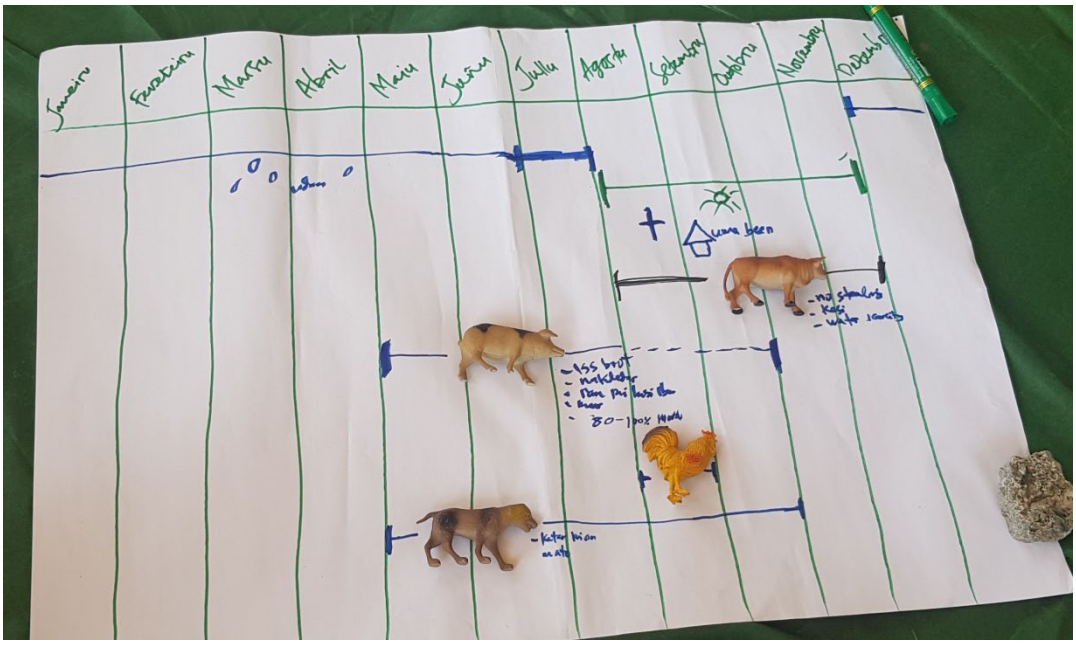


Figure 23 Seasonality of livestock diseases as described by female farmers in Alas

The animal health sector continues to be faced with many challenges in terms of capacity building needs and resourcing from the Timor-Leste government and from donor agencies. Without systemic intervention and support for the animal health sector at a national level and across all municipalities, impactful and sustainable improvements to the system will be difficult to achieve.

9.2 Recommendations

Systemic and coordinated support for animal health and livestock sectors. The efforts of Government of Timor-Leste and donor agencies in support of the livestock and animal health sectors in Timor-Leste should be as coordinated and synergistic where possible, focusing on capacity building and also resourcing and supporting community relationship-building by veterinary and livestock technicians. Many laudable efforts at geographically focused, species focused, or disease focused support have not achieved expected results due to not addressing the underlying systemic challenges facing the livestock and animal health sectors.

Cattle production systems should orient to the domestic market for cattle, rather than export. While there are relatively few physical barriers to trade between Timor-Leste and Indonesia, in the case of cattle exports there are still significant regulatory barriers to trade, especially barriers related to brucellosis.

Formal trade in cattle between Timor-Leste and West Timor will not be able to take place unless there is Brucellosis free status for all Timor Island. The Indonesian government has committed to working towards this status, but for Timor-Leste this would be difficult to achieve; the vaccination rate would have to be increased to 70% and a test and slaughter system put in place, with compensation for farmers, which would be very expensive.

In addition to the regulatory barriers to trade, there are significant economic barriers to trade. The strong appreciation of the USD against the Indonesian Rupiah over the past decade (as shown in Figure 18) has seen Timor-Leste exports become less competitive in Indonesia, while Indonesian exports are becoming increasingly competitive in Timor-Leste. In the livestock sector this has led to a decrease in competitiveness of Timor-Leste cattle for export.

The current exchange rate situation and the entry of Indian Buffalo Meat and increases in the NTT herd pose significant challenges to cattle exports. The physical conditions for trade are in place, but until the trade becomes more economically attractive then it is unlikely that the significant remaining political and regulatory barriers to formalizing cattle exports can be overcome.

Pig Sector should be supported, but not with an orientation to supplying pork to Dili market. The vital cultural, social and economic role that pigs play for households in Timor-Leste has been noted in numerous studies ((Bettencourt et al., 2015; Hunter, 2019) and confirmed during the fieldwork for the current SRA. The current outbreak of ASF in the country has further highlighted the importance of pigs and the potential for pig disease to have serious implications for livelihoods across the country. These factors, combined with the widespread nature of pig raising across the country means that there is a very strong case for supporting household level pig rearing across the country as a means of supporting livelihoods and reducing vulnerability.

However, the lack of non-ceremonial demand for pork, the lack of value chains and slaughtering facilities, combined with the high price of domestic pigs and the extremely low price of imported pork products means that any strategy for supporting the smallholder pig raising sector in Timor-Leste should not be oriented towards producing pork for the market in Dili.

10 References

10.1 References cited in report

ADB (2018) Scoping Study on Enhanced Cross-Border Cooperation and Integration between Indonesia and Timor-Leste, Sustainable Infrastructure Assistance Programme, ADB, Manila.

Barnes, T. (2020). *Final Report Small Research and Development Activity: Identifying husbandry options for smallholder pig farmers in Timor-Leste (LS/2017/102)*. Retrieved from Canberra, Australia:

Barnes, T. S., Morais, O., Cargill, C., Parke, C. R., & Urlings, A. (2020). First steps in managing the challenge of African Swine Fever in Timor-Leste. *One Health, 10*, 100151. doi:https://doi.org/10.1016/j.onehlt.2020.100151

Bettencourt, E. M. V., Tilman, M., Narciso, V., Carvalho, M. L. d. S., & Henriques, P. D. d. S. (2015). The Livestock Roles in the Wellbeing of Rural Communities of Timor-Leste. *Revista de Economia e Sociologia Rural, 53*, 63-80.

Cargill, C. (2017). *Assessment of Smallholder Pig Production Development Opportunities in Timor-Leste, Technical Report 14*. Retrieved from

Castro, A. F. (2013). *An Approach to the food habits of three communities in Timor-Leste*. Retrieved from https://www.care.org.au/wp-content/uploads/2014/12/Timor-Leste-food-habits-report.pdf

DNE. (2016). 2015 Timor-Leste Population and Housing Census. Retrieved from http://dataspace.princeton.edu/jspui/bitstream/88435/dsp015q47rr25x/1/DSTimorCensus2015DataSheet.pdf

European Commission and Ministry of Agriculture and Fisheries (MAF) Timor-Leste. (2009). *Rural Development Programme Phase III (RDP III), Timor-Leste: Terms of Reference*. Dili, Timor-Leste

Food and Agriculture Organisation of the United Nations (FAO). (2010). Pig Production and Disease Control in Timor-Leste. *FAO Timor-Leste E-News, 2*. Retrieved from http://www.fao.org/fileadmin/user_upload/emergencies/docs/TimorLeste_March10.pdf

Food and Agriculture Organisation of the United Nations (FAO). (2011). *Evaluation Report: Biosecurity Strengthening Project in Timor-Leste OSRO/TIM/701/AUL*. Retrieved from http://www.fao.org/3/a-bd319e.pdf

Fulton, R. M. (2015). Backyard Poultry Medicine and Surgery. In (pp. 137-144). Hoboken, NJ, USA: John Wiley & Sons, Inc.

Hunter, C. (2019). *Final report of ACIAR Project AH/2012/065 Regional approach to enhance smallholder pig systems in Timor-Leste.* The University of Sydney, Sydney.

Miranda, S. (2011). *Género e Agricultura em Quatro Distritos de Timor-Leste (Bobonaro, Ermera, Manatuto e Viqueque)*. Retrieved from Díli, Timor-Leste:

Muhairwa, A. P., Mtambo, M. M. A., Christensen, J. P., & Bisgaard, M. (2001). Occurrence of Pasteurella multocida and related species in village free ranging chickens and their animal contacts in Tanzania. *Vet Microbiol, 78*(2), 139-153. doi:https://doi.org/10.1016/S0378-1135(00)00296-0

OIE. (2019). 27/09/2019: African Swine Fever, Timor-Leste (immediate notification). Vol. 32 – Number 40. Retrieved from https://www.oie.int/wahis_2/public/wahid.php/Diseaseinformation/WI/index/newlang/en

OIE. (2020). Situational Updates of ASF in Asia and the Pacific. Retrieved from https://rr-asia.oie.int/en/projects/asf/situational-updates-of-asf/

República Democrática de Timor-Leste (RDTL). (2011a). *Timor-Leste Household Income and Expenditure Survey 2011*. Dili Retrieved from http://www.statistics.gov.tl/wp-content/uploads/2013/12/HIES2011_Report_20-_20Final.pdf

República Democrática de Timor-Leste (RDTL). (2011b). Timor-Leste Strategic Development Plan 2011–2030. In: RDTL Dili, Timor-Leste.

República Democrática de Timor-Leste (RDTL). (2015). *Timor-Leste Population and Housing Census 2015: Analytical Report on Agriculture*. Retrieved from

República Democrática de Timor-Leste (RDTL). (2017). Distribution of motorcycles to technical assistants in Livestock and Veterinary Medicine. Retrieved from http://timor-leste.gov.tl/?p=17659&lang=en

República Democrática de Timor-Leste (RDTL). (2020). *Strengthening Animal Health Service Policies in Timor-Leste: Virtual Roundtable in Dili Timor-Leste*. Dili: Crawford Fund

Sawford, K., do Karmo, A., da Conceicao, F., Geong, M., Tenaya, I. W. M., Hartawan, D. H., & Toribio, J.-A. L. (2015). An investigation of classical swine fever virus seroprevalence and risk factors in pigs in Timor-Leste. *Preventive Veterinary Medicine, 122*(1-2), 99-106.

Silva, H. (1954). Panorama Pecuária de Timor. *Revista de Ciências Veterinárias, XLIX*, 348-349.

Simarmata, Y. T., Tophianong, T. C., Amalo, F. A., Nitbani, H., & Lenda, V. (2020). The Description of The Pathology Anatomy of Landrace Pig Suspect African Swine Fever (ASF) in Kupang District. *JURNAL KAJIAN VETERINER, 8*(2), 136-146.

Singh, R., Remington, B., Blackall, P., & Turni, C. (2013). Epidemiology of Fowl Cholera in Free Range Broilers. *Avian Diseases, 58*(1), 124-128, 125. Retrieved from https://doi.org/10.1637/10656-090313-Reg.1

Smith, D., Cooper, T., Pereira, A., & da Costa Jong, J. (2019). Counting the cost: The potential impact of African Swine Fever on smallholders in Timor-Leste. *One Health*, 100109.

Smith, D., Cooper, T., Pereira, A., & Jong, J. B. d. C. (2019). Counting the cost: The potential impact of African Swine Fever on smallholders in Timor-Leste. *One Health, 8*, 100109. doi:https://doi.org/10.1016/j.onehlt.2019.100109

Tomaselli, M., Kutz, S., Gerlach, C., & Checkley, S. (2018). Local knowledge to enhance wildlife population health surveillance: Conserving muskoxen and caribou in the Canadian Arctic. *Biological Conservation, 217*, 337-348. doi:https://doi.org/10.1016/j.biocon.2017.11.010

UNESCO. (2020). Timor-Leste: Education and Literacy. Retrieved from http://uis.unesco.org/country/TL

Wong, J. T., Bagnol, B., Grieve, H., da Costa Jong, J. B., Li, M., & Alders, R. G. J. F. S. (2018). Factors influencing animal-source food consumption in Timor-Leste. *10*(3), 741-762.

10.2 List of publications produced by project

Dominic Smith, Tarni Cooper, Abrao Pereira, Joanita Bendita da Costa Jong (2019), Counting the cost: The potential impact of African Swine Fever on smallholders in Timor-Leste, One Health, Volume 8, 2019, 100109, ISSN 2352-7714, https://doi.org/10.1016/j.onehlt.2019.100109

Trip Report Field Mission July 2019 (see Appendix 1)

Trip Report Field Mission September 2019 (see Appendix 2)

Proceedings of Livestock Options Roundtable meeting (see Appendix 3)

Report on Beef and Trade Online Discussion

Discussion paper on Livestock Production and Trade