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Australian Centre for International Agricultural Research

Final report

Small research and development activity

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2 Executive summary

The goal of the Small Research Activity (SRA) LPS/2016/021 was to understand current small ruminant (SR) production and marketing, the demand for SR meat, and to identify the research needed for developing profitable smallholder SR production in Pacific Island countries. It aimed to assess the existing potential, and additional needs, for future small ruminant production system research to have an impact on the livelihoods of small-scale farmers in the Pacific. It sought to broadly describe the markets and value chains for small ruminants across the Pacific region, with a focus on the key small ruminant producing countries of Fiji, Vanuatu and Samoa. It assessed the institutional support and capacity in the region for future small ruminant Research for Development (R4D) projects, identifying key personnel and institutions, and areas where further capacity-building is required. It undertook a more detailed analysis of production systems and farmers in Fiji, the most significant small ruminant producing country in the region.

In both Fiji and Samoa the two largest value chains for small ruminant product are: a formal retail market that is dominated by imported frozen product from Australia and New Zealand, sold through formal retail outlets; and a festival market for locally produced whole animals sold at farm gate for backyard slaughter, mostly for religious holidays and customary uses. In Fiji, the maqiti festival market has strong demand, but appears saturated for some growers. However the quantity of imported meat for retail sale is approximately 10 times local production (7500 tonnes per year). In Samoa the trade imbalance is even greater due to the lower local production. The retail market therefore represents a huge opportunity for smallholders in both countries via import substitution, if local production is able to meet consumer requirements. This opportunity, combined with strong government support and confidence of farm investors suggests that both of these countries are likely to benefit from further development investment targeting the SR sector. The size of the market (supply and demand) for SR meat in Vanuatu was not considered large enough to warrant further R4D investment at this time.

Production systems and constraints were analysed using a farmer survey and focus group discussions at five locations in Fiji. It is clear that most SR farms in Fiji are underperforming in terms of productivity of breeding and growth, and it was agreed by key informants in Samoa that farmers face similar issues there. Gastrointestinal Nematodes (GIN) management and feed gaps are the major technical issues facing farmers in both countries. Current drenching protocols for GIN are expensive in terms of labour and drench, are likely to be promoting drench resistance, and are clearly ineffective in reducing Worm Egg Count (WEC). Poor nutrition is a cross-cutting constraint, likely affecting growth and reproduction rates, the impact of GIN on animals, and lamb and kid mortality. Both the Samoan and Fijian governments are making significant investments into upgrading and multiplying national nucleus flock genetics, and are seeking information on the performance, strengths and weaknesses of different genetics in smallholder and semi-commercial flocks.

In both Fiji and Samoa, there is strong domestic retail demand for SR meat, but this is almost entirely supplied by imported product. The majority of local SR production goes to festival markets, which in Fiji, are approaching saturation. Further research is required to understand what production, distribution and marketing systems in Fiji and Samoa would enable local producers to better compete against imported product; how to develop and implement sustainable value chains; and increase the participation of semi-commercial and smallholder farmers.

In Fiji, there do not appear to be any social, cultural or religious taboos or restrictions for either women or men to engage in small ruminant farming. It was clear that women are not well engaged in the existing support networks and structures for livestock farming, nor in the decision making processes related to both the production and marketing of sheep and goats. The findings of this research emphasise the importance of small ruminants as part of a diversified livelihood strategy in Fiji.

3 Introduction

Fiji has the largest small ruminant population of the Pacific Island Countries (PICs), with 24,000 farmers running 260,000 goats and 17,500 sheep (Pacific Community 2008; FAO n.d.). Vanuatu and Samoa are other significant producers of small ruminants (SR), with national flocks of 25,000 goats and 13,000 sheep, respectively (Pacific Community 2008; FAO n.d.). In Fiji, goats play an integral part in traditional Fijian cultural activities and are important as a source of meat as 37% of the population are Hindus - and do not consume beef – while 7% are Muslim with goat being sacrificed during the Festival of Eid.

Local production of goat and sheep meat in Fiji exceeds 1,100 tonnes/year (UNCOMTRADE 2017); however demand is unable to be met by local supply. A large amount of this demand is met by imported carcasses and meat from Australia and New Zealand. Fiji (5,000 tons/yr) and PNG (15,000 tons/yr) are the largest importers of small ruminant products in Oceania (UNCOMTRADE 2017). This creates an opportunity for smallholder farmers to increase production to supply local markets instead of imported goat meat, which would both improve individual farmer livelihoods, as well as improving national trade balances by import substitution.

The evident importance of SR meat and animals in Fiji prompted this SRA to undertake a more detailed investigation of the Fijian SR sector – the production systems, value chains and livelihoods of SR and stakeholders. It was identified that Samoa and Vanuatu had smaller SR numbers than Fiji, but that a rapid assessment of the sector in each country, along with desktop analysis of supply and demand, may yield information supporting a business case for further SR research in these countries.

Up-to-date production statistics and bench-marks for small ruminant production are not readily available, however, in 1998 the FAO assessed growth rates of small ruminants in the region to be in the order of 60 – 80 g/head/day, compared to an estimated potential for liveweight gains of 130 – 150 g/head/day (Macfarlane 1998). This project aimed to gather information on current production systems, rates of productivity, and on-farm constraints in Fijian SR production.

Small ruminants are perceived by many to be ideal ‘entry-level’ livestock for young, poor, marginalised and/or female farmers as they are easily handled (Mtenga *et al.* 2002), require relatively low investment and due to their fecundity and fast maturation quickly produce income (Devendra 1999), and therefore offers the opportunity for poverty alleviation for these types of farmers. There is a common view that for women, the benefits of sheep or goat ownership are more direct, and perhaps more permanent than for men: These include improved household nutrition and alleviation of hunger, better livelihoods, more effective utilization of unpaid family labour, more stable households, and increased self-reliance (Devendra 1999). This project sought to better understand Fijian SR farmers and their livelihoods, and assess the constraints to and opportunities for small ruminant production to improve the livelihoods of poor smallholder producers including women and marginalised groups.

With strong market demand for small ruminants, Fiji and its neighbouring PICs have the opportunity to increase productivity, increase market participation and hence improve livelihoods of smallholders. However, the value chain for live animals, carcasses and meat needs to be evaluated in order to identify the role that the value chain actors can play in improving the efficiency of the value chain and hence the opportunity to improve smallholder access and livelihoods. Production systems need to be assessed so that they are aligned appropriately with value chains. The evaluation of production systems will identify constraints to improved efficiency and alignment with value chains that could be addressed by further ACIAR investment.

A significant impediment to the long-term impact of small ruminant research projects worldwide is lack of a viable value chain for goats and sheep products. The strength of demand for small ruminant meat, carcasses and live animals in PICs offers the

opportunity for sustainable development across the value chain. However, an analysis of small ruminant value chains and production systems is required to identify opportunities for targeted future interventions, including those that can bring benefits to women and marginalised groups as new and existing small ruminant producers.

This SRA aimed to assess the existing potential, and additional needs, for future small ruminant production system research to have an impact on the livelihoods of small-scale farmers in the Pacific. It sought to broadly describe the markets and value chains for small ruminants across the Pacific region, with a focus on the key small ruminant producing countries of Fiji, Vanuatu and Samoa. It assessed the institutional support and capacity in the region for future small ruminant R4D projects, identifying key personnel and institutions, and areas where further capacity-building is required. It undertook a more detailed analysis of production systems and farmers in Fiji, the most significant small ruminant producing country in the region.

4 Objectives

The goal of the SRA was to understand current small ruminant (SR) production and marketing, the demand for SR meat, and to identify the research needed for developing profitable smallholder SR production in Pacific Island countries.

Objective 1: Assess the supply, demand and institutional support for improved small ruminant production in key countries (Fiji, Vanuatu and Samoa) in the Pacific region.

Objective 2: Describe existing small ruminant production and marketing systems in Fiji, and identify constraints to and opportunities for developing profitable smallholder production systems

Objective 3: Develop a typology of small ruminant producers in Fiji, and assess the constraints to and opportunities for small ruminant production improving the livelihoods of poor smallholder producers including women and marginalised groups.

Variation 1:

Objective 4: Conduct targeted capacity building in participatory research approaches and technical capacity for the sheep and goat sectors of Fiji and Samoa, jointly with LPS/2016/027 (Laos/Vietnam)

Objective 5: Develop a formal research proposal for ACIAR-supported sheep and goat production and marketing research in Fiji and Samoa

5 Methodology

Overview

To achieve the goal of understanding current SR demand, production and marketing, and to identify next step research requirements in the Pacific SR sector, this project employed a range of methodologies:

- A comprehensive review of available literature and statistics on the sector in Fiji, Samoa and Vanuatu,
- A key stakeholder workshop in Suva including representatives from USP, MoA Fiji, SPC and FAO,
- Fieldwork (key informant interviews) for an initial two weeks on Viti Levu: four days in Central division, including Suva, Nausori, Navua and Sigatoka, and four days in Western division, including Nadi, Lautoka, Ba, and Tavua,
- Fieldwork (key informant interviews) for five days in Samoa on Opulo, and 3 days in Vanuatu on Santo and Efate,
- A mixed method collection of production, marketing and household characteristics of 48 small ruminant farmers in Fiji, using survey and focus group discussion instruments,
- A rapid appraisal of flock health, worm egg count (WEC) and body condition score (BCS), and pasture availability on 12 farms across Viti Levu (Nausori, Lautoka and Ba) and Vanu Levu (Lambasa and Dreketi).

The work reported in this SRA was conducted by the University of New England team (Table 1). As the first livestock project in Fiji or Samoa, and the first SR project in the Pacific region, this SRA did have local research partners, but worked with new contacts at the Pacific Community, University of the South Pacific and Ministry of Agriculture (Fiji) for fieldwork, and assessed the research capacity at local institutions for partnering on future projects.

Table 1: Project team

Team member	Role	Fieldwork sites
Fran Cowley	Team Leader; animal production expertise	Fiji: Viti Levu
Steve Walkden-Brown	Animal health expert; Fiji expertise and experience	No Fieldwork
Geoff Smith	Value Chains	Fiji: Viti Levu and Vanua Levu, Samoa: Upulo, Vanuatu; Santo and Efate.
Romana Roschinsky	Extension Animal production	Fiji: Viti Levu and Vanua Levu
Michelle Carnegie	Gender and Social Science	Fiji: Viti Levu and Vanua Levu
Students from USP	Enumerators and facilitators for household survey and focus group discussions. On-farm sampling and measurement	Fiji: Viti Levu and Vanua Levu

5.1 Key informant interviewees

The number of stakeholder organisations or sub-institutions interviewed is shown in Table 2. At most institutions, several individuals participated in interviews. Farmer numbers are

those interviewed on-farm as key informants during initial investigations. The larger number of farm survey respondents are detailed in Section 5.3.

Table 2. Stakeholder engagement in key informant interviews†*.

	Government	University	Farmer assoc.	Commercial farmers	Smallholders	Traders	Abattoir	Wholesaler/ processor	Retail	Total
Viti Levu	4	2	3	3	3	2	2	4	6	29
Vanua Levu	2				4	1		2	3	12
Samoa	2	1		2	3		2	1	4	15
Vanuatu	2			1	3		1	1	3	11
Total	10	3	3	6	13	3	5	8	16	67

†Stakeholder organisations, not individuals; * Farmers surveyed are detailed in Section 5.3

5.1.1 Fiji

Policy focus group discussion

A focus group discussion concerning the policy environment around Pacific small ruminant production was held at the Secretariat of the Pacific Community in Suva in November 2016, with key informants from the following institutions:

SPC

Ilagi Puana - Animal Health and Production Adviser
Andrew Takuana - Animal Production Extension Officer

Ministry of Agriculture

Avinesh Dayal – Acting Principal Agriculture Officer - Policy
Eroni Tamani – Principal Agriculture Officer, Research
Paulini Tulati - Senior Agricultural Officer
Eduari Navukiboro – Principal extension officer

FAO

Tim Martyn – Policy Officer, FAO Country Officer

This FGD discussed topics such as:

- Local demand and supply of sheep and goat meat
- Issues around imported mutton
- Abattoir and slaughter policy
- Pacific regional supply and demand for small ruminants and their products
- Regulation of animal trade, movement and biosecurity

Ministry of Agriculture

- Tomasi Tunabuna, Director – Animal Health and Production, Ministry of Agriculture
- Dr Stephen Angus, Principal Veterinary Officer
- Veterinary Pathology Lab: Dr Leo Borja, Senior Veterinary Officer
- Koronivia Research Station: Senior Research Officer

- Chemistry Laboratory
- Nawicoba Sheep Research Station: Alipate Karikari (Agricultural Officer)
- Sigatoka Research Station: Alfred Chanel (Senior Research Officer), Taniela Raobula (Agricultural Officer), Raji (Agricultural Technical Officer – Goats)).
- Northern Division Extension office: Ananasa Ralogaivau (senior Agricultural Officer) and other Agricultural Officers
- Western Division Extension office: Agricultural Officers in Lautoka and Ba
- Karishma Gounder – National Goat Coordinator and Acting National Sheep Coordinator
- Dr Colin Wakelin and Dr Paul Colville - Veterinarians on 2 year secondment to MoA from New Zealand, charged broadly with improving animal health operations at MoA, drafting SOPs etc.

Research Institutions

University of South Pacific: Dr Poasa Tabuaciri (Lecturer in Animal Production), and Assoc. Prof. Jito Vanualailai (Director of Research). Ass. Prof Anand Chand (Business)

Fiji National University: Prof Paras Nath - Dean, College of Agriculture, Fisheries and Forestry and Dr Singh - Dean, School of Veterinary Science.

Key Industry Stakeholders

Fiji Meat Industry Board: Steven Ting (CEO) and Manager of Vuda Abattoir

Fiji Crop and Livestock Council: Jiu Daunivalu (CEO) and Simon Cole (Chair)

Fiji Grazing Livestock Association: Anil Goundar (Chair)

Fiji Sugar Cane Council

Sheep and goat producers

Several sheep and goat farmers were interviewed and production and marketing systems were described. Farmers interviewed were from wet and dry agro-ecological zones and of several different sized flocks. A more detailed formal survey of farmers was undertaken to develop a typology of farmers.

The numbers of farmers interviewed and surveyed are presented below. Data from the survey are analysed and case studies are presented that demonstrate typical issues for common farming systems.

Processors/Retailers

FMIB and private abattoir operators and several processors involved with value adding of both local meats and imported product were interviewed. Supermarkets, butchers shops and restaurants were surveyed and interviewed (semi-structured) in Suva, Nadi and Lautoka in Viti Levu and in Labasa on Vanua Levu.

5.1.2 Samoa

Ministry of Agriculture and Fisheries: Tony Aiolupo; Director - Animal Health and Production; Renee Orange - Senior Animal Health Officer, Donna Sila Aiulu; Senior Research Officer, Seykeen Lupe Meleisea, Senior Extension Officer, Sam Animal Health Officer.

University of South Pacific: Dr Jagdish Bahti

Several farmers, including smallholders and three of the seven multiplier farmers involved with new sheep imports were interviewed. The only local processor and the new mobile abbatoir operator, supermarkets and butchers shops were also interviewed and surveyed.

5.1.3 Vanuatu

Department of Livestock officers on Efate and Santo, several smallholders and one large abattoir were interviewed. Several butchers shops were surveyed.

5.2 Desktop analysis

Past research in the Fijian and Pacific small ruminant sector was reviewed. Country population, production and demand and supply data were gleaned from most recent Agricultural census data, FOA databases, government import statistics, strategy and policy documents and other available reports.

A masters student from the University of the South Pacific conducted a review of research in the SR production in the Pacific in the last 20 years, focussing particularly on the grey literature in the USP libraries. A summary of the key findings are presented below, and the full literature review submitted as a separate monograph.

5.3 Farm household survey and focus group discussion (Fiji)

Five fieldwork sites, representing three different small ruminant production zones of Fiji, were selected for data collection: Western Division (Lautoka and Ba), Northern Division (Labasa and Dreketi) and Central Division (Nausori). The Western and Northern Divisions are in the dry zone of Fiji, and the Central Division is in the humid wet zone. On-farm visits were conducted on sheep and goat farms in the respective surrounding area (Figure 1). Data collection work was conducted from 28 June – 6 July 2017 starting with 2 days methodological training of student researchers from the project partner University of the South Pacific. Four students were trained on focus group discussions (FGD), three students were trained on household survey and on-farm data collection methods at MoA in Lautoka. Field testing of the survey and focus group discussion instruments was done one day before the start of the fieldwork, on a farm close to Lautoka. Final adaptations to the methodology were conducted after the field test.

Figure 1: Field work sites (on-farm survey) in Fiji visited during June/July 2017 (source GPS coordinates output KoBo Toolbox/google maps)

Participating farmers were invited by the local MoA representative. Pre-conditions set by the research team included that households were keeping goats and/or sheep, were small to medium scale sheep and/or goat producers that pursued SR production as a livelihood strategy, and represented different ethnic groups and genders. The gender and ethnic spreads of farmers who actually participated in the fieldwork are summarised in Table 3. The reported spread of annual income of respondents is summarised in Figure 2. The quantitative survey and FGD took place at a local MoA offices, and farmers had to make their own way there. Farmers were offered payment for their time and travel costs.

Table 3: Ethnic and gender description of farmers participating in survey and focus group discussion fieldwork

Location	Fijian Indian		iTaukei Fijian		Other		Total
	Men	Women	Men	Women	Men	Women	
Lautoka	4	-	2	-			6
Ba	7	-	5	-			12
Labasa (North) [1]	11	1	3	-	2	1	18
Labasa (South/West)	9	-	1	-			10
Nausori	2	2	-	-			4
Total	34	3	11	0	2	1	49

[1] 1 x European man, 1 x Korean man and 1 x Korean woman also participated at this fieldwork site

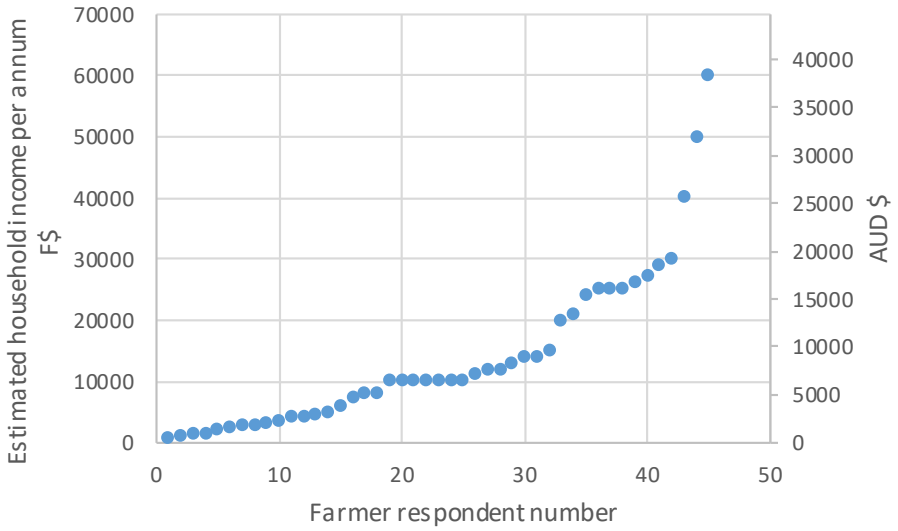

Figure 2: Distribution of annual household income of farmers participating in fieldwork survey and focus group discussions

Survey

For the creation and implementation of a questionnaire comprising of 225 quantitative and qualitative questions and data collection, Kobo toolbox - an open source software package, was used on hand-held tablets. The survey was tested, adapted and translated into Hindi and i-Taukei before the start of data collection. Individual interviews were conducted with 48 farmers (who were also focus group discussions participants) in all five fieldwork sites between 26 June and 6 July 2017. Where two members of a household participated in the fieldwork, only one contributed to the survey.

Figure 3: Student enumerator during a household survey interview in Labasa 03/07/2017

Farmers were surveyed on household demographics, land and assets, income sources and labour, sheep and goat flock numbers, purchases, mating, births, feed sources, grazing management, syndromic observations of animal health, gastrointestinal nematode (GIN) control, production costs, and marketing of sheep and goats. Surveys were

conducted by Indian Fijian and iTaukei Fijian enumerators in English, Hindi or iTaukei. Survey analysis was done in Excel and SPSS Statistics 24.

Focus group discussion

For FGD, participating farmers were arranged so that they were in groups of no more than six. FGD groups were arranged in the most homogenous groups possible according to the participants present on each day. Sometimes focus groups were distinguished by ethnicity/language, other times by enterprise size. Where two members of a household participated in the fieldwork, both were welcomed to participate in the FGD. The discussion was led by a trained student facilitator and a trained student scribe who were both fluent in the language of the group participants. A discussion topic guide was used to direct the discussion, and covered topics related to livelihoods and livelihood changes, household labour, purpose and benefits of keeping SR, access to land, farmer cooperation, and constraints that limit SR production. Discussion notes were transcribed immediately after they had concluded. These reports were later combined and analysed using NVIVO software.

Farm production benchmarking

At each of the survey locations, a sub-sample of 2-3 farms were chosen for farm production benchmarking, from the farmers who participated in the survey and focus group discussion, totalling 12 sample farms across all 5 fieldwork sites (Lautoka: 3 farms; Ba: 2; Labasa: 2; Dreketi: 3; Nausori: 2). The sample farms were selected by the local Ministry of Agriculture representative. Selection criteria were a small to medium scale flock size, availability at time of visit and accessibility (distance from workshop venue, road conditions, and travel time). Supervised by UNE researchers and Ministry of Agriculture staff, student researchers conducted an introductory survey recording village name and GPS location was taken, as well as sheep and goat flock sizes, last drenching date, and a photo of the animal shelter (if present).

At each farm, 20 mature animals were selected for measurement and sampling. The animal species (sheep/goat), sex, and lactation status was recorded. Body condition score was assessed visually and by manual palpation on a 1-5 scale (Villaquiran et al., 2004), and the animals were measured for body length, height at the withers and girth conducted according to the recommendations in (FAO, 2012). Any signs of ill-health were noted for each individual. A faecal sample (approximately 4 pellets/animal) was then collected from each animal from the rectum.

The twenty faecal samples were bulked according to species and stored cool until processing and analysis. Individual animal faecal samples (approximately 4 pellets/animal) were collected from 129 sheep and 117 goats respectively on all 12 sample farms. Samples were bulked according to species and stored cool until processing and analysis. Total WEC was analysed for the flock using a modified McMaster method (Whitlock 1948).

At each farm, pasture was photographed and height measured along a transect across the sample pasture (1 measurement every 20 paces, chosen by the PROGRAZE throw method (Bishop 1995)) in both the paddock where sheep/goats were currently grazing, and the paddock where they were next scheduled to graze (if known).

6 Achievements against activities and outputs/milestones

Objective 1: Assess the supply, demand and institutional support for improved small ruminant production in key countries (Fiji, Vanuatu and Samoa) in the Pacific region.

no.	activity	outputs/ milestones	completion date	comments
1.1	Conduct a workshop with the South Pacific Community (SPC) to identify key value chains and stakeholders in the region.	Report submitted by LPS/2017/027 project	29 November 16	A workshop was held at SPC. Key informants attended from SPC, MoA and FAO.
1.2	Rapid assessment of value chains for small ruminant animals and products in Fiji, Vanuatu and Samoa, identifying supply and demand.	Full details in this report	June 17	Geoff Smith conducted rapid assessments to Fiji (Viti Levu – Dec 16; Vanua Levu – June 17), Vanuatu (Feb 17) and Samoa (June 17). See report for details.
1.3	Assess institutional capacity to improve small ruminant production systems in Fiji, Vanuatu and Samoa, including government institutions, private sector companies and key personnel who could contribute to improving small ruminant production systems.	Full details in this report	June 17	Key informant interviews were conducted in Fiji (Dec 16), Vanuatu (Feb 17) and Samoa (June 17).

PC = partner country, A = Australia

Objective 2: Describe existing small ruminant production and marketing systems in Fiji, and identify constraints to and opportunities for developing profitable smallholder production systems.

no.	Activity	outputs/ milestones	completion date	comments
2.1	Conduct a workshop reviewing past, current and future ACIAR-funded and related research on small ruminant production and marketing systems.	A Research Workshop Report – 'Goat Production and Marketing in South East Asia and the Pacific' was delivered to ACIAR by LPS/2016/027 in December 2016	7-8 November 16	A workshop was conducted in conjunction with the Laos Goat SRA LPS/2016/027. Geoff Smith, Fran Cowley and Michelle Carnegie (UNE) contributed, as did Ilagi Puana from SPC. Out of the discussions in this workshop, Michelle Carnegie was added to the project team of LPS/2016/027.
2.2	Identify key small ruminant production zones in Fiji.	Full details in this report.	December 2016	Informed by MoA sheep and goat report data and key informant interviews.

no.	Activity	outputs/ milestones	completion date	comments
2.3	Map points of value addition and commercialisation in the key marketing chains from these production zones, and spatial and seasonal variation in supply and demand.	Full details in this report.	July 17	Seasonal variation in supply and demand was assessed in a survey in June/July 17. Opportunities for value addition and commercialisation were assessed in key informant interviews in Viti Levu and Vanua Levu.
2.4	Describe typical production systems and calendars for small ruminants in these key production zones.	Full details in this report.	July 17	Data was collected in surveys and focus group discussions in the Western, Northern and Central Divisions in June/July 17.
2.5	Identify constraints and potential interventions and research needed to improve the efficiency and market-focus of small ruminant production.	Full details in this report. Phase I for a full project will be submitted to April IHR.		Data was collected in surveys and focus group discussions in the Western, Northern and Central Divisions in June/July 17. Analysis of qualitative data was completed in October 2017. A workshop with key stakeholders was held in Fiji in November 17 to agree on strategies for a Phase 1 project proposal.

PC = partner country, A = Australia

Objective 3: Develop a typology of small ruminant producers in Fiji, and assess the constraints to and opportunities for small ruminant production improving the livelihoods of poor smallholder producers including women and marginalised groups

no.	Activity	outputs/ milestones	completion date	comments
3.1	Describe the types of small ruminant producers and their livelihood strategies in key production zones.	Full details in this report.	July 17	Data was collected in key informant interviews in Dec 16 and June 17; and surveys and focus group discussions in the Western, Northern and Central Divisions in June/July 17.
3.2	Identify benefits, constraints, opportunities and potential interventions in small ruminant production to improve the livelihoods of poor smallholder farmers including women and marginalised groups.	Full details in this report.	Expected October 17	Data was collected in surveys and focus group discussions in the Western, Northern and Central Divisions in June/July 17. Analysis of qualitative data reported here. Despite specifically requesting that women farmers be invited to participate in the data collection activities, only one woman farmer attended, and so reporting on the benefits, constraints, and opportunities for women farmers is derived from interviews with men farmers. See Section 7 for critique of why this occurred and what was learned from this.

Variation 1:

Objective 4: Conduct targeted capacity building in participatory research approaches and technical capacity for the sheep and goat sectors of Fiji and Samoa, jointly with LPS/2016/027 (Laos/Vietnam)

no.	Activity	outputs/ milestones	completion date	comments
4.1	A two-week training course will be held at the University of New England, for 6 participants from the Pacific, together with 4 participants from Laos.	A two-week training course held	March 2018	The Small Ruminant Partner Workshop 2018 was successfully implemented 18.2.-2.3.2018. and led to the development of 13 detailed Action Plans for be implemented in the participant's workplace upon their return to their home countries. The workshop was also used to facilitate research proposal development of follow up research activities to the participating ACIAR funded projects (LPS/2016/021) and LPS/2016/027). In addition cross-project networking and learning opportunities were highly appreciated by participants and project leaders.
		An evaluation report on the use of action-plan based training for capacity building	June 2019	The final part of section 11 in this document reports on the progress of the 13 Action Plans developed. It is based on the feedback returned by 8 of the 13 Small Ruminant Partner Workshop Participants. While only a third of the Action Plans was implemented (due to external influencing factors) an action plan based training does have potential to be used as capacity building method in research projects.

Objective 5: Develop a formal research proposal for ACIAR-supported sheep and goat production and marketing research in Fiji and Samoa

no.	Activity	outputs/ milestones	completion date	comments
5.1	Preliminary partner consultation workshop	Preliminary Proposal	February 2018	A 1.5 day preliminary partner consultation workshop was held in Suva on 23 & 24 November 2017. Agenda is presented in Appendix 2. From this a Phase 1 proposal was submitted to ACIAR and approved for full project development
5.2	Final partner consultations	Full proposal	January 2019	After IHR review of the Phase 1 consultations were held in Fiji and Samoa to refine the project document which was submitted as a full proposal to ACIAR and was approved in Sept 2018.

7 Key results and discussion

Reporting in this section is a synthesis drawn from all methodologies described in Section 5, including desktop and literature review, key information interviews, focus group discussions, quantitative surveys and on-farm sampling.

7.1 Literature review

The University of the South Pacific conducted a review of industry statistics and research conducted in the Pacific SR sector since 1990. The full literature review can be found in Appendix 1. An abstract is presented here:

Due to the many benefits of sheep and goats, countries in the South Pacific have introduced these ruminants to help diversify and strengthen their farm outputs. However, many farmers still face deterrents to sheep and goat farming. Issues affecting regional agriculture include farmers migrating to city work, lack of access to investment capital, land tenure issues which lead to lack of available land, and lack of infrastructure and transport. Issues specific to livestock include lack of adequate management of imported genetic breeding stock, poor nutrition and disease of livestock, and poor management skills, and a limited number of trained personnel and veterinarians.

Sheep and goat production in the region is based on grazing. Much research on sheep and goat performance using Batiki or Guinea grass as the basal diet and examining the potential use of forages and agricultural by-products has been conducted. The value of these forages and by-products however is limited to their availability and farmers' ability to access them. Forages seem to be the better option for farmers since these can be planted and maintained relatively inexpensively and their availability made constant throughout the year. In contrast, by-products may not be readily and inexpensively available particularly to small holders who may not have access to transport of bulky feedstuffs. Furthermore, as seen in many published data, the nutritional value of many by-products varies according to season and processing techniques. It is unlikely small holders will have the initiative and capital to undertake a proximate analysis of the feedstuffs to determine ideal inclusion levels in the diet of sheep and goats. A further limitation to the published data is the small number of animals and short duration of trials in some instances. In addition, evidence on the effect of milk yield and carcass qualities are lacking. The effects of long term use of these by-products on animal performance is difficult to determine given some of the limitations stated. Finally, conflicting use of a resource with human nutrition will result in the diversion of such a resource for human consumption as is the case for breadfruit.

Disease and parasite management play an important role in the successful implementation of sheep and goat farming in the region. Given the warm, moist environment it is not surprising that internal parasites are among leading causes of economic loss to farmers. The prominent internal parasites in Fiji and Samoa include *Haemonchus contortus* and *Trichostrongylus colubriformis*. Though no data on economic loss due to internal parasites was available it has been identified as a major setback to sheep and goat farming in Samoa and Fiji. The Fiji Fantastic sheep is reported to have a heritability of 30 % in terms of internal parasite resistance. Samoa has also reported the Fiji Fantastic sheep performed better than Dorpers comparing their resistance to internal parasites.

7.2 Fiji Sheep and Goat industry

7.2.1 Institutional and policy environment

Policy

After many years of political disruption, Fiji held elections in 2014 under a new Constitution and electoral system aimed at stability and inclusiveness. The agriculture sector as a whole contributed 7.6% ($ 485.4m) of Fiji's total GDP in 2014 (Krisitiana 2016), declining from approximately 16% in the 1990s. Despite this, the sector employs close to two thirds of the labour force, indicating that productivity is low. Recent challenges have included the decline in the sugar industry, inability to cope with trade liberalization, natural disasters, pest and disease outbreaks, export trade restrictions, and dumping of imported product, political instability and inconsistent public sector support (Box 1, Box 2). Agriculture, forestry and marine ecosystems are under threat from increasing population pressure and the adverse effects of climate change.

The Ministry of Agriculture released a draft Livestock Sector Strategy in March 2016, to provide a plan for the next 10 years, aligned with the Fiji National Agriculture Policy 2020. The 2020 Agriculture Policy prioritizes six livestock commodities, including sheep. Livestock contributed $48.3m to total GDP, with a declining growth rate of -3% from 2010-2014. Livestock was calculated in 2015 to contribute 10% to the total Agriculture GPD, which is dominated by sugar cane (52% of Agriculture GDP - Fiji Agriculture and Rural Statistics Unit). Official statistics show sheep and goats to be a relatively small proportion of agricultural GDP. However, the informal nature of markets for sheep and goats suggest the true scale may not be captured by official figures. Sheep and goat meat represent the greatest trade imbalance of any livestock product with local production satisfying only 12% of domestic consumption.

The share of subsistence farming and sugarcane production has shrunk in the economy, while the shares of other crops and livestock (beef, dairy, pork, poultry, goat and bee stocks) have increased over the past decade, indicating a gradual transformation from semi-subsistence to semi-commercial farming. Although the MoA has traditionally provided considerable support for subsistence farming, the Livestock Strategy tasks MoA with a focus on commercial agriculture aimed

Figure 4: Poster from Central Division Agriculture Show 'Climate Smart Agriculture for Fiji'

Box 1. The policy makers view: A time of change for Fijian Agriculture

"The number of goats has decreased substantially since 2000, due to the expiration of land leases for cane farmers. As a result prices have almost doubled."

"The MoA livestock sector strategy comes at a time of change for Fijian farmers. Access to land is a very important constraint, especially for cane farmers with expiring leases. However, most cane farmers are leaving the cane sector even if they have access to land due to lifting of price controls. These farmers need to be resettled into new sectors such as cash crops or livestock"

- Acting Director, Division of Animal Health and Production

at competing with imports, while providing supportive roles, such as training and advisory, to other Ministries involved in community development, livelihoods and social services.

The Livestock Sector Strategy has four outcome goals*: Improved governance, Competitive value chains, Sustainability and resilience,* and *New generation opportunity*, and sheep and goats have been identified as important means of achieving these goals (Figure 4).

The *Improved Governance* outcome includes improved delivery of agriculture support services and a proposed funding model for the Fiji Crop and Livestock Council (FCLC, see also *Producer Associations*, below). The role of the FCLC would include provision of market and other information services, advocacy, and possible roles in quality assurance, market linkages and paraveterinary services. The FCLC would also have a role in approving research supported by a proposed R&D fund.

The *Competitive value chains* outcome aims to develop integrated infrastructure and modernise agricultural systems, increasing the livestock balance of trade by F$1.5m. Livestock GDP growth is targeted at 3%. As well as the funding and role of the FCLC mentioned above, the *Competitive value chains* goal specifies research, development and extension that is responsive to industry and, for sheep and goats the criteria for evaluating potential interventions are; the involvement of smallholders, reducing poverty and import substitution. Other important activities that align with research are strengthening value chain linkages, training in farming as a business, and linking smallholders to markets

The *New generation opportunities* outcome aims to increase labour productivity and the proportion of women in employed in livestock value chains from 7 to 30%.

The *Sustainability and risk management* outcome aims to increase the contribution of livestock to domestic meat supply from 53 to 60%. The Sustainability and Resilience goal specifies R&D to promote stress tolerant feed resources as well as promotion of small livestock for household food security.

Box 2. The farmers' view: The changing economy

Most farmers agreed that the cost of living, including daily commodities, is increasing every year. The price of labour also increased. Because labourers are becoming increasingly scarce, they have considerable power to negotiate for conditions that suit them. For example, labourers may only want to work for limited time, and they may refuse to work in hot weather. Fencing material is slowly going up in price. The prices for small ruminants fluctuate: they can go up and down, while the price has risen for all other commodities required for small ruminant farming, especially fencing materials.

But at the same time, farmers' experience is that some government services have improved and become more accessible, for example, the free education for their children, pensions, wages, social welfare, which has lifted or lessened the household burdens. Another example of government assistance is provision of solar power in areas without electricity, which has helped children to study at night. Also farmers are now able to access clean and safe water that was previously unavailable in their rural area.

Access to finance

Finance for small ruminant value chains is available through the Fiji Development Bank (FDB), but there has been a sharp decline in lending for agriculture from F$120m in 1993 to F$14m in 2012. There are products aimed at livestock that include goats in a list of species, (interest rates ~ 8-11%)[1]. There is concessional funding available (lower interest rates) for import substitution, but the only livestock species specifically mentioned are

[1] http://www.fdb.com.fj/pages.cfm/our-products/agriculture-sme-loans/livestock.html. *Accessed March 2 2017.*

cattle. Farmers in the Northern Division reported that they can access loans through commercial banks and the Northern Development Program (NDP).

Of SR farmers surveyed in fieldwork, 35% had borrowed money to spend on their SR flock. Constraints to lending identified include lease documentation, remoteness, poor financial literacy and management practices, and disaster risk. Interest-free loans from extended family, friends, and adult children, including via overseas remittances, appear to be the most common source of credit, as opposed to loans from commercial banks (Box 3).

Box 3. The farmers' view: Access to finance

Ba (Western Division) Farmer 6 had difficulty in obtaining funds in order to expand his farm. FGD7 (Farmers of with flocks of less than 50 head around Lambasa, Northern Division) stated that the process of obtaining finance from commercial banks is daunting and requires professional help and proposals which requires a lot of money, and documentation such as property papers. Some farmers reported paying for professional consultants to assist with loan applications.

FGD7 (Northern Division) noted that it is very hard to obtain loans from sources such as banks for many farmers since their farm is not that well established and it is difficult to provide evidence of farm profitability.

FGD6 Farmer 2 obtained a $70k loan from the bank and had to pay $15k per year in interest but knew that it would be impossible to pay back the interest with the available stock he had.

The decline in FDB lending may be indicative of other sources of finance becoming available. Fiji Sugar Cane Growers Fund small loans are available for diversification (including livestock), and it is noted that a large number of organisations had matched grant funding and loans available for landholders. This large variety of funding and finance options can make it difficult for lenders to assess landholders' situations with regards creditworthiness and has made it easier for landholders to become overcommitted (Box 3).

Land tenure and investment

Land tenure and access to land is a primary motivating force in Fijian politics. Successive military coups have occurred in response to the election of Indo-Fijian governments with land reform agendas, leading to thousands of cane farm land leases not being renewed in the early 2000s, and emigration of a significant proportion of the Indo-Fijian population (Dodd 2012). The government acknowledges the non-renewal of land leases is a problem for livestock production; "It has been evident that the expiry of land leases has significantly reduced the amount of agriculture land available for livestock and to the decrease in livestock numbers." (Fiji Ministry of Agriculture, 2009).

Table 4. Fiji Census population demographics

Population	1996	2007
iTaukei	393,575 (50.8%)	475,739 (56.8%)
Indo-Fijian	338,818 (43.7%)	313,798 (37.5%)
Other	42,648 (5.5%)	47,734 (5.7%)
Total	775,077	837,271

Source: Fiji facts and figures

Land tenure and access to leases was frequently cited by farmers and key informants as one of the greatest limitations on investment in livestock enterprises in Fiji (Box 4). Land tenure in Fiji is classified into several types. Freehold land comprises about 8% of land area and state land about 5%. The remaining 87% is *iTaukei* (formerly called Native) lands that are either leased under a western type formal system (~30%) or are under Vakavanua, or mataqali (~clan) customary land tenure arrangements (~60%) (Figure 5; (Fiji Ministry of Agriculture 2009; Dodd 2012; United Nations n.d.). Formal land leases are controlled by the iTaukei Land Trust Board (TLTB) and are for a maximum 99-years, but

for agricultural leases the maximum is 50 years. Traditionally, many of these leases were to Indo-Fijian cane farmers, and individual leases covered areas of 200-300 acres. As these leases expire they are reverting back to native lands and are becoming available for lease again. New leases are commonly 30 years, with an option for a renewal of 20 years. Formal TLTB leases make up only 17% of agreements but account for 35% of area. Mataqali tenure is the opposite, accounting for 65% of farms but only 35% of farm area (Figure 5). Most of the formal leases are in Northern and Western Divisions, with Eastern and Central Divisions being predominantly mataqali leasehold land.

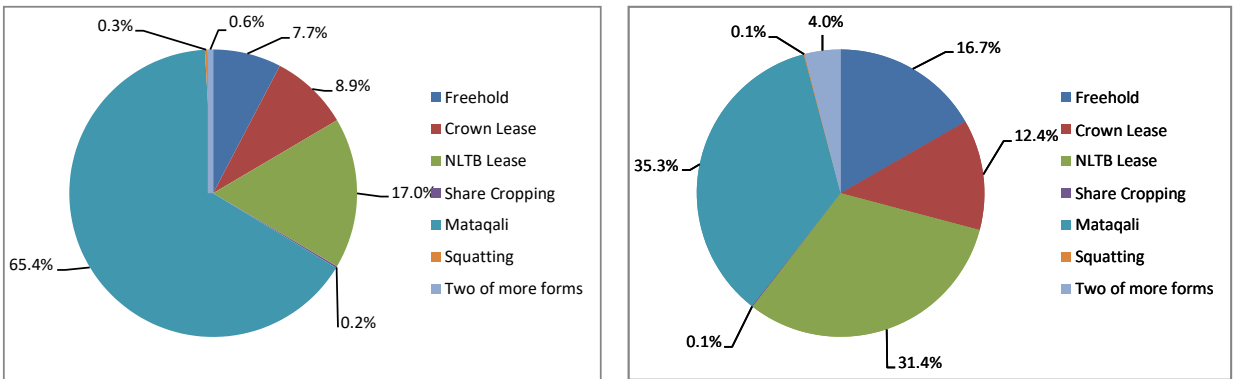

Figure 5: Farm land tenure in Fiji a) according to number of farms (%) and b) according to farm area (%)

In many low- and middle-income countries, small ruminants are often held by landless farmers in zero-grazing or transhumant production systems (Devendra 2010). Estimates of landlessness in Fiji are varied. For iTaukei Fijians, who have customary rights to land through their *mataqali*, this is only a small number: the Native Lands Commission estimated 5,520 iTaukei Fijians did not own (or have rights to) land (Reddy and Lal 2002), although in practice, this may be much higher as a result of inter-island and rural-urban migration (Naidu 2009). In contrast, over 50% of non-iTaukei Fijians are landless (Reddy and Lal 2002). Because of customary title, landless non-iTaukei people in Fiji without leasehold land do not have ready access to grazing lands, and so there is no substantial group of landless small ruminant farmers in Fiji.

There are large areas of native lands which are not leased for farming, nor are utilised by the iTaukei owners. However some mataqali experience land shortages, when clans grow, but their mataqali land area is fixed. In these cases neighbouring Mataqali will be approached to lease land by the gifting of a *tabua* (whale tooth) and an arm-length *yaqona* (kava root) in a traditional ceremony to formalise the arrangement. There is no other payment made for this arrangement. Mataqali lease is also an alternative to TLTB leases for non-iTaukei people. This is generally no more than 5-10 years in length and the lease may be paid in cash, or in kind, for instance, delivery of 1 cow each year (value ~$1000).

In response to underutilisation of much land and problems with the TLTB, the Land Use Unit was created in the Department of Lands. Its

Box 4. The farmers' view: Access to land

Large commercial farmers in northern division who had applied for land leases to expand their farms complained that the processing of their application by the NLTB either took too long or was unreliable with no guarantee of leases being issued in a transparent manner.

Several livestock farmers interviewed were pursuing the opportunity presented by available land by combining many small parcels, however they complained of the difficulty in securing leases. One of these farmers had been trying for several years and had complained to his member of parliament, another had spent more than FJ$15,000 in bribes to speed up the process. One said that he had applied and fully paid for a lease but the NLTB then gave that allocated leased land to another farmer, and he lost his money in the process.

One farmer recounted that he has a 30 year land lease about to expire in the next 30 days, but he was still negotiating with the government and the mataqali.

functioning and efficacy was reviewed by Dodd (2012). New leases with the iTaukei Land Title Board (TLTB) require a 5-year farm plan with the agricultural lease application. The TLTB has an MoU with MoA, that provides oversight of the lease. The MoA can issue a certificate of 'Bad Agricultural Practices' which allows MoA intervention.

The Sugar Cane Growers Council (SCGC) negotiates with TLTB to enable efficient renewal of leases for cane growers. Groups of growers surrender leases several years early so that there is no decrease in production coming up to the lease renewal date. Land lessees then negotiate with TLTB and the land owning unit to enable renewal well before expiry. The extra time allows clearance of all rent arrears and more complex transitions such as the next generation of farmer taking over the lease (SCGC 2017).

Several factors are causing the low rate of renewal of land leases. Sugar farmers have experienced declines in productivity due to poor management practices and lower sugar prices due to reforms in the EU sugar quota system (Fairtrade Foundation 2016). Leases are also not renewed by owners (lessors) as the returns to owners are often very low (Dodd 2012). Many goat and sheep farmers interviewed were former sugar cane farmers, and listed land leases and a lack of available labour as reasons for abandoning cane farming. One farmer described cane farming as contracted slavery. The decline in cane growing has caused a significant displacement of former cane farmers to urban areas.

Small ruminant farmers engaged in our project fieldwork described a variety of land tenure types (Table 5). For all but 2 of the 48 survey participants only one tenure type was recorded per household. The most common land tenure types were freehold (35.4%), mataqali lease (35.4%) followed by TLTB lease (31.3%) and few households with village/clan owned land (4.2%). Details on land sizes and lease durations were also recorded. The land area used for small ruminant production varied greatly with an average of 45 acres/farm (range 1-1500).

Table 5: Land tenure details of the farms participating in the household survey (n=48)

Land tenure type	**Land size/farm (acres)**		
	average	min	max
Freehold (n=17)	56.7	11	140
Mataqali lease (n=17)	159.4	1	1500
TLTB lease (n=15)	70.6	2	387
Lease type	**Lease length (years remaining)**		
	average	min	max
Mataqali lease (n=17)	30.3	12	91
TLTB lease (n=15)	33.3	13	99

The TLTB has been plagued by inefficiency and lack of accountability. Several staff have been jailed for fraud, although improvements have been attempted in the last decade (Dodd 2012).

Land tenure is a major problem for some Indo-Fijian farmers, especially those without freehold land. For some farmers the small size of their leased land limits the flock size, their ability to expand their farms, and hinders their long term goals for their farm enterprises. Some farmers have problems renewing their land leases, and especially

doing so in a timely manner. It is a common problem that new land leases can sometimes take years, and cost thousands of dollars for the lease payment and all other associated costs of making an application to the TLTB. Farmers expressed their frustration, as they are aware of TLTB lands that are idle and not being used.

Despite recent reforms the system remains problematic and politically sensitive (Dodd 2012).

Producer Associations

The Fiji government has recently mandated the establishment of producer associations for key agricultural commodities. These producer associations fall under the umbrella of the Fiji Crop and Livestock Council (FCLC). The progress in the development of these associations into functional bodies is slow, and hampered by a lack of funding. As recognised by FCLC, producers need a clear reason to become involved in producer associations. These may be better organised regionally, by divisions, instead of nationally.

Fiji Crop and Livestock Council

The Fijian government has mandated the establishment of industry bodies that aim to strengthen and restructure the non-sugar agriculture industry. The Fiji Crop and Livestock Council (FCLC) was established in 2013 funded under a 3-year project by the International Trade Council. Its funding by ITC ends in December 2016, but funding will continue from the government. The mechanism and funding is outlined in the Agriculture and Livestock Strategies. FCLC was established to provide an industry umbrella and the first years have focussed on setting up the structure and registering farmers. The chairman of the FCLC sits on a parliamentary Secretary level facilitation committee for agriculture. The committee is very powerful, for example, there are timeframes in which the Minister must respond.

FCLC has 6 staff and approximately 33,000 registered farmers and still recruiting. Of these 2,500 are commercial farmers. They have setup commodity associations for ginger, coca, rice, organics, beekeepers, pigs, copra, grazing livestock, fruit and veg, and exporters.

FCLC is aware of the need to begin building activity with the associations. The first will be the provision of information, however the funding and mechanisms to do this are still uncertain. The database still resides in Europe as part of the EU project that began the formation. FCLC has had some success stories, such as work with ginger farmers on value chain training - after interacting with buyers they were able to change the mindset of growers into a market focus.

Grazing Livestock Association

The Grazing Livestock Association was established under the FCLC in 2016. It has an interim president (Anil Goundar, a sheep farmer and restauranteur), but has no subscribed members, committee, or activities as at December 2016. Coordinating membership enrolment and logistics for meeting with producers have been difficult. Grazing livestock are all in one association as there are not large enough numbers to form separate associations. Most farmers interviewed in this project had several species of livestock, however some said they had only registered with FCLC as cattle producers, so how well the data will capture small ruminant producers with small numbers of animals is uncertain.

Sugar Cane Growers Council[2]

Sugar is the largest sector of the Fijian economy and employs 25% of the workforce. Goats and sheep are traditionally integrated with cane growing in Fiji due to their similar agro-ecological requirements (Figure 6), the suitability of small livestock to grazing in and around sugar crops, and the traditional role of Indo-Fijians as both growers of cane and consumers of goat meat. There were 12,632 active cane growers in 2013, located throughout the cane growing areas on the north western coastal regions of the two main islands. As well as representing interests of growers, the council assists with renewal of leases, research and education and financial functions. Importantly, the council is tasked with assisting growers with agricultural diversification, and small ruminants are a specific strategy for SCGC to achieve this goal. The EU has contributed significant funding to diversification of sugar growers through the SCGC.

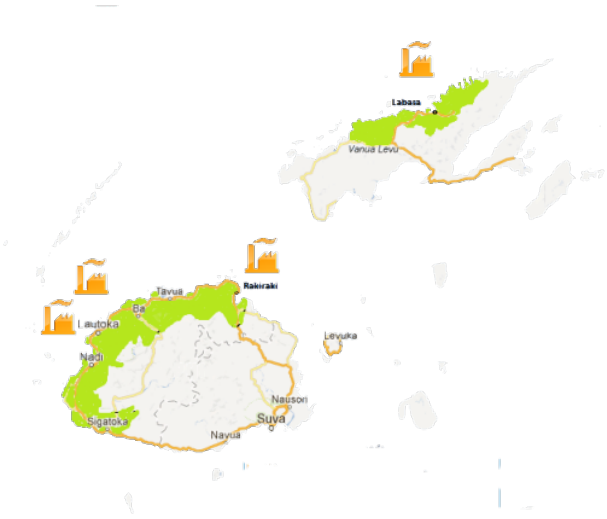

Figure 6. Location of cane growing areas in Fiji.

7.2.2 Extension and farmer support services

The MoA is responsible for extension services to sheep and goat producers in Fiji. There is only one division in MoA for animal health, animal production, research and livestock extension services (DAHP), unlike the cropping sector, where these roles are coordinated by separate divisions. The MoA in Fiji has national coordinators for sheep and goats. These coordinators are primarily responsible for collecting quarterly data on livestock numbers from supervised farms on top of other activities in clinics and extension work.

There is a DAHP office in each district, which contains Livestock Extension officers. These extension officers cover all livestock species, but are very few in number. It was estimated by key informants in MoA that the ratio of extension officers to farm clients may be 1:2500. These extension officers also act as paravets. They provide advice free of charge, and sell drugs to farmers. The MoA extension staff usually have a Diploma-level qualification. SPC runs paravet refresher courses every few years, which are funded 50% by the host country.

The view was expressed by extension staff that farmers are more ready to make practice changes or adopt extension messages if it is associated with a new technology, rather than a better way of doing old things.

The MoA co-funds development projects for sheep and goat farmers, providing partial funding for infrastructure or technologies. The co-fund percentage varies according to circumstances between 25 and 75%. Until early 2017, there was a minimum breeder flock size of 25 ewes or does for farmers to become eligible to receive this government support. Realising that this excluded many smaller farmers, MoA has now revised its approach to providing support.

The new MoA approach to financial support is now based on soon-to-be-established farmer clusters. Farmers will likely be grouped in clusters of ~20 households (by sub-sector and location), or will be asked to form groups if they wish to apply for funding.

[2] *http://www.sugarcanegrowerscouncilfiji.com*

These clusters will receive MoA funding, and will be responsible for distributing that funding among their members. It is envisioned by MoA that the clusters will offer the opportunity for sharing of genetics, and group marketing. This new development offers a research opportunity in the formation and success of farmer groups.

In a survey of farmers during the development of the Fiji Livestock Strategy, 30% of farmers reported having been visited by an MoA officer. Nevertheless, the FGDs reported that farmers' productivity is severely hampered by a lack of access to technical assistance and extension services, and to necessary inputs (Box 5). The frustration expressed by farmers is multi-factorial. There are no private providers of animal health service or inputs, but until 2019, there were no government veterinarians in small ruminant farming areas, and MoA is the only distributor of drugs, drenches, castration rings etc. in Fiji. The MoA provides extension services, paravet services and inputs free or at minimal charge. Government budgets therefore limit the availability of inputs and staff. As is experienced in almost all countries, to maintain system integrity, government distribution systems are necessarily bureaucratic, and therefore lacking in agility. This, together with limited staffing, affects the timeliness and responsiveness of MoA services. The examples provided here (Box 5) reflect farmer frustration that MoA has insufficient human and other resources, and that they have no alternatives to choose from. Nevertheless, DAHP is staffed by mostly young officers, who work long hours for relatively low salaries, and who are dedicated and passionate about their work, and keen to build their own skills so that they can better serve their fellow Fijians.

7.2.3 Research Capacity

Ministry of Agriculture – Department of Animal Health and Production (DAHP)

Building of capacity, in particular for research, is a serious need in the Fijian Livestock sector. The Ministry of Agriculture has identified this as one of the greatest impediments to their ability to bring about change, and one of the key areas where Fiji would benefit from an ACIAR project in this area. Key areas of research weakness identified in interviews with MoA staff include:

- Experience and knowledge in experimental design

Box 5. The farmers' view: Extension services

All farmers stated that medicines, equipment and new breeds that MoA are supposed to provide are often unavailable.

"Available medication for treating diseases is lacking."

"MOA does not have breeders available to cope with the demand of farmers."

"The government doesn't provide seed, herbicides or advice on pasture management."

Farmers perceive that the technical assistance that is provided is inadequate and insufficient, and in the case of vets, unaffordable. They are of the view that many extension officers have limited knowledge of small ruminant farming and breeding. Farmers also felt that these officers should get to know all the farmers well.

"The staff in MoA are not technically qualified."

"There are no qualified pasture engineers. They have no experience and are not experts in the pasture area."

"There are no qualified and experienced vets and the vets are also very expensive to hire"

Farmers perceive that MoA are slow to respond to farmer requests for assistance and advice. Farmers report that they have difficulty getting MoA to visit their farm to treat their sick animals, but also to do so in a timely manner. One Western Division farmer was in this situation and had asked MoA if he could get the medicine to treat them himself, but his request was declined. Another farmer in Western division stated:

"Medicine is not available on time or at the right time and this causes animal deaths."

Farmers in Northern Division stated that if farmers wanted the MoA extension officers to visit their farms they have to pick up the officers from Labasa and take them to their farms. Farmers stated that MoA officers are not readily available and timeliness is a problem.

"If you want an official to visit your farm then we [the farmers] have to provide the transport or fuel costs [for MoA officers] and cater for their needs."

"If a farmer's need arises then he personally has to provide for the transportation of the officials to his farm and back."

- Confidence in applying innovative thinking
- Lack of facilities for conducting livestock research at USP and MoA research stations
- Lack of staff with post-graduate training (only the acting Director (M.Sc) and Principal Research Officer (Grad. Cert.) in DAHP), and few post-graduate students coming through the universities. USP is the only university that offers post-graduate degrees, although FNU is developing a Masters program for Animal Science. The USP agriculture campus is in Samoa. Those students who are completing post-graduate qualifications are self-funded.

The Division of Animal Health and Production (DAHP) of the MoA has two sections, Livestock Production and Livestock Feed Technology (which covers pasture development). Activities cover both research and extension. The livestock research stations are staffed by a Principal Research Officer and a senior research officer, both based at Koronivia Research Station, and 6 research officers (one for each livestock sector). The sheep research officer is based at Nawicoba Research Station, Nadi. The goat research officer is based at Sigatoka Research Station. The primary tasks of these research officers are managing the breeding of nucleus flocks at Nawicomba, Taveuni and Sigatoka Research Stations, and updating records of current and new breeding stock at the research station.

Research Stations

The Ministry of Agriculture operates four sheep research stations and one goat research station across Fiji's three main islands. These facilities are more rightly considered nucleus breeding centres, as their main purpose is to breed improved breeding stock, which are then sent out to multiplier flocks.

The livestock research officers are given a budget each year. In 2016, the budget for sheep research and development was $170,000, to cover the operations and salaries of three research stations, including management of the nucleus breeding flocks. In 2016 and 2017, the research focus is on small scale silage production. DAHP conduct research both on-station and on-farm with partner farmers. Collaborating farmers are utilised for demonstration sites and for farmer field days. When selecting partner farmers for on-farm research, MoA staff apply a criteria of a minimum five-years farming experience, a secure land lease, and ask farmers to sign an MoU or agreement. Partnering farmers do not receive payment or incentives to collaborate with research.

Research scientists extend the findings of their research with training of trainers of locality livestock officers and paravets. They also engage extension staff in this training of trainers.

When asked about challenges that the MoA research stations face in conducting research, two problems were nominated. Firstly, the research stations face challenges in obtaining disease-free stock for research purposes – this applies mostly to cattle, which are affected by bovine tuberculosis (BTB) and brucellosis. Secondly, procuring sufficient labour to complete research tasks can be a challenge. Research officers are not able to place research station staff on research projects without the written approval in advance from the Permanent Secretary of the Ministry of Agriculture. This can cause significant challenges, if additional staff are needed to be temporarily redeployed to complete other activities, even if for only a short while.

Nawicoba Sheep Quarantine Station (NQS) has a large area of which 1000 acres are currently utilised (Leslie 1984). Its sole purpose is as a multiplication facility for the MoA nucleus sheep flock. Stocks are usually between 600-800 head of sheep (and some

goats). Nawicoba is charged with supplying breeding sheep to farmers in the Western Division.

Nawicoba Quarantine Station has a large sheep shed with around 12 small group pens, which may be suitable for small scale pen-based research if necessary. Nawicoba Quarantine Station has 52 paddocks which it normally utilises in with four groups of sheep and goats on a 4 day, 11 paddock rotation as a means of worm control. Until recent years, all stock were drenched with anthelmintics every 21 days using a rotation of Haloxon (Loxon), Fenbendazole and Levamisole (Nilverm). Sheep at NQS display high faecal egg counts, in the range of 1000-3000, even after drenching. Drench resistance testing is needed to confirm.

Nawicoba Research Station has a staff of 11, lead by an Agricultural Officer, and supported by a staff of stockment and labourers.

Sigatoka Research Station (SRS) conducts research covering a range of livestock and crop commodities. The principal MoA goat breeding nucleus is held at SRS, and it is also a MoA base for beef and pasture research. Sigatoka has a large research staff.

Mua Sheep Research Station is on the island of Taveuni, and being more isolated is less engaged in research activities.

University of the South Pacific

USP is funded by several PICT countries, including Samoa, Vanuatu and Fiji. The main agriculture campus of USP is in Samoa, however, the bulk of USP agriculture students come from Fiji, and conduct their studies at the Suva Laucala campus by distance learning. USP has recently moved Dr Poasa Tabuaciri from Samoa to the Suva campus to provide greater engagement with agriculture students in Fiji and to help reduce attrition rates.

The research office at USP gives internal grants to encourage USP researchers to collaborate with governments in its key countries of activity. So far, few of these grants have been given to the School of Agriculture. A future ACIAR research project would provide the impetus for conducting collaborative research with the Ministry of Agriculture, thus fulfilling strategic aims of USP.

As the USP Faculty of Agriculture is based in Samoa, they have few facilities (farms or labs) in Fiji. However Animal Science students and staff are able to use the chemistry and biology faculty labs. When animal research is conducted, USP normally partners with the MoA research station to conduct experiments.

USP has 600-800 undergraduate students in its B.Ag.Sc degree. This degree offers majors in agribusiness and applied science (with streams in crop and animal science in the latter major). There is only one unit of animal science presented at the Suva campus, and students must go to the Samoa campus to complete the animal science stream. It does not have a veterinary science degree. Animal Science at USP Laucala campus usually has 1 Masters student (privately funded) and 2 post-graduate diploma students each year. USP have a need for scholarships to fund post graduate students. A future ACIAR research project would be able to offer junior scientists working on the project the opportunity to complete Masters degrees with USP.

In summary, USP has experienced and knowledgeable staff, and although the research facilities in Fiji are limited, there is the opportunity to collaborate with the Science Faculty.

Fiji National University

Fiji National University (FNU) was established in 2010 when several government run colleges were consolidated into one University. The Faculty of Agriculture is based on the campus of the old Fiji College of Agriculture. It offers a 5 ½ year degree in Veterinary

Science and Animal Husbandry (BVSc) (the first in Fiji) and 3 ½ year degrees in Animal Husbandry (BSc AnHus) and Agriculture (BScAg).

FNU is funded by the Fijian government, and the Faculty of Agriculture has received large (~FJ$5 million) grants to build and equip new laboratories.

FNU is mostly staffed by expatriate staff. Most staff have been recruited since 2014. These staff have a significant proportion (~40%) of their time available for research, but to date have had limited opportunities to engage in, or experience in conducting research, and should be considered to be in a phase of building up their research experience and portfolios. As most of the staff are not local Fijian-born or raised, they have few contacts in Fijian agriculture or amongst key stakeholders. This also limits their knowledge of local production systems. However FNU has significant goodwill and support from the Government.

FNU has received significant government and international support to build and equip new laboratories for teaching Veterinary, Animal Science and Agriculture students. They have very well equipped laboratories, with more equipment still under procurement. Technicians were not available to speak to us on our visit, but it is likely that capacity building will be required for FNU to fully utilise all their equipment. Their laboratory equipment compared well with that at USP or VPL, but their capacity to use it is likely lower.

FNU has a research farm at their Koronivia campus in Suva. It is well stocked with sheep and goats, although it does not have animal house facilities. The Dean expressed a desire to develop these animal facilities in the future.

FNU does not have post-graduate students (although a Masters program is in development), but their BVSc and BAg students do final year projects and may be able to participate in research.

In summary, FNU has very good laboratory facilities, but low technical capacity to put them to use. The academic staff cover a good range of animal health and husbandry expertise, but lack local contacts or experience, particularly in on-farm research. FNU could benefit from capacity building by participating in an ACIAR project if there was interest from the staff and support from the administration.

Fiji Veterinary Pathology Laboratory

The Fiji Veterinary Pathology Laboratory (VPL) provides services in bacteriology, haemopathology, histopathology, serology, post-mortem, and parasitology. VPL provides all services free of charge to all users, but has a very limited budget. Samples are usually submitted by MoA staff on behalf of farmers. Farmers are encouraged to submit samples so as to monitor disease status in the country, but farmers and government research stations find that the time for results to be reported (> 2 weeks) does not allow practical action.

Fiji VPL has eight staff, most of whom are fairly young. The director has identified that VPL staff have a large need for capacity building, and hope that a future project could help improve VPL capacity, particularly in parasitology.

Ministry of Agriculture Chemistry Laboratory

The MoA Chemistry Laboratory at Koronivia is able to conduct feed analysis in crude protein by Kjeldahl, crude fibre, ether extract, and macro-minerals. This is a government funded service, free of charge to all users.

7.2.4 Industry value chains

Goat and sheep populations

Most recently available census data (2009) gives the populations of goats at 101000 and sheep at 14,000 (Table 6) and close to half of both populations is in each of Northern and Western provinces. However, FAO data puts the populations at greater than 260,000 goats and 17,500 for sheep (Figure 7) (FAO n.d.). The sheep population has increased due to the multiplier programs and as farmers build flocks. Many farmers interviewed were transitioning to sheep from goats as they considered sheep to be less work. Census data gives an average farm population of 10 animals (Fiji Ministry of Agriculture 2009). Household survey results (section 7.2.5) had an average of 100 head and therefore was biased to semi-commercial farms, although flocks of less than 20 were the most common flock size. The discrepancy between census and FOA data shows the difficulty in estimating numbers when the population is dominated by large numbers of households with very small flocks and the majority of sales are farm gate. MoA has a system of supervised farmers used to monitor trends on farm but are not a sample designed to estimate population. MoA quarterly reports on supervised farm document trends within the group of farmers monitored and shows increasing numbers recently after a decline post cyclone Winston.

Table 6: Number of farms with goats and sheep by Division

Division	Farms with goats or sheep	% of all farms	Total goats or sheep numbers	% of all livestock
Goats				
Central	464	4.9%	4 640	4.6%
Western	4 772	50.7%	48 186	47.6%
Northern	4 029	42.8%	46 995	46.4%
Eastern	144	1.5%	1 376	1.4%
Fiji total	9 408		101 196	
Sheep				
Central	47	5.7%	516	3.7%
Western	355	43.4%	6 537	46.5%
Northern	409	50.0%	6 873	48.9%
Eastern	8	1.0%	142	1.0%
Fiji Total	818		14,068	

Source: Fiji national Agricultural census 2009

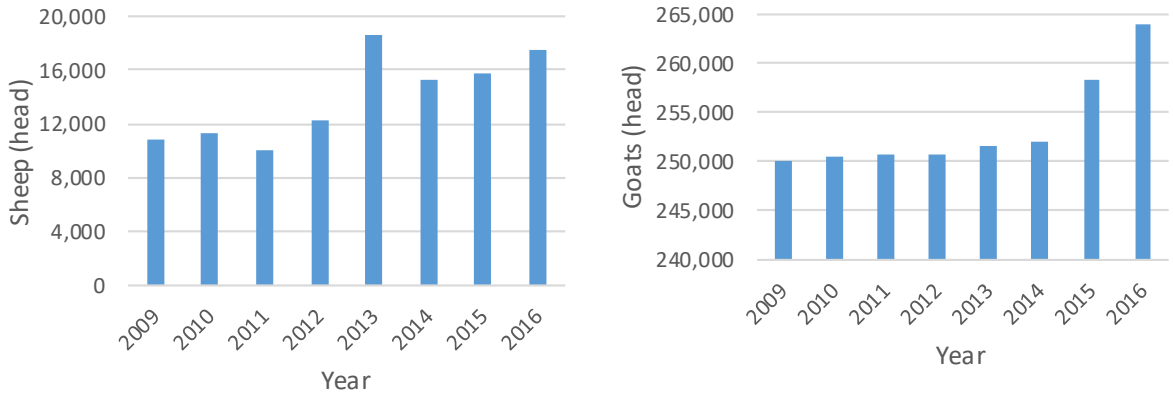

Figure 7. FAO estimates of Fijian sheep and goat populations, 2009 (Source FAOstat)

Demand and supply of sheep and goats and their products

Sheep meat is the second most consumed meat in Fiji, behind chicken (Figure 9). Demand for poultry, pork and eggs is filled 90-100% by local production, and approximately half of beef consumed is locally produced (Figure 10). This is strongly contrasted by mutton and goat meat, where frozen imports represent 88% of consumption (Figure 10). The majority of imports are frozen sheep cuts from Australia and NZ, being 5000 tonnes in 2015 and rising to 7500 tonnes for 2016 (Fiji Bureau Statistics provisional data for 2016). Goat meat imports are small because unlike sheep meat, only whole carcasses are imported, making imported goat meat relatively expensive.

The SR sector was projected in 2012 to offer the largest potential growth of any of the livestock sectors, with estimated growth potential of double current supply (Table 7). The beef sector has the second greatest potential growth at an additional 50% of current supply. The great imbalance in consumption of small ruminant meat is the main reason for the large potential for growth of local production.

The beef sector provides an interesting contrast to the mutton market. The majority of beef cuts for sale in supermarkets and butchers were locally grown, freshly butchered product. The appearance of the meat in cold cabinets was lean and clearly fresh and unfrozen. Whole frozen sheep carcases are imported, butchered by ban-saw and sold as (still) frozen cuts, often of high fat content (Figure 8). Existing value chains for local beef should be investigated as a potential model for new retail value chains for local SR. A large point of difference of the two value chains may be the function of abattoirs (see below for further discussion).

Figure 8: Frozen imported lamb shoulder chops (F$ 19.95/kg) and curry pieces (F$14.45/kg); and freshly butchered local beef cuts (F$14.95-17.75/kg) for sale in a supermarket on Viti Levu.

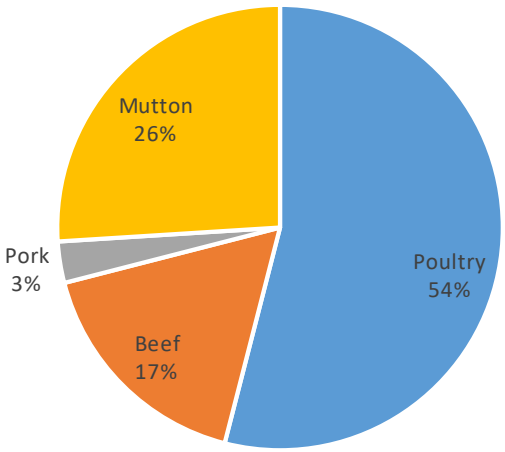

Figure 9: Meat consumption in Fiji. (Source: S. Cole 2016. A look at the Pacific Region Meat Supply. Fiji Livestock Strategy Validation Workshop)

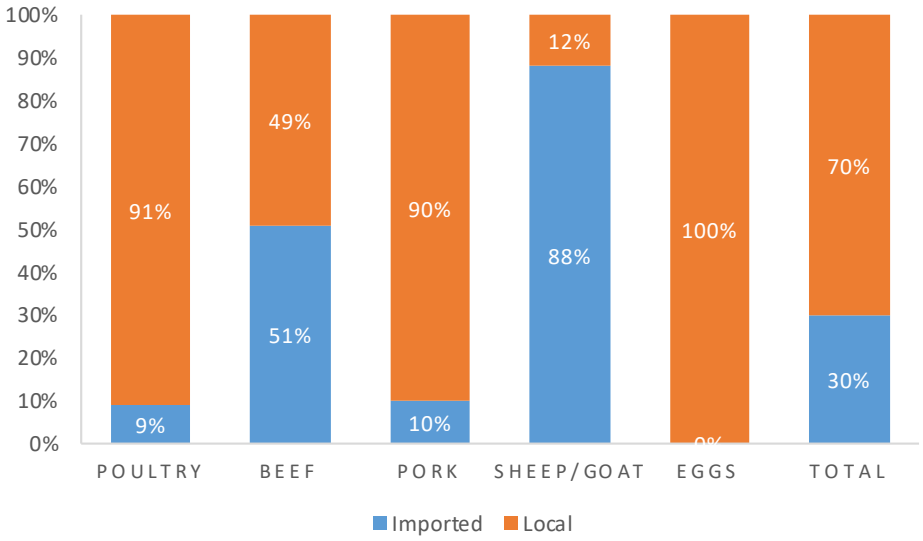

Figure 10: Meat trade balance (Source: S. Cole 2016. A look at the Pacific Region Meat Supply. Fiji Livestock Strategy Validation Workshop)

The volume of imported sheep meat is nearly ten times local small ruminant production. The latest Livestock sector report prepared by Cardno Agrisystems Ltd in 2010 lists goat meat production at 620 tonnes of which 600 tonnes is from smallholders with around 10 animals. The maqiti market was estimated by interviewees to be 95% of the local market.

Table 7. Estimated growth potential of local livestock industries, additional to current supply (source: Proand Associates Australia (2012))

Product	Growth potential	Comment
Beef meat	50%	Based on FMIB historic throughput. Impact of brucellosis and TB culling is recognized.
Dairy milk	At least 20% to meet domestic demand	Culling out TB-infected stock will reduce flock in the near future. Currently 80% import of combined dairy products (cheese, yoghurt, ice cream, etc.)
Pork	25%	Import substitution. Further potential to export to other MSG countries.
Goat meat	100%	Based on import substitution.
Lamb/goat	100% at least	Sheep flock is small and cannot be expected to grow fast. Sheep and poultry meat are substitutive products to some extent in the Fijian market.
Poultry	Limited growth	Heavy competition from cheap imports from USA in the region.

Notes: FMIB = Fiji Meat Industry Board; TB = tuberculosis; MSG = Melanesian Spearhead Group;

Small ruminant supply channels and value chains considered in this study

There are two major areas of SR production in Fiji on the two largest islands - Viti Levu and Vanau Levu. The animals from these regions form two distinct market channels. Farmers and value chain stakeholders participated in key informant interviews, a farmer survey and farmer FGDs in three divisions in Fiji – Central, Western and Northern. Only the supply channels in Northern and Western Divisions are considered further due to the very small populations of ruminants in the Central Division, and the geographical isolation of the other provinces in Fiji. The small population in the Central Division reflects the disadvantages (mainly related to intestinal parasitism and kid/lamb mortality) of growing small ruminants in the higher rainfall zone. It would appear that the disadvantages outweigh advantages of proximity to markets and availability of feed. However, with development of the sector and value chains, dedicated fattening enterprises may be successful in the Central Division, purchasing animals bred in the dry zones of the North and West. This is a researchable issue.

There are four main value chains for SR animals and meat in Fiji - 1) a chain supplying whole live animals for religious feasts and festivals (known as *maqiti* and including Christmas, Qurbani (Eid), Easter, and other family occasions (eg funerals)); 2) a very large (>7,500 tonnes per annum) chain supplying meat for domestic consumption via supermarkets and butcher shops; 3) a chain supplying high quality cuts to tourist restaurants and hotels; and 4) a chain supplying local restaurants and takeaway BBQ sales. These are described briefly here, and examined in more detail further below.

The great majority (95%) of local goat and sheep production from both the Northern Division and Western Division channels is sold in farm gate sales of live animals for the maqiti market (chain 1). This value chain was estimated in 2012 to form 2% of the total market for SR product (Proand Associates Australia 2012). Animals sold in the maqiti market are generally sold directly to the consumer at the farm gate, for consumers in the production region. Consumers in urban markets in Nadi (Western Division) and Suva (Central Division) are more likely to make maqiti purchases via roadside sales from traders. These animals are slaughtered in backyards and barbequed.

Small ruminant meat is in high demand for home consumption via retail sales (chain 2), which forms 90 % of the total demand for SR products in Fiji (Proand Associates Australia 2012). A small percentage of local animals are sold through retail outlets, however, the

great majority of small ruminant meat sold in Fiji (and Samoa) is imported mutton from Australia and New Zealand. An important and somewhat unusual characteristic of the retail value chains is that there are no sales of meat (local or imported product) at traditional markets (Johns et al 2017). The only retail outlets of fresh meat are supermarkets and butchers shops. Goat curry is the most famous Fijian dish made from SR meat. In a survey of supermarkets and butchers in Viti Levu conducted between December 2016 and Jun 2017, 77% of SR cuts for sale were 'budget' cuts (including sliced necks, curry pieces (frame bones), chump chops, shanks, and shoulder pieces), on average selling for F$15/kg (A$10/kg); 23% of cuts were classified as 'mid-range' cuts (whole roasting legs or shoulders, bone in), on average selling for F$20/kg (A$12.50/kg); and no 'premium' cuts (from the loin area) were observed for sale. All imported SR products sold through chain 2 are imported frozen, mostly cut up into chops and curry pieces by ban saw at the retailer.

The tourist restaurant and resort market (chain 3) is entirely supplied by chilled imported meat, and forms 4% of the total demand for SR products in Fiji (Proand Associates Australia 2012). This high value market has a preference for premium cuts, although goat or lamb curries are also commonly sold at tourist venues. As for most food sold through hotels and resorts, SR meat is mostly sourced directly by the hotel through food logistics chains supplying from Australia and New Zealand. There are some Fijian meat wholesale businesses who import chilled carcases and butcher and distribute into this chain.

The last chain is the local restaurant (mostly Indo-Fijian) and takeaway market and is the most diverse (chain 4). Roadside BBQ stalls sell '*lovo* packs' of barbequed dishes for takeaway, often on Friday nights. These retailers purchase their SR meat from a variety of suppliers. Some is purchased through supermarkets and butchers, some from abattoirs, and some in informal backyard slaughter. This value chain forms 4 % of the total demand for SR products in Fiji (Proand Associates Australia 2012).

Key issues for marketing and stakeholders in these value chains are discussed below. The greatest opportunity for expanding markets for local produce is in supplying into the domestic retail markets (chains 2 and 4) as import substitution. Value chains for Fijian SR farmers to access and compete in these markets would need to be developed, although there are some farmers and other value chain stakeholders beginning to pilot approaches.

The two main production regions in the Northern and Western Divisions of Fiji supply over 90% of animals both locally and into the main urban centres on Viti Levu, and approximately half of all farms in these two divisions produce sheep and/or goats (Table 6). The supply chains in Western Division and Northern Division are outlined in

Figure 11 and Figure 12, respectively. These diagrams show the major market channels and destination of animals, stakeholders within each market channel and the estimated proportion of animals going into each market chain.

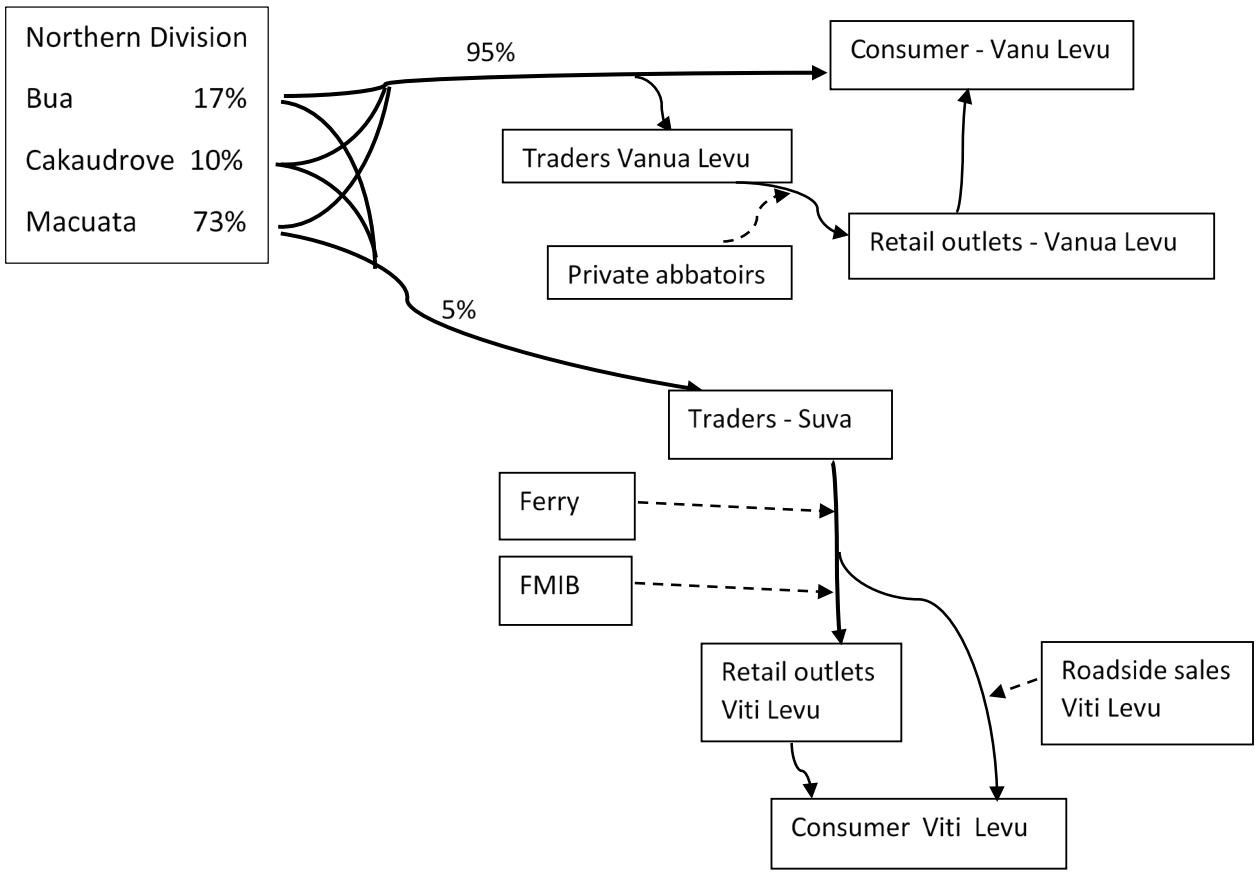

Figure 11. Northern Division - Vanua Levu small ruminant supply chain. (FMIB = Fiji Meat Industry Board)

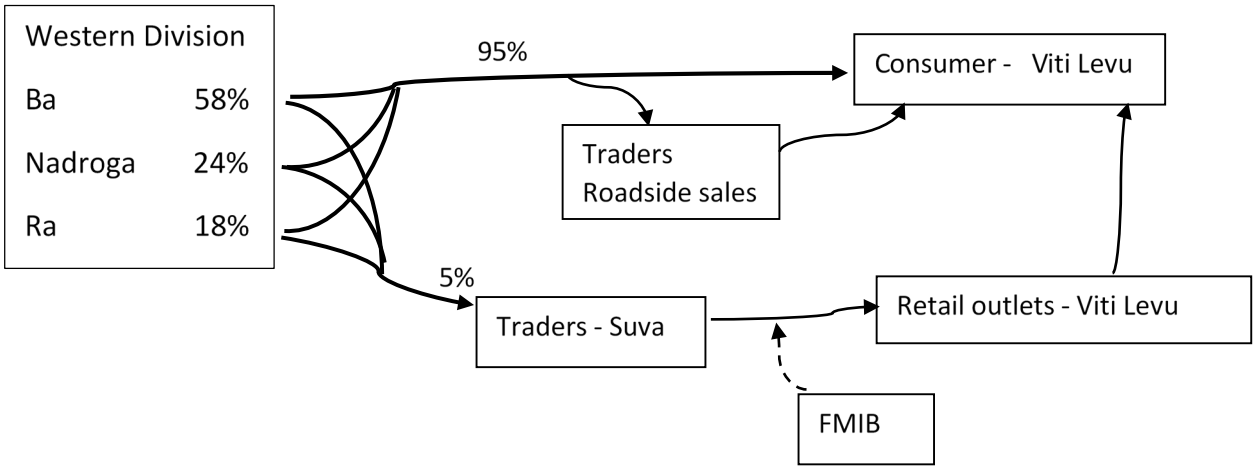

Figure 12. Western Division -- Viti Levu small ruminant supply chain (FMIB = Fiji Meat Industry Board)

The main difference between these supply channels is the crossing from Vanua Levu to Viti Levu. Although Vanua Levu has approximately half the small ruminant population, Viti Levu is home to approximately 80% of the human population and the two largest urban centres of Suva and Nadi. Extra transport costs and higher local production coupled with lower demand was reflected in lower prices on Vanua Levu. There are currently approximately 400 goats per month being transported from Vanua Levu to Viti Levu, with the main market of Suva close to the ferry port. There is also a different structure to slaughterhouses, as discussed below.

Processors and wholesalers

There are wholesalers and processors active in the retail market engaged in value adding and distribution of locally produced meat. One wholesaler of imported product to the higher value tourist market who are value adding and moving into local production. Although local small ruminants represent a very small part of the businesses, there were rare examples of differentiation of cuts of local goat meat in some retail butchers shops. Ideal presentation and utilisation of local product is hampered by problems associated with low turnover volume and inconsistent quality.

Fiji Meat Industry Board (FMIB) on Viti Levu

FMIB operates two slaughterhouses on Viti Levu; one at Nasinu (in Suva) and one at Vuda (Nadi). The numbers of goats and sheep being slaughtered is very low. For example the target for the Suva plant was 17 goats in November 2016 but only 7 were slaughtered.

It is illegal to slaughter for commercial sale outside of a registered slaughterhouse, and on Viti Levu no registered slaughterhouses are allowed to be established in competition with FMIB. FMIB is legally required to deliver the carcass via refrigerated transport after slaughter to retail outlets, at a fixed price, sometimes a considerable distance and irrespective of volume.

There are cultural restrictions that apply to butchers shops, processing facilities and abattoirs. Many Muslims won't buy from an outlet that sells or processes pork, many Hindus won't buy from an outlet that sells beef.

There are issues with the structure of FMIB slaughterhouses:

- Fees are set by government and haven't been increased in 10 years. Therefore there is no possibility of a private slaughterhouse able to compete with FMIB on price, nor for FMIB slaughterhouses being able to operate profitably.
- Cultural differences: Goats are slaughtered on the same line as pork at FMIB – therefore Muslims, who are a significant main market, won't use the facility or purchase meat processed there. Similar restrictions occur in retail butcher shops.
- Goats are small and agile and therefore present problems for standard equipment designed for pigs.
- Declines in throughput mean that slaughtering only takes place at FMIB one day per week or less for goats and sheep. Therefore a restaurant that needs two animals per week has a supply problem. One restauranteur said he would be willing to pay some F$30-40 for slaughter but private facilities don't exist on Viti Levu as they are illegal.
- For various reasons, including the inability to set fees and declining numbers, FMIB has experienced some financial pressure and so entered the maqiti market. They buy whole animals (pigs) and resell whole carcasses. There is a potential conflict between being a market player and having a regulatory role.

Registered private slaughterhouses on Vanua Levu

There are several small private registered slaughterhouses on Vanua Levu. Local producers must arrange for the MoA meat inspector to be present for the slaughter. Farmers who used a nearby facility said this was convenient and worked reasonably well. Prices quoted ranged from F$20-50/head. This corresponded to the price a restaurant owner was willing to pay for a convenient service. There was previously a restriction on transporting carcasses from Vanua Levu to Viti Levu due to the lack of a cold chain between the small private slaughterhouses and main refrigerated transport locations, however anecdotally this may be resolved. This would allow refrigerated transport of carcasses in the many trucks returning empty from Labasa. This supply link is an important opportunity for development and could become the main market access for growers on Vanua Levu into urban Suva retail markets. Further work is needed to understand what other constraints may limit the ability of these private slaughterhouses to supply local demand, especially meeting food safety requirements.

Value adding processors

These processors in the early stages of ventures to value add to locally produced small ruminant products are potential project partners.

Fresha Fine Foods is an import business that supplies to the high value tourist markets. The owner is interested in developing local product and has purchased a farm and built new facilities in Nadi. He is conducting ad-hoc financing of pig farmers already and is interested in working with an NGO in developing a suitable finance model.

Fiji Meats is based in Nadi (as well as Suva) and mostly staffed by i-Taukei women. They undertake various value adding activities such as smoking and sausage making and produce a variety of meat products (pork and beef), selling into markets in Suva and Nadi. They only buy goats at Christmas.

Palmlea Farms (Vanua Levu) were the first to introduce Boer goat genetics to Fiji. They have been supplying a group of famers multiplying Boer goat genetics. They are planning a vertically integrated business specialising in pies made from local ingredients and selling through a retail outlet in Labasa initially. They are planning goat, sheep, chicken and vegetarian flavours, avoiding beef and pork so as not to alienate any market sectors.

Main Marketing channels, arrangements and costs along the value chain.

Participants of the household survey sold an average of 11.1 sheep (range 0-50, n=32) and 15.5 goats (range 0-90, n=40) last year. 77% of the respondents have 1 or 2 market outlets through which they sell animals.

Table 8: Market types and consumer types available to household survey respondents (n=48)

How does your household sell goats and/or sheep?	% of respondents (n=48)
Farm gate	89.6
To friends or family	85.4
To a trader	14.6
At a market	12.5
Directly to a butchers shop or supermarket	4.2
Other	2.1

Farmer to Consumer

The great majority of small ruminants are currently sold at farm gate for the maqiti festival market, and many are unsolicited. Some farmers said they transport their animals to markets themselves, and this appears to be especially for those farmers with farms located further from the main roads (in the interior) or with poor road conditions to reach their farms. A detailed overview about which type of markets the participating households have access to is given in Table 8. It is unclear how many are to traders and middlemen or directly to the consumer for home slaughter and consumption, since traders did not always announce themselves as such.

Box 6. The farmers' view: Marketing sheep and goats

The farmers in Northern Division raised the issue of having to search out buyers, in the absence of a stable market for buying and selling goats, outside of the Christmas-New Year peak selling period.

There is price competition between farmers. One respondent noted:

"If a very rich farmer lowers the price of his sheep or goat then the poorer farmer will have to lower their price even more."

Roadside sales are common in the main urban areas during the main festival times at Christmas, then Easter and Qurbani. One grower near Nadi said that there is sometimes oversupply at Christmas. The previous Christmas he prepared some 70 animals for sale but could only sell approximately 10. Several more isolated growers interviewed on both Viti Levu and Vanua Levu also had problems with visits from buyers being unreliable. The prices enjoyed by producers are high. On Viti Levu growers achieve F$10/kg live weight in the maqiti market. Some Viti Levu growers reported taking lower prices down to F$8/kg live weight. Although many farmers interviewed used scales to weigh their animals at sale, market price is for many producers based on the size of the animal rather than the weight. Rather buyers and traders set the prices through careful observation and it is not the sellers that negotiate the price and have bargaining power.

On Vanua Levu prices were lower for farm gate sales reflecting lower demand. Growers generally reported prices from $F6 to 8 /kg liveweight. Some farmers had scales although many did not, therefore sales prices were often described by sex, age and approximate size. There are also nuances to the festival market. One Hindu festival favours pure black goats, other traders said horn or scrotum size was important.

Farmers to trader/collectors

No farmers were encountered who transported animals. There are many traders who purchase from farmers to sell on the roadside during peak festival times in major urban centres or for sale to retail outlets. Traders generally paid less and only took the best animals. A roadside trader in Suva was paying $F200-220 for approximately 25-30 kg animal (on Viti Levu), which equates to $F8/kg liveweight. For a truck that can carry 30 animals, transport and labour costs of $F500 for a collection trip equates to 16.70 per animal or approximately 50c per kg liveweight. Animals sold at roadside achieved similar prices to farm gate sales (280 for 25-30kg animal), therefore profit for such as trip could

be F$1000-1500. There were examples of both spot market purchase by traders, and those who had relationships with growers for regular purchase and collection.

Extra costs are encountered for transport across from Vanua Levu. The cost for a truck load on the ferry to Vanua Levu and return is approximately $F600 for a small truck. One trader said his costs for a load (mixed cattle and goats) was approximately $F1000. Assuming a full truck was 30 goats, the ferry cost equates to F$0.60 per kg live weight. If a trader can buy for $F8, sell for $F10 on the roadside in Suva and outlay costs of $F1000 there is profit of $F1000 for a trip. If they are selling to retailers then there are extra costs and margins and the farm gate price will need to be close to the $F6 encountered with some farmers (see discussion of margins, below).

Another issue for traders was movement permits issued by MoA, and these were most apparent in movement on the ferry from Vanua Levu to Viti Levu. There is no fee to obtain movement permits but the system appears to cause issues in efficient trade. One trader in Suva said transporting from Vanua Levu was too difficult and he therefore only bought on the east coast of Viti Levu. The permit system is discussed in more detail below.

Sixty percent of farmers surveyed plan a range of improvements to their marketing of goat and sheep meat. These improvements include seeking better access to urban markets (51%), preparing animals better (30%), and seeking new relationships with butchers (28%).

Farmers view the underdeveloped market as one of the biggest problems for the small ruminant industry and that there are too few slaughter houses for sheep and goats, restricting their sales to live animals. Most farmers would like sales 365 days a year, not just majority sales at Christmas-New Year (Box 6). Large commercial farmers in Northern Division believe that a [government approved] abattoir for slaughtering is needed, but this is stalled, undermining confidence in the market. These farmers want licenses from the government for slaughtering, and chilling trucks to transport the fresh meat to urban markets on Viti Levu.

Traders to retailers

Few traders were interviewed and none that supplied retail outlets, despite numerous attempts at contact. One difficulty was that all animals destined for retail outlets must be slaughtered at a registered slaughterhouse. On Viti Levu, this means one of two FMIB slaughterhouses. Slaughter numbers of sheep and goats at the FMIB slaughterhouses indicate this is not occurring. There is also discrepancy between the numbers of permits issued and slaughter numbers. The issues are discussed in detail below. The costs for slaughtering at FMIB are set by government regulation and was F$15 for a goat or sheep in late 2016. The FMIB cost was significantly lower than the private slaughterhouse cost quoted on Vanua Levu of between F$20-50/head which equates to F$0.50 - 1.00 per kg live weight. Processing costs were quoted at F$0.80/kg. Therefore, overall transport and processing costs could equate to F$3-4/kg using current legal channels which may explain why those channels are not being used.

There are anecdotal examples of traders entering the retail market legally. A trader near Sigatoka was supplying a supermarket with meat sourced from a group of growers and processed at FMIB. The meat was selling for higher prices than imported product and sales were sufficient that consistency of supply became a problem.

Retailers to consumers

The retail sector in Fiji is unusual in that there is no meat sold in traditional or wet markets (Johns *et al.* 2017). The main outlets are supermarkets and butchers.

Retail prices for goat and sheep meat are generally F$21, although vary considerably. A small number of retailers were selling cuts of local meat for different prices, although it

was limited cuts. The economics of product development would depend on market preferences and animal conformation.

Butchers shops rarely had imported or local goat meat available. Imported goat meat is less common because only whole animals or carcasses are imported and therefore are not as profitable for retailers as importing particular cuts. When local goat meat was available it was usually frozen due to slow sales since the price was over F$20 compared to F$16-18 for imported mutton. Butchers said they have to buy a whole goat carcass, freeze it because it doesn't sell quickly enough and won't buy another until the previous is sold. Tourist restaurants and hotels weren't surveyed extensively, however all those questioned sold only imported product. One local restaurant owner said it wasn't possible for him to slaughter animals legally and still get a satisfactory service for his business. Local restaurants servicing domestic consumers (rather than tourists) may represent an important market segment for local product, although the size needs to be determined.

Interviewees consistently said that they preferred local sheep and goat meat over imported mutton, but commented that prices had increased and availability had diminished in recent years. Stated reasons for a preference for local meat included: preferred flavour, a preference for fresh product over frozen, and the very high fat content of imported products (which tend to come from low quality cuts and older animals).

Margins along the value chain

Farmers currently enjoy good returns and high prices due to the dominance of the maqiti market. Prices are high because local production fell after cyclone Winston. Retail margins accrue to farmers, but may also reflect high costs of production. Margins appear to reflect costs along the chain, with few large profits for traders or retailers at the prices encountered in fieldwork. For example, most goat and sheep meat in retail outlets sold for approximately F$21 per kg. Assuming a carcass dressing percentage of 50%, means margins for traders and processors at the commonly quote maqiti price of F$10 would be very small. Farmers do sell for significantly below the maqiti prices, especially at other times of year. The margins are summarised in Table 9.

Table 9 Margins in main market channels in Vanua Levu and Viti Levu.

F$/kg carcass (50% dressing)	Producer	Trader	Retailer	Consumer
Maqiti (live animal) market - direct				
Buying price				20
Selling price	20			
Maqiti (live animal) traders				
Buying price		16		20
Costs				
Margin				
Selling price	16	20		
Retail meat market- Viti Levu				
Buying price		16	18	21
Costs		1		
Margin		1	3	
Selling price	16	18	21	
Retail meat market- Vanua Levu				
Buying price		12	16	21
Costs		2	2	

F$/kg carcass (50% dressing)	Producer	Trader	Retailer	Consumer
Margin		2	3	
Selling price	12	16	21	

The question that needs to be addressed is how profitable farming can be with increased production efficiency selling into the retail market chain. Increased production may mean lower prices for farmers, but with increased productivity, regular and higher volume sales may be more profitable. Current farm-gate price also likely reflects cost of production (see 7.2.6).Infrastructure

Infrastructure development was an issue for most farmers and pasture, roads, water and fencing were quoted as limitations by most farmers. Eighty percent of surveyed farmers said they planned improvements to animal housing and fencing. Significant damage occurred to much infrastructure through the sugar region during Cyclone Winston in February 2016.

Water supply is a major constraint to farming productivity, and many households do not have piped water supplies. Many villages share a single water tap. A farmer from Lautoka (Western Division) reported that he uses water from a creek for sheep and goats and drinking water supplied by government in tanks for household consumption. Farmers from Northern Division reported having water problems because creeks dry out and they have to go deeper into creek beds to access water.

Many farmers in the Northern and Western Divisions reported that roads are so bad as to affect their access to buyers. One farmer in Ba, Western Division reported that he has no proper road access and believes this prevents extension officers visiting his farm. He delivers his goats to buyers by horse back.

Farmers in Dreketi (Northern Division) stated that they need improved road conditions or good fibre boats to be able to cross the deep Dreketi River. Farmers who must cross the river in order to move their livestock for breeding and for selling sometimes lose animals due to drowning in poor homemade rafts.

Large commercial farmers are more able to address their infrastructure constraints using their own capital. Some commercial farmers have received Mulatto II seeds provided by MOA and ITC for pasture improvement and new sheep breeds from Australia.

Many farmers have received government grants from MoA or as part of cyclone reconstruction funding for this infrastructure. Farmers in Western and Northern divisions stated that government grants are not equally distributed between all farmers only to wealthier farmers and those who are registered with MOA as supervised farms. Some farmers had requested a grant from MOA but not receiving anything, and there was no explanation as to why. Farmers perceive grants and subsidies to be unfairly distributed and that the program is poorly implemented. Farmers also perceive that there is no recourse for changing or improving the situation (Box 7).

Most sheep and goats in Fiji are grazed in semi-extensive systems. There are some examples of intensive, housed systems and some farmers use supplementary feed. Sheep and goats are universally penned, or more often, housed, at night, although some farmers said that they had no proper housing for their goats. Subsidies for fencing and shedding are very important to farmers as purchasing this from hardware stores is often beyond their means. Farmers consider the shedding to be essential to protect their stock from the wild dog attacks that are prevalent throughout Fiji.

Production/management systems, below), and so production improvements may result in a farm-gate price reduction while maintaining farmer margins. The second question is how competitive local meat can be against imported product. There were few retailers selling

differentiated products and so comparisons and effect on profitability are difficult to quantify.

Anecdotally, goat ownership was previously much more ubiquitous in Fiji, prices significantly lower and consumption much more common – all inter-related issues. Opinions varied about price variation over time, but it was agreed that prices of animals had increased substantially, with one report of prices previously as low as F$60 for a female animal. This is comparable to current prices encountered in Vanuatu of 6000 vatu.

Animal movement permits

Many small traders operate from Suva and source animals in the Western and Northern Divisions, destined for roadside maqiti sales, supermarkets and retail butcher shops, requiring an animal movement permit. MoA staff explained that there were two permit types; one for slaughter and one for farm to farm transfer. The slaughter permit was less onerous to obtain, not requiring a health inspection. Both are free, however it is not clear how easy it is to get MoA staff to come to a farm to inspect. For the ferry crossing, where it is possible to police numbers accurately, there is a large mismatch between the number of slaughter permits and the number of animals going through FMIB, suggesting many animals end up in the maqiti or retail markets after transport to Viti Levu.

There are other discrepancies in animal movement permitting. Animals that are walked are not policed, whereas road transported animals are. Carcasses were observed being transported wrapped in tarpaulins with ice. Carcasses are confiscated and a fine issued if this is detected.

7.2.5 Infrastructure

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Box 7. The farmers' view: Infrastructure grants

"Farmers are not getting what they ask for"

"Some farmers are unaware of when to apply [for subsidies] and when will they receive these subsidies."

"The quotation gets mixed up and there are plenty of 'inside jobs'"

"If farmers complain then they will be targeted."

"The size and quality of fencing material (especially fencing material made in China) is very poor"

"Fencing material has deteriorated rapidly in recent years, but still increased in price. The wire is soft, easily broken, and the gaps too large where the animal can get stuck, or the wild dogs could get through it."

"Much of the fencing supplied after the damage caused by Cyclone Winston came from China. The height of the fence is the issue – at 3 feet it's too low – it needs to be 4 feet or more to prevent dogs jumping"

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7.2.6 Production/management systems

Key production zones

The main agro-ecological gradient on the islands of Fiji is characterised by a monsoonal tropics gradient from wet south-eastern sides of islands through to the dry north and west. The detailed pattern depends on the topography. Many smaller islands would be intermediate, lacking the mountainous terrain to induce high rainfall on one side and a rain shadow on the other. Many sheep and goat farms are located in the sugar cane belt which is in the seasonally dry North West of Viti Levu (Western Division) and Vanua Levu (Northern Division). Although drier areas are more suited to goat production they also present problem for feed availability during the dry season from May to November. The wet zone in the Central Division is close to the urban population centre of Suva. There are a small number of SR farmers in the wet zone, but the high rainfall and humid tropical climate are likely to lead to mortalities and high GIN burdens.

Production systems

Almost all SR in Fiji are grazed during the daytime and confined at night. Very few farmers are practicing intensively raised SR fed with cut and carry forage. However there are a few examples, including one commercial-scale farmer (>100 head) with sophisticated

intensive production systems. These examples may make interesting case studies of the benefits and costs of these production systems, informing which aspects, and under which conditions, intensified production could be more widely adopted.

Husbandry

An animal house for night-time confinement was considered essential by all farmers and extension staff. They protect flocks from theft, wild predator attacks and extreme weather. Infrastructural improvements have been among the top listed constraints and desired changes of both focus group discussions and household surveys. During the on-farm visits the large variety of goat and sheep shelter could be observed. These range from simple fenced enclosure (Figure 14a) to quite sophisticated, solid structures (Figure 14b). Improved shelters and handling facilities could not only reduce animal losses (due to nocturnal theft or predation) but they also make animal management easier and more efficient.

Figure 14a: Fenced area for the small ruminant flock on sample farm 5 – Western Division

Figure 14b: Sophisticated sheep shelter on sample farm 6 – Northern Division

Predation is a large challenge. The most common predators are wild dogs, which are a threat in all research sites. Farmers also reported losses of lambs and kids from wild pigs, red mongoose and hawks.

Sheep and goats are let out to graze during the day, for up to nine hours, but for as little as four hours. Farmers may choose to graze stock for limited periods to avoid grazing moist dewy pastures, or to prevent goats in particular wandering too far from home. Some farmers have observed greater incidence of ill-thrift and scours when their stock graze on dewy pastures in the morning. Locally this is thought to be a symptom of increased GIN burdens from larval ingestion when grazing moist grass, although this is not a view endorsed by experts in sheep parasitology, suggesting that this is a researchable question. Stock are freely grazed within fenced paddocks, shepherded in unfenced mataqali or common land or are tethered.

Several farmers reported keeping kids and lambs separate from the rest of the flock during grazing times in the first month or two after birth. In some cases, lambs and kids are shedded while mothers are sent out to graze (particularly if short period grazing is practiced) or may be kept around the house garden with their mothers. Although lambs are not generally fed in this case, this management practice offers the chance for targeted supplementary feeding of young lambs/kids and their mothers, a practice which is likely to reduce mortality rates and increase growth rates of suckling lambs and kids.

Input supplies

There are no private livestock input suppliers in Fiji, apart from producers of agro-by-products used for supplementary feeding. Drugs and medications, including drenches, can only be obtained from MoA extension officers. Farmers also want medication and animal husbandry equipment and materials to be subsidised to make them more affordable (Box 8).

Labour

Most survey respondents hire labour either permanently (10%) or temporarily (56%). The compensation of hired labour varies depending on the type of employment. The usual arrangement is cash payment leading to an average annual labour cost of F$4100 per year (range: F$250-40000).

The lower labour requirements of small ruminants was an attraction for many participants to take up sheep and goat farming. Across all six sites, labour for the management and care of small ruminants is provided mostly by both adult male family members and adult male hired labour. Family labour was important for small ruminant enterprises, and the proportion nominating family labour as contributing the most labour to small ruminant enterprises was not related to flock size. Half of farmers earning less than $FJ20,000/year reported that men in the family contributed the most labour to their small ruminant activities. Overall, only 13% of farmers reported that women in the family contributed the most labour to small ruminants, and 5% reported that children contributed the most labour. This contrasts with cattle production, where 3% of farmers reported that women contributed the most labour in their households, and poultry production, where 79% of men reported that women contributed the most labour. Small ruminant farming still had a requirement for hired labour, but this was for much smaller periods of time (Box 8). Only 10% of participants employed permanent labour specifically for small ruminant production, and this was mostly farmers in the higher income bracket. However, 40% of farmers earning less than $FJ5,000 per year, and 60-66% of other farmers, employed temporary labour to assist with certain small ruminant tasks. For example, nine participants hired additional labour specifically for drenching, which costs them an average of F$29 per drench. Temporary labour hire was not used for flocks smaller than 20 head (Figure 15).

Box 8. The farmers' view: Inputs and labour

On input supplies:

"The drenching equipment (like the drench gun) and drenching medicine prices are very high. There is no subsidy for those materials."

"There are not enough vets and their charges are really high for one simple injection."

"Costs of animal husbandry equipment is very high in hardware stores."

On labour:

"During cane cutting it is the most difficult time to secure labour. There is a shortage of labour for fencing and drenching."

"My biggest problem is labour because I alone work the farm and I am running three enterprises. During the last rainy season 6-7 goats of mine died because there was no one to look after them."

Figure 15. Use of hired labour for flocks of different sizes

Other than for large-scale commercial farms, permanent labour is not readily available, and difficult to procure as labourers often have other non-agricultural jobs. Labour availability is seasonally dependent, with cane harvesting season causing shortages. Labourers will only work for farmers that offer them a good wage. Labour costs in Fiji were considered by many to be high. Several farmers working off-farm in unskilled labouring jobs were paid (F$2-4 per hour). For those farmers relying on hired labour, having enough income to pay them can be a problem. If they provide food for the labourers, the daily wage rate is reduced. Farmers said increasingly they had to pay more for wage labourers in order to convince them to take on the work. The cost of hiring labour has a significant impact on the profitability of small ruminant farming for some farmers.

Feeding and feed resources

Grazing is by far the most important source of feed for sheep and goats, with 94% of farmers surveyed putting their stock out to pasture. The bottom 30th percentile of SR farmers surveyed during fieldwork had ≤ 16 acres of land for SR grazing; the bottom 66th percentile had ≤ 45 acres of land for SR grazing. 18 % of SR farmers surveyed had 50 – 100 acres and the top 16th percentile of SR farmers had 100-150 acres of land for SR farming. Average stocking rate for all farmers surveyed was 3.4 head per acre. For famers with less than 20 acres of grazing land available to them, stocking rate was much higher, at an average of 5.5 head per acre. Pasture management varied widely between farms.

Forty-five percent of farmers surveyed had used supplementary feeds, most commonly, molasses, mill mix and copra, with 86% of those farmers purchasing some of their supplements from external sources. Thirty-one percent of surveyed farmers reported using cut and carry to some extent. This data seems to contradict the prevailing MoA extension staff opinion that supplementary and cut and carry feeding was not acceptable to most Fijian farmers. There is an important researchable issue here in identifying what is the value proposition of, and the barriers and opportunities to, farmers adopting more intensive feeding and supplementation of SR, particularly in a strategic approach.

Pasture species

The majority of feed available to sheep and goat farmers is unimproved pasture (Table 10), and many farms visited had large herbage mass of unpalatable species. Very few modern improved species are widely available, and strict quarantine laws limit the ability to import new varieties. For example, Mulatto II was only recently introduced and is largely unavailable to most smaller and semi-commercial farmers. Improved signal grass pastures were observed only on large commercial farms. Koronivia grass is the most

widely available improved pasture, but the only significant resources of it are at Koronivia Research Station in Central Division. MoA has a pasture improvement project based at Sigatoka Research Station, and from here are slowly building distribution of these and other pasture species.

Table 10: Number of farms with pasture and area of pasture by type

Division	Type of Pasture	Farms with Pasture	% Farms	Area of Pasture (Ha)
Central	Improved Planted	123	6.0%	1112
	Exotic Pastures	69	3.4%	257
	Improved Native Pastures	238	11.7%	3 665
	Unimproved Native Pastures	1598	78.4%	42498
	Other Pasture Types	10	0.5%	11
	Total	**2038**	**29.4%**	**47546**
Western	Improved Planted	62	2.5%	568
	Exotic Pastures	20	0.8%	16
	Improved Native Pastures	553	22.5%	3019
	Unimproved Native Pastures	1798	73.3%	12382
	Other Pasture Types	21	0.9%	62
	Total	**2454**	**35.4%**	**16048**
Northern	Improved Planted	215	8.9%	993
	Exotic Pastures	62	2.6%	391
	Improved Native Pastures	710	29.5%	2581
	Unimproved Native Pastures	1365	56.8%	4680
	Other Pasture Types	52	2.16%	59
	Total	**2403**	**34.7%**	**8706**
Eastern	Improved Planted	9	22.5%	0.09
	Improved Native Pastures	5	12.5%	41
	Unimproved Native Pastures	16	40.0%	55
	Other Pasture Types	11	27.5%	10
	Total	**40**	**0.6%**	**107**

Source: Fiji Ag Census 2009

Tree legumes

Soils in Fiji are well suited to several types of forage tree legume (FTL) including Leucaena and Gliricidia. Wild-type Leucaena is observed to grow wild on road-sides and disused lands, but few cases (15% of surveyed farmers) were recorded of farmers grazing their stock on tree legumes, nor utilising them in a cut and carry system. Gliricidia was observed being used as living fence posts, but not as a feed resource. Outer (uninhabited) islands with large cover of Leucaena have been reported to support populations of wild goats which are sometimes harvested. MoA has recently obtained seed stock of Leucaena 'Wondergraze'. This is suitable as a grazing Leucaena, but not for cut and carry systems.

Forage tree legumes have proven to be a transformational technology in many smallholder livestock systems similar to those in Fiji, especially where a long, intense dry season causes severe feed restrictions, as is found in the Western and Northern Divisions of Fiji. The use FTLs in grazing paddocks may offer the opportunity to increase the amount of "browse" in the diet, lifting grazing away from the ground, and potentially reducing the ingestion of GIN larvae. Their high protein content makes FTLs a potentially significant feed resource to support growing and reproducing stock, and as a nutritional strategy to improve resistance to GIN. Most Southeast Asian smallholder systems successfully integrate FTLs as cut and carry resources, which is not a common SR production system in Fiji. It would be important to conduct research to understand how

tree legumes could fit into existing or emerging production systems and livelihood strategies, before scaling up this technology.

Figure 16: Pasture species on show at Central Division Agriculture Show 'Climate Smart Agriculture for Fiji', June 2017 (Photo Fran Cowley).

Herbage availability

On the 12 sample farms on which we conducted data collection all small ruminants had access to pasture (with farm 8 restricting animals to indoor feeding during the time of data collection. 58% of sample farms had more than one paddock available with a wide range of 1 to 13 paddocks per farm. The range of pasture management strategies is also reflected in the separation of 58% of all survey farmers who rest paddocks from grazing versus 42% who do not manage their grazing areas in that manner.

Pictures of sample pasture illustrate the large variety of available pasture types and different management intensities. These range from large, unfenced grazing areas with unmanaged native vegetation to highly segmented paddocks with improved pasture species.

Pasture ruler measurements allowing rough estimates of available pasture mass were conducted on 10 farms where pastures were easily accessible from the location of the sheep and/or goat shelter or enclosure where the animal sampling was taking place. Results show the often large range between individual measuring points at farm level and between farm averages (Table 11**Error! Reference source not found.**). Where estimated grazing pasture mass is less than 1200 kg DM/ha on a tropical grass of ≤ 60% digestibility, production is likely to be highly limited, and not suited for growing or reproducing SR (MLA 2014).

Table 11 Mean, minimum and maximum pasture ruler measurements for each sample farm (n=10)

Farm number	Project site	Sampling points	Mean pasture height (cm)	minimum pasture height (cm)	maximum pasture height (cm)	Estimated pasture biomass (kg DM/ha)
1	Lautoka	21	4	1	15	1200
2	Lautoka	22	13	8	15	3000+
3	Lautoka	20	3	2	5	1000
4	Ba	19	3	1	5	1000
6	Labasa	20	10	4	15	2200
8	Dreketi	21	6	2	15	1600
9	Dreketi	19	3	1	6	1000
10	Dreketi	20	3	2	3	1000
11	Nausori	20	12	7	15	2500
12	Nausori	20	6	2	10	1600
all farms		202	6	1	15	1600

Seventy-seven percent of surveyed farmers experienced a feed shortage (feed gap) in two or more months per year, and 52% in three or more months per year (Table 12, Box 9). As to be expected, the months of greatest feed shortage coincided with the mid-late dry season (Figure 17).

Table 12: Farmer reported duration of feed shortages

Months of feed shortage	% of farmers
1	23
2	25
3	29
4	13
5	2
6	6
7	2

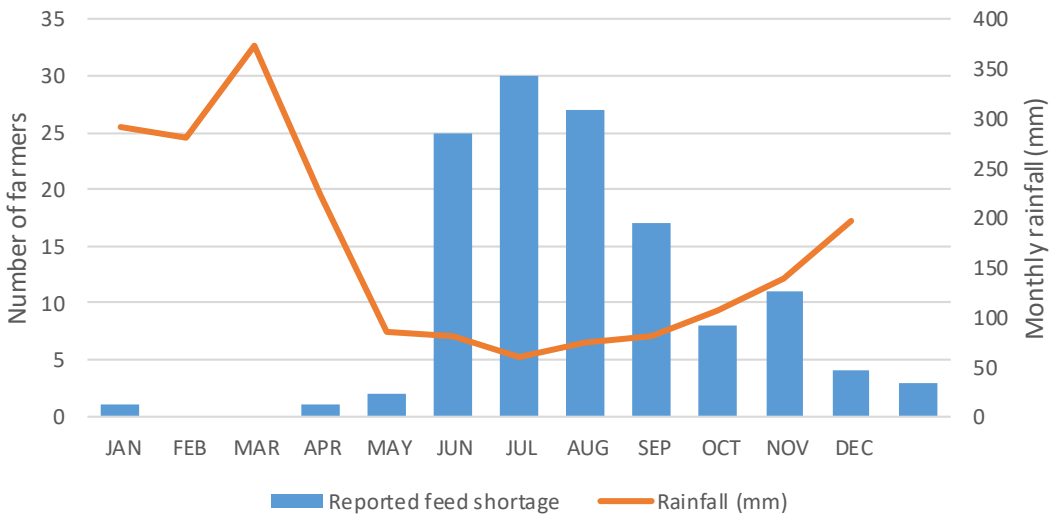

Figure 17: Incidence of farmer-reported feed shortages, and monthly rainfall

As farms are located on two different islands of Fiji, five different districts and a range of climatic zones, these pasture results are only a mere snapshot of the current situation on a small number of farms. Buts they still provide an important first glance at current pasture management and status which is useful for the development of future activities and research.

Research is required to identify which pasture technologies and grazing management strategies can best help farmers to better manage their pasture so that quantity and quality of feed are matched to animal requirements, and are most adoptable given the social, livelihood and production system constraints that farmers experience.

Figure 18: Mulatto II hybrid pasture was 'officially released' in Fiji in December 2017, following trials at Sigatoka Research Station. It is now being slowly scaled out to farmers (Photo Fran Cowley).

Box 9. The farmers' view: Feed constraints

In the dry season in Northern division farmers experience harsh dry seasons and have to cut and carry and use supplementary feeds.

"Access to supplementary feed is very difficult in Dreketi area where pasture growth is a problem. This is due to the soil type and to drought (big rains only come in December and January). Weeds also affect pasture growth, such as Chakorrr, but there are no weed controlling chemicals available."

Also in western division, in the dry season farmers have a shortage of pasture and have to buy supplementary feed such as molasses, copra mill, and meal mix. One farmer mentioned taking his animals to graze on other farmer's idle land, some distance from his own farm.

"There is a need for both farmers and MOA to work together in order for a better production of sheep/goat"

Body condition

A total of 279 animals (128 goats and 151 sheep) were measured for body size and body condition score (BCS; between 8 and 35 individual animals per farm; Figure 19). The general body condition scores were below desirable BCS of 2-3 in both species (average of 127 goats 1.4, average of 152 sheep: 1.8). On average sheep had a higher body condition scores than goats. The time of sampling was early July, in the early-mid wet season, and before most females had begun in kid or lamb. This indicated that flock average BCS was likely to fall further in the coming months.

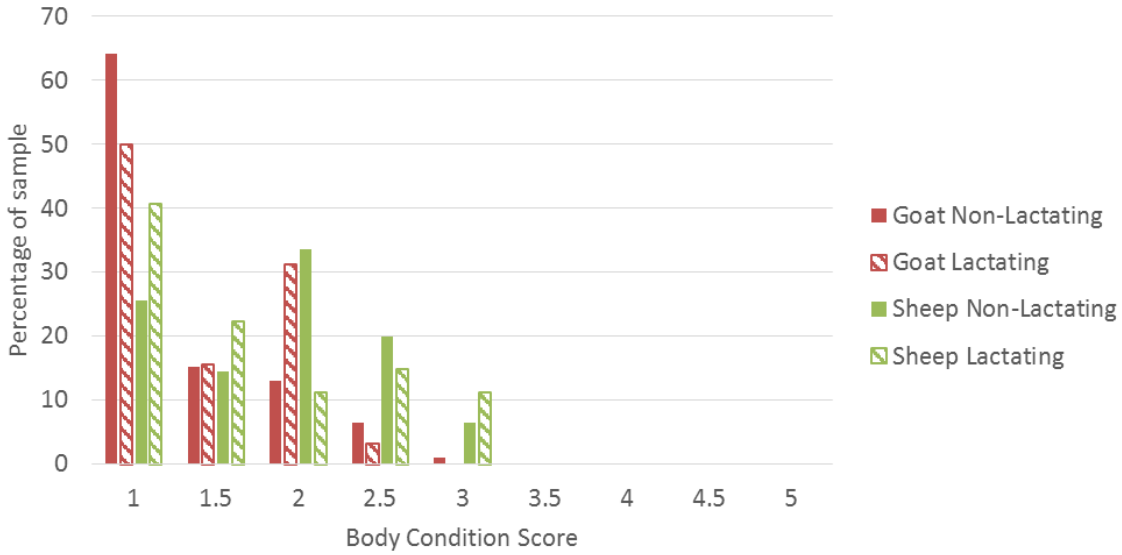

Figure 19: Distribution (%) of goat (red) and sheep (green) body condition scores

Reproduction

From surveyed farmer reports of the number of breeding females in their herds and the number of kids born last year, lambing and kidding rates appear to both be around 60%. This data has weak reliability, depending on farmer recall, rather than written records, but this result is in line with our expectation given our results of body condition scoring and observations of pasture availability.

In addition to poor body condition, low lambing and kidding rates may reflect poor flock structure management. Dr Colin Wakelin, veterinarian seconded to MoA, suggested that farmers do not cull old or unproductive females. If this is the case, then farmers would be wasting inputs (feed, drenches) on these animals. This could be contributing significantly to the poor productivity of Fijian flocks. When considered together with the high stocking rates reported above, especially on smaller farms, there may be an opportunity to encourage farmers to practice culling to improve their flock structure and productivity. Currently, the incidence of unproductive females in Fijian herds is unquantified. Research is required to identify the best way to help farmers identify such animals, and to understand farmer decision-making regarding culling.

Most small ruminant farmers practice uncontrolled mating. Fiji is at a high latitude, similar to Cairns, and so photoperiod effects on seasonal breeding should be small. A strong breeding seasonality is evident in all flocks observed, with the main lambing/kidding time occurring in the dry season, with a peak in months May – July, which is likely a combined effect of photoperiod and nutrition. This lambing/kidding period coincides with dry seasonal conditions, when GIN burdens are likely to be lower, however this is a time when feed may be in shorter supply, particularly in the Western and Northern Divisions. It indicates that conception is likely occurring in the mid wet season, when nutrition is least limiting (Figure 20). Research in Australia has shown that lamb survival is closely linked to maternal nutrition and in twin-born lambs in particular, drops rapidly, by nearly 20% per body condition score (BCS) decrease in mothers. Lambing in the wet season, although a time of greater feed quality and quantity, may increase lamb/kid mortalities due to environmental-induced illness and high GIN burdens. Farmers observed that lamb mortality is increased in the wet season, and attribute it to lambs getting 'sick' in the rain. It is possible that in Fiji's Northern and Western Division (dry zone) that these risks may not be as high as in the eastern wet zone.

Further research is needed to answer the questions of a) whether the benefits/costs of controlling mating season to target a period of better nutrition at lambing/kidding is a value

proposition for farmers; and b) which husbandry interventions could reduce neonatal mortalities for lambing in the dry season.

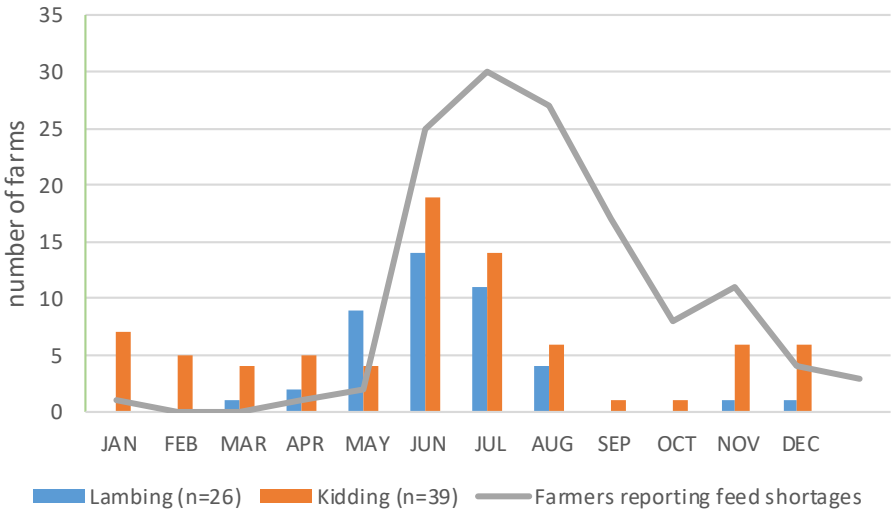

Figure 20: Incidence of lambing (green bars), kidding (red bars) and feed shortages (orange line), according to farmer reporting.

Of all household survey respondents owning sheep, 84% owned at least one breeding ram and 16% did not own a breeding ram. All survey respondents owning goats also own at least one breeding buck. Most farmers exchange their male breeding animals yearly or every few years (Table 13).

Table 13: Usage periods of male breeding animals on farms participating in the household survey

Interval of exchange	rams (% of sheep farms, n=32)	bucks (% of goat farms, n=40)
every 6 months	6.3	2.5
every year	56.3	40.0
every few years	21.9	40.0
other	9.4	0.0
not specified	6.3	17.5

Renting male breeding animals was not common in the participating households. Only 16% of sheep farmers (n=5) and 15% of goat farmers (n=6) rent a male breeding animal for mating. Two farmers payed for ram hire (200FJD/year), and 3 farmers payed for buck hire (330 FJD/year). For the remaining farmers, using rental animals was a service provided for free by friends and neighbours.

Mating is neither controlled nor not restricted on the majority of farms. 75% of sheep farms do not castrate male lambs, 85% of goat farms do not castrate male kids.

Disease

Surveyed farmers were asked about the most common health symptoms they observed on their farms (Table 14). Scouring (97%) and ill-thrift (57%) were the most commonly cited health issues. Both are likely related to GIN: *Trichostrongylus* and *Nematodirus* are known to cause scouring, and *Haemonchus contortus* (Barbers Pole Worm) is likely a cause of ill-thrift (anaemia). More information is needed to identify which classes of stock

experience these symptoms and at what time of year, so that appropriate interventions can be trialled.

Abortions and neonatal mortality were the next most commonly observed health issues (~30% of respondents each). More research is required to understand the causes of these two significant contributors to low farm productivity and low lambing/kidding rates.

Gastro-intestinal nematodes

Gastrointestinal nematodes (GIN) were an important topic for all surveyed farmers. All farmers manage GIN by drenching and 38% also use rotational grazing as additional GIN management strategy. Most farmers (88%) drench their animals at regular intervals. The average time between drenches is 1.6 months (ranging from 0.5 to 5 months). The average cost for a bottle of drench was F$25 and an average of 3 bottles were needed by farmers for one drench (range: 0.5-12 bottles). Nine survey participants reported that they hire additional labour specifically for drenching, which costs them an average of F$29 per drench.

Table 14: Symptoms of illness reported on survey farms by farmers

Symptom	% of all farms (n=35)
Diarrhoea	94.3
Losing/not gaining weight	57.1
Lameness/injury	34.3
Young lambs/kids dying	31.4
Abortion or lambs/kids born dead	31.4
Skin problems	31.4
Sleepy-looking	25.7
Nasal discharge	25.7
Rough hair	11.4
Mites or fleas or itchiness	8.6
Coughing	5.7

On-farm sampling included a bulk flock worm egg count (separated by species), to estimate average load of GIN. Average WEC were higher for goats than for sheep, even on the same farm. This is consistent with evidence that goats have lower immunity to worm infection (Hoste *et al.* 2010), and metabolise drenches faster than sheep (Knox and Hunt 2014). The results were very high for both species (sheep >1400 eggs per gram (epg), goats >2400 epg), as WEC below 250 epg are considered low, between 250 and 750 epg medium and above 750 epg high. Larval differentiation was not conducted on these samples, but the high prevalence of diarrhoea reported in the farmer survey is suggestive of *Trichostrongylus* infection, and the reports of 'sleepy-looking' (anaemic) and ill-thrift-affected sheep are suggestive of *H. contortus* infection (Table 14). Both genus are known to be present in Fiji.

The fact that all sampled farms applied drenching regularly, leads to the conclusion that current drenching practices are not effective and are unable to control the present GIN burden. However, if there is no effect of drenching on worm infection rates, then this raises questions about why farmers are persisting with drenching, without apparent return on their investment in labour and product, and what this means for achieving change in drenching practices? Potential answers to the former question could be that a) farmers are unaware of the lack of impact of their drenching practices (due to lack of record keeping, seasonal variation or other cause), b) farmers continue to drench as a risk management strategy, believing that their situation would be even worse if they stopped, or c) the current level of worm infection actually represents an improvement compared to undrenched flocks.The widespread promotion and adoption of the practice of drenching whole flocks on a 21-28 day cycle is one of several factors likely to be promoting drench resistance and/or poor GIN control on farms in Fiji. Other high risk practices (Paraboss 2018) observed in Fiji include: under-dosing, lack of renewal in available drench classes, use of drenches singly, instead in combination, and drenching onto pastures that have very few unselected worms on them.

The drenches which are available in Fiji are all 30 – 60 year-old drench families – levamisoles, benzimidazoles and macrocyclic lactones (Ivermectin). These are used singly in rotation depending on availability from MoA, the only supplier of drench in Fiji.

The availability of different drenches depends on the procurement division of MoA, rather than advice from DAHP. Key recommendations for improved drenching are to introduce modern families of drench, promote the use of combination drenches, use of non-chemotherapeutic management of GIN, and promotion of strategic and tactical (rather than routine) drenching programs.

It is likely that drench resistance is a threat and its incidence on farms in Fiji needs to be testing with faecal egg count reduction tests (FECRT), before development and testing of more strategic approaches to GIN management that incorporate the principles of integrated parasite management (IPM).

IPM strategies which may be beneficial in Fiji include improved nutrition, strategic drenching based on class of animal (e.g. lambing females, weaners), visual assessment of anaemia (e.g. FAMCHA, for *H. contortus*), preparing clean paddocks, and working with climate limitations to GIN larval development. It is likely that a basket of options will need to be tested for effectiveness *combined with* adoptability by farmers.

Infectious diseases

Brucellosis and tuberculosis (TB) are both present in Fiji. The Brucellosis and Tuberculosis Eradication Campaign (BTEC) has a budget of F$1 million per year and 15 staff, and is focussed on cattle, with no activity related to small ruminants. This campaign runs a test and cull method, and farmers of culled animals are compensated and my take part in a livestock rehabilitation program that provides replacement animals and infrastructure. The BTEC model does not conduct routine monitoring, but relies on sampling from meat inspections at abattoirs, and reporting of outbreaks at farm level. However, because the majority of sheep and goats are not slaughtered through formal abattoirs, carcase sample numbers are low.

Brucellosis had been thought to be eradicated from Fiji since 2009, however a large outbreak occurred in dairy herds in recent years. While focus has been on brucellosis during the outbreak, testing for TB has ceased or been reduced, and its incidence has consequently risen.

Footrot is a problem in the Central Division due to its high rainfall, and in other parts of Fiji during the wet season. Scabby mouth outbreaks have worsened in recent years.

Breeding and Genetics

The main breed of goats in Fiji are a naturalised hybrid of Anglo Nubian, Saanen and Toggenberg descent. Most sheep on Fiji are of a locally produced breed called the Fiji Fantastic Sheep (FFS), developed in Fiji over ten years from 1980 from Wiltshire Horn and Barbados Black Belly genetics. These breeds appear to be highly adapted to the intense seasonal dry and wet conditions in Fiji. To upgrade the genetic potential of sheep and goat bloodlines in Fiji, in 2016 the government imported 52 Dorper breeders (males and females) and 20 Boer goat breeders to inject new genetics into the nucleus studs. However, key informants are concerned that these new bloodlines will soon be dispersed throughout the nucleus flocks and inbreeding will result unless strategic breeding plans for the nucleus flock are put into place. The breeding management of flocks on MoA research stations should be investigated for opportunities to improve breeding plans to control these issues. If breeding plans were put into place for nucleus flocks, it was suggested by key informants that these could then be used to devise and implement strategic breeding objectives, such as GIN resistance, and improved retail meat yield. The MoA has recently appointed a breeding consultant to assist with devising and implementing breeding and management strategies in nucleus flocks.

There are concerns about the adaptation to local environments and management required for new Dorper and Boer genetics, with some farmers reporting that these South African-derived breeds are able to cope in the intense humid tropical wet season, although they thrive during the dry season. There is a need to research which traits are advantageous to

smallholder and semi-commercial farmers, either in terms of on-farm productivity or marketability. An analysis of which traits have the greatest impact on the profitability of these enterprises would provide crucial information to inform government selection strategies for their nucleus flocks.

The distribution of improved genetics in Fiji is managed by a system of government nucleus breeding flocks and commercial multiplier flocks. The Government of Fiji has recently made purchases of Dorper sheep and Boer goat breeding stock from Australia to improve the genetics of nucleus breeding flocks. These breeding animals are kept in nucleus stud flocks on the MoA research stations, which are scattered throughout Fiji's three largest islands. The offspring from these stud flocks are sold at a government discounted price to commercial sheep and goat producers (more than 200 head). It is intended that these commercial producers act as multiplier flocks for improved breeding stock, which would then be sold to small producers. However, in practice, small producers are bypassing the multiplier flocks and purchasing breeding stock directly from the government nucleus flock so as to obtain the government discount, rather than pay commercial prices to the multiplier flocks. As a consequence, multiplier farms are now tending to castrate their males and sell them for slaughter.

Bypassing commercial multipliers is not necessarily a problem, *per se*. However, potential issues that may be arising as a result of bypassing the multiplier flocks may include:

- Reduced nucleus stud flock numbers at Government research stations from sales,
- Impacts on multiplier flocks business models,
- Reduced incentive for multiplier flocks to participate in national programs or partnerships with government and smallholders.

The MoA is aware that this program is not working as intended, and are considering revising their policy so that the commercial multiplier flocks are the primary source for small producers to obtain their improved bloodlines.

In common with many developing livestock systems, discussions with key stakeholders in Fiji often suggested that the local sheep and goat populations suffer from inbreeding depression. It is suggested that this is the cause of a reduction in animal size over the last 20 years. Certainly inbreeding depression is a risk among small goat or sheep flocks, especially where castration is not practiced and mating is not control, and where offspring may therefore be mated back to a parent. Inbreeding may be a problem in the Government managed nucleus flocks (which are the source of stock for ram and buck distribution programs), as for many years, there were no new animals brought into the research stations, and what were originally several separate lines of stud stock have now been bred together in an unmanaged manner. However even if this is the case, when out-crossed to ewes in commercial or smallholder flocks, heterosis should resolve any inbreeding depression, although may not counter the increased occurrence of deleterious alleles from inbreeding.

7.2.7 Farmer typology and livelihoods

The following results are from the household survey and FGDs conducted in June 2017 in collaboration with USP and MoA. The sampling cannot be considered random but gives a representation of households involved in small ruminant farming, and particularly farmers registered with and known to MoA.

Size of flocks and land area

Farms can be classified according to the scale of operations and therefore the number of animals. The scale of farms tend to fall into orders of magnitude groupings of the number of animals – several, tens, or hundreds of sheep and goats, corresponding to the non-commercial, semi-commercial or commercial nature of enterprises. The majority of farms have a very small flock size of about 20 animals (Figure 21). MoA classifies SR farmers

as ‘commercial’, with flocks over 100 head, ‘semi-commercial’, with flocks of 20-100 head, and ‘smallholder’, with flocks of less than 20 head, and we have applied those definitions here. This report used farmer-reported annual incomes in some analyses, but has not applied any quantitative classification of farmers into wealth categories. However, in FGDs farmers applied their own definitions of “poor” and “wealthy” farmers.

A large number of semi-commercial farms with less than 100 head were encountered and some were land and capital limited. Some of these farms have potential to increase productivity and perhaps develop markets in Suva and Nadi. The semi-commercial farms visited had inadequate infrastructure, especially fencing for adequate rotation and relied on frequent drenching.

The largest privately-owned flocks were >150 head of small ruminants as well as other species of livestock. These are classified by MoA as ‘commercial’ and were generally owned by people with other sources of income and capital, who were building flocks. These businesses have potential to become lead businesses, having the resources to develop markets and acquire the technical capacity needed for improved efficiency. They could then demonstrate efficiencies to semi-commercial and small-scale farms. It is early days for these farms, however the timing is perhaps opportune as the industry is growing. These farms may offer an opportunity for collaborative marketing or out-grower systems in conjunction with semi-commercial and smallholder farmers.During the household survey most farmers, regardless of current flock size or land area, said they are aiming to increase flock size to about double the current size for goats and more than double for sheep (Figure 21). Ninety-four percent of sheep farmers and 88% of goat farmers had plans to increase their flock size. Most farmers do not buy in stock, except for breeding males, and rely on natural increase to grow their flocks. While it is unlikely that most farmers will be able to achieve these expansion goals, it is an important finding, which indicates the confidence that these farmers have in the market for SR.

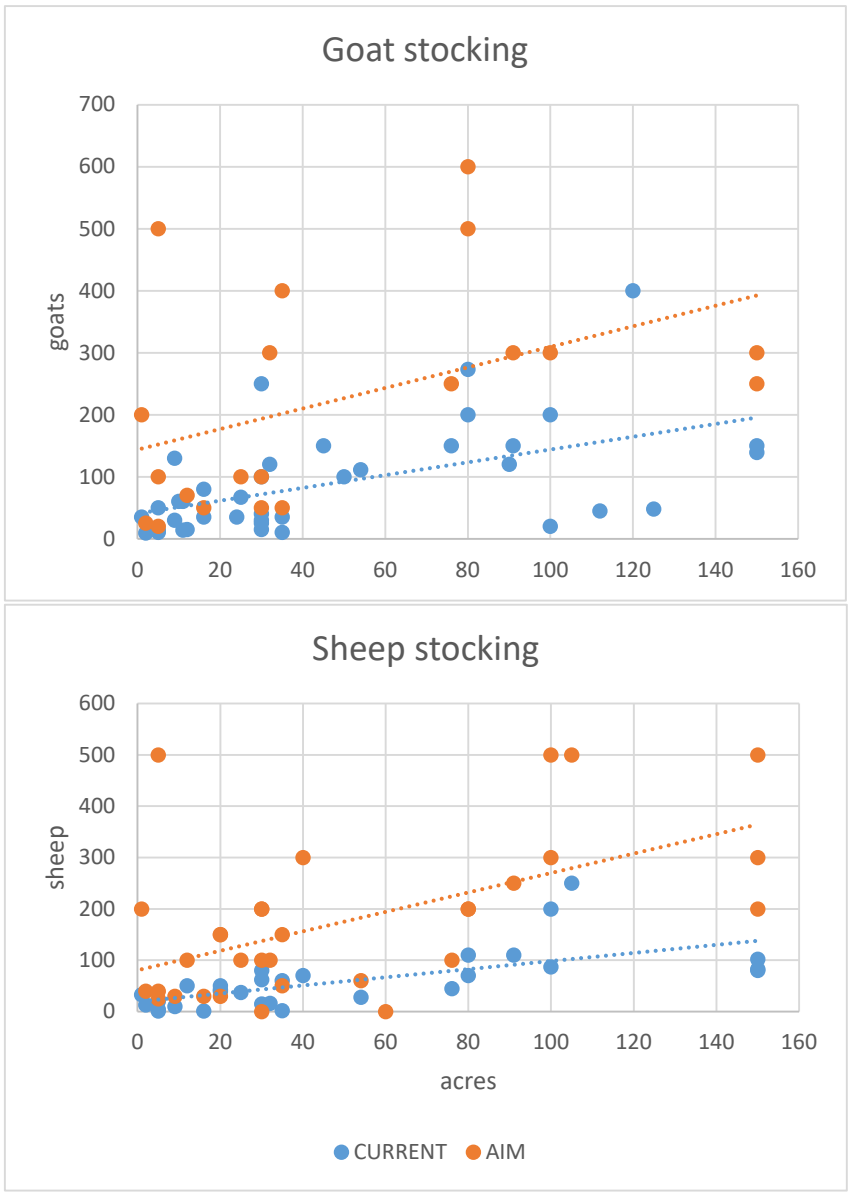

Figure 21. Farmers' current and future goals for flock size, according to current area of land that they are using for small ruminant farming. Future stocking is the aimed for flock size for farmers who indicated they were increasing flock size.

Mix of household income enterprises

Most small ruminant farmers surveyed pursue a diversified livelihood strategy with an average of three agricultural and/or income earning activities (ranging between one and six) listed by survey respondents. For many farmers in the study, sheep or goat farming is important, but not the most important income source. Non-agricultural work, cane farming, dairy cattle, and vegetable farming were cited as being more important.

Small ruminant farming is most commonly one of 2 or 3 income producing activities, and produces on average a third of household income (Figure 22). There was no relationship between flock size and the number of income sources. Average household income increased with more income sources (Figure 23), highlighting the value of diversified agricultural livelihoods. For 13% of farmers surveyed, SR farming was the only source of income. For approximately 40 % of the SR farmers surveyed SR farming was the greatest source of income. About half the farmers interviewed also raised cattle as a source of income. Farms that had cattle or SR farming as the greatest source of income were

amongst the lowest total income households of farmers surveyed (Table 15), emphasising the significance that improved SR enterprises would have for these farmers. The most common income activities associated with SR farming were (in order) cattle, sugar cane, other crops and off farm work.

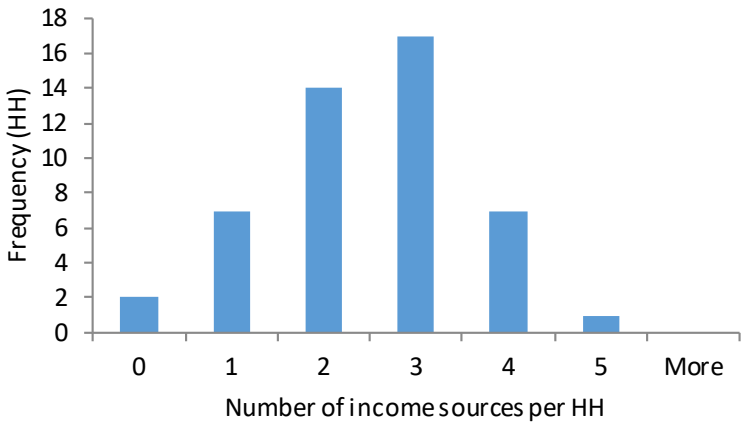

Figure 22. Number of income generating activities per small ruminant farming household (HH).

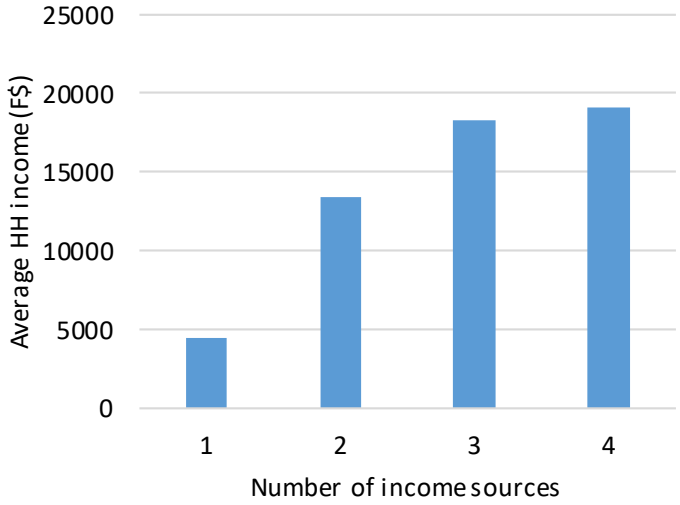

Figure 23. Average income (F$) of households (HH) by number of income sources.

Table 15. Average income of households with different primary income sources

Primary income generating enterprise	Average total household income (F$)
Small ruminants	9032
Cattle	8035
Crops	11450
Off-farm income	14750
Sugar	17260

The trend toward diversification has been accelerated by recent declines in profitable returns from sugar cane and labour scarcity. Small ruminants are commonly integrated with cane farming. Traditionally cane farmers have owned a majority of sheep and goats in Fiji because cane plantations have space to run large flocks, and small ruminants do not cause significant damage to cane once the crop has grown to a certain stage. Cane plantations are typically ~200 acres in size and often run flocks of ~ 100 sheep and goats.

There is a significant cane industry in Fiji, comprising more than 12,600 growers and contributing about 40% of agricultural GDP. Since 2000 there has been significant restructuring of the cane industry, with many farmers leaving the land and moving to Suva or other urban centres. This has had significant impacts on small ruminant production in Fiji. The restructuring of the cane industry was associated with several key factors. Firstly, sugar price fluctuations significantly reduce the profitability of cane farming. This will be exacerbated by the lifting of price controls by the EU. The expiry of large numbers of 99-year leases in 2002/03 and the reversion to iTaukei ownership has removed many (typically Indo-Fijian) farmers from their cane leases. These cane farmers were usually owners of large flocks of sheep and goats, which were sold off when the farm leases expired. This had a significant impact on the national small ruminant population, and coincided with a doubling of the value of sheep and goats. The availability of labour restricts many cane famers, and rising prices, plus debt levels and price fluctuations put growers under high financial pressure.

In the last past five years respondents said that sugar cane farming has become more difficult because of the higher costs of inputs, including labour costs, and the difficulty of securing labour, particularly during harvest season. While sugar cane still remains important for many farmers, additional activities that farmers are moving into include beekeeping, livestock rearing and vegetables.

Non-agricultural work is part of the household livelihood activities for farmers of different types, including better-off farmers, small and medium smallholders and hobby farmers. Examples of farmer non-agricultural occupations include: bus driver, own furniture and contractor business, bailiff (squatter settlements), civil servant, hospital worker, office worker, carpenter, school manager, feedlot factory worker, sawmill employee, market vendor, private company employee (e.g. cocoa cola plant). The minimum wage in Fiji is F$ 2.68 (A$ 1.71) per hour. Some farmers rely on overseas migrant remittances from spouses and sons and/or daughters.

Income from sheep and goats

Among survey respondents the average estimated annual income reached F$14,000 (AUD $9,000), ranging from as low as F$800 to a maximum of F$60,000 p.a. As to be expected, there is in general a positive correlation between flock size and farmers estimates of the income they gain from sheep and goats. When this relationship is further explored (Figure 24 and Figure 25), some notable trends emerge. A number of farmers, across a wide range of flock sizes, are in flock-building phase and so are not selling stock, and currently generating very little income from either sheep or goats (Box 10). In goat flocks smaller than 50 head, there is no relationship between flock size and the income farmers estimate it generates, and some farmers with small flocks (<50 head) reported relatively large incomes from goats. In some cases these are farmers who derive a greater percentage of their income from goats. Financial illiteracy and lack of financial record keeping may affect the accuracy of farmer estimates of their income.

Box 10. The farmers' view: Income from sheep and goats

Three Indo-Fijian farmers in Ba said that goat and sheep are in demand and they get a good return. It is profitable. However, two of the farmers said that if they cannot sell their sheep and goat each year then they have to go into debt, while the third farmer had other profitable enterprises as a back-up.

In one FGD group in Ba, only one farmer in the group keeps small ruminants as a main income earning activity. He said that he only just gets enough return to cover the cost of production.

"*My income from goat production is not good because I have to use that money to hire transport to take my goats to the market.*" – iTaukei male farmer, Ba.

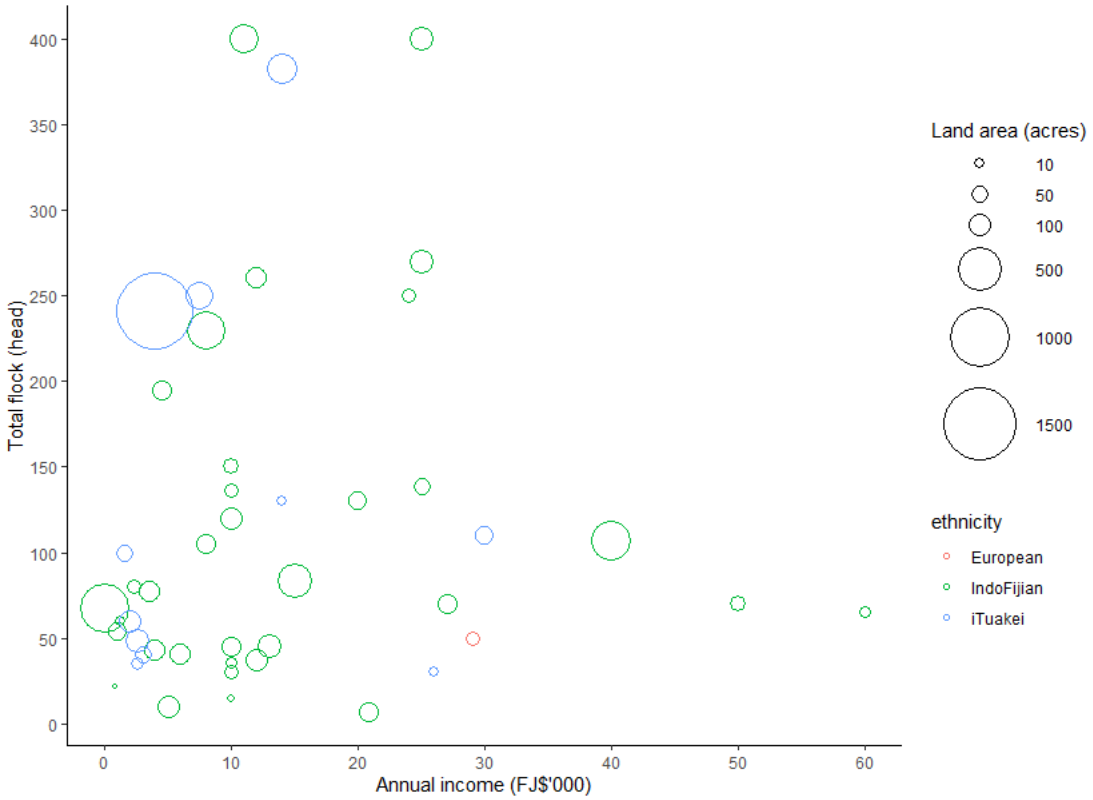

Figure 24. Relationship between total annual income (farmer assessment), and flock and land sizes, according to farmer ethnicity.

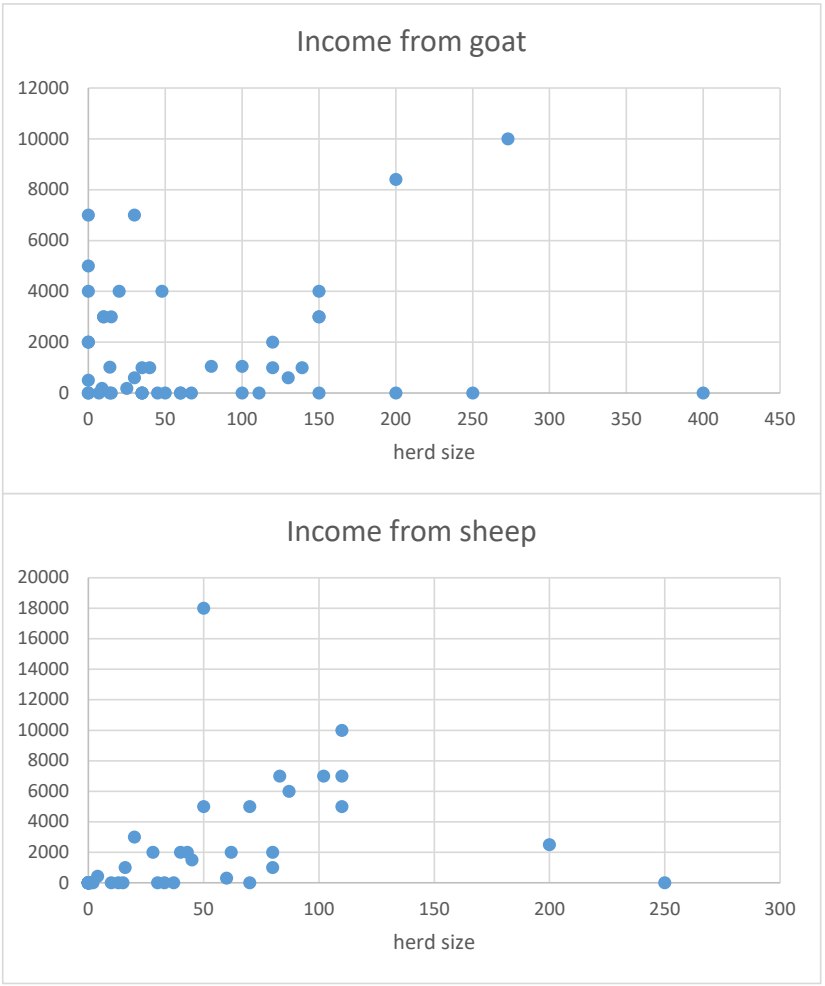

Figure 25. Annual income (farmer estimates) derived from goats and sheep only for different flock sizes

Although they were not included in the study, subsistence sheep and goat farmers do exist, keeping their animals near their home garden, mainly keeping them for home consumption and sometimes to sell to family members or neighbours.

7.2.8 Benefits of keeping small ruminants

As an income source

Farmers consider sheep and goat farming to be a good source of income relative to other livelihood activities, despite that the income is unevenly distributed during any given year, with the majority of their sales during the Christmas and New Year festive season. Most farmers sell according to their flock size, and sell a higher volume of stock then than any other time of the year.

Farmers stated that there may be times they are forced to sell out their sheep and goats, in times of need or emergency to help with cash flow, for example, when there is an unforeseen event such as illness or death. The trade-off is that they have to significantly lower the prices at these times in order to sell their animals quickly. Selling out to meet needs or for emergency is considered a more common practice for poorer farmers. For better-off farmers, short term cash needs are met by vegetable cash crops, and longer term cash is derived from livestock.

Benefits of small ruminants over cattle; and sheep over goats

Most farmers that participated in our research kept cattle, but preferred keeping small ruminants over larger ruminants, believing that small ruminants are easier to manage and are lower care and maintenance. Small ruminants also give birth more frequently than cattle, bringing more frequent income to the household and more quickly building up animal numbers. Farmers stated that the production costs of small ruminants are less than that for cattle: for example, their pasture/feed intake is less, and that with small ruminants a smaller land area is possible, for example, more than three sheep can be raised per unit of land compared to only one or two cattle on the same unit of land.

Some farmers prefer small ruminant farming to sugarcane, as the latter requires seasonal labour that is hard to secure. While hired labour inputs are required on a more regular basis for small ruminants, most farmers had available family labour. Farmers also compared the benefits of keeping sheep rather than goats, stating that sheep have a faster growth rate because they are continuous eaters and that sheep are less prone to diseases. Our on-farm sampling supported this in terms of WEC, with goats having GIN burdens almost twice as high as those of sheep, although few clinical symptoms of GIN infection were observed during on-farm sampling of either species.

Use of land otherwise unsuitable for alternative farming pursuits

In relation to land, sheep and goats are useful for clearing up or maintaining a piece of land (removing the need for human labour). For farmers with non-arable land and hilly, steep, stoney, rocky areas that are not suitable for cropping or other farming, sheep and goats allowed them to put this land to use. Manure collected from under small ruminant housing is used for improving soil for vegetable farming.

Sheep/goat meat for household consumption

Better-off farmers and those with large flock sizes or commercial enterprises consume their own sheep and goat meat on a regular basis, whereas those semi-commercial and hobby farmers with smaller herd sizes tend to consume their own stock on special occasions (maqiti feasting) only. Among the survey participants the average annual household consumption was 2.8 sheep (range 0-13, n=32) and 6.5 goats (range 0-30, n=40).

The most common dishes made from sheep and goat meat that farmers mentioned are turmeric curry and barbeque. Maqiti occasions include religious holidays like birthdays, during the Christmas-New Year period, and when hosting visitors (especially those visiting from urban areas or from overseas). Because refrigeration is uncommon, fresh meat needs to be consumed immediately and for this reason the meat is shared amongst family, friends and neighbours. One farmer stated that in his household they do not consume their goat meat since his family members considers the animals to be *a part of their family*. Those who do consume their own sheep and goats consider it to be a good source of fresh meat that is readily available when they need it, a good source of protein and a healthy (lean) option.

Gifting, religious obligations and festive purposes

Muslim farmers gift live goats or goat meat on religious holy days (Eid). For example, under Islam, Muslims are required to donate to the poor as part of their religious obligations. The gifting of sheep and goat to be sacrificed is especially important during the annual holy fasting month of Ramadan and on Eid Al Fitr – the Islamic religious holiday that marks the end of Ramadan). Some Muslim farmers spoke of their Muslim relatives living and working overseas sending money to purchase goats to be used to fulfil their religious obligations during these periods. For example, a farmer described how he will slaughter one of his goats in the name of the overseas relative to give to a poor family.

Some farmers gift sheep and/or goat meat for community fundraising and especially for Muslims, for family weddings and funerals. Farmers also sell sheep and goat meat for Muslim wedding feasts, whereas the Hindu religion does not use goat or sheep for this purpose. In Fiji, citizens of all religious denominations celebrate Christmas, not just Christians, so for most farmers, whatever scale of sheep and goat operation they have, their greatest sales are at Christmas.

7.2.9 Involvement of women, youth and marginalised groups in sheep and goat farming

The role of women in sheep and goat farming

The issue of gender roles in agriculture in Pacific countries is an ongoing area of concern. From the UN report, Rural Pacific Women and Agriculture:

"*Women continue to be constrained by persistent and near universal gender discrimination. This manifests itself most clearly in women's unequal access to land, which is frequently held communally in ways that do not always provide women with adequate decision making powers even when they perform the vast majority of agricultural work. Women also suffer from more limited access to training, credit, and job opportunities than their male counterparts, as well as an unequal time burden in which women are expected to engage in agriculture as part of their normal household responsibilities* (UN Women 2012)."

Some information on gender roles in farming can be gleaned from government reports. It is important to remember the limitations of data that is gathered without this specific question in mind. For example, the 2009 agriculture census in Samoa identified 23 % of farm operators as women. This is a much higher percentage than was seen in previous census results. However, the increase may only be a result of the phrasing of census questions; prior to 2009 the responder was asked to identify only one farm operator per household, but in the 2009 census responders could identify one or more farm operators per household.

The Fiji 2009 agriculture census reports 96.4 % of farmers are men, and 3.6 women. "Farmer" is defined as the head of operations and decision making on the farm. However, farming households are almost evenly divided by sex, with 53.8 % of the household comprised of males, and 46.2 % female. Women participate in the livestock husbandry tasks, including the daily feeding, milking, and grazing of sheep and goats, but at slightly less percentages than men in the households. The census tallied three types of farms: crops, livestock, and mixed. Out of all women farmers, 12 % are livestock- only farmers, and 53 % have mixed farms. This differs slightly from male farmers, out of whom 3 % farm livestock exclusively, while 59 % farm mixed livestock and crops. The Government of Fiji is specifically interested in growing the role of women in livestock farming, and includes this as one of the 4 goals to attain in the next 20 years in the Fiji Livestock Sector Strategy 2016 (Fiji Ministry of Agriculture 2016). The goal is to increase the proportion of women in all areas of livestock farming by 2020. Fiji also aims to increase the amount of women working in the MoA, with a special focus on training women as extension officers to work with women farmers (Fiji Ministry of Agriculture, 2016). "*The Strategy will provide training scholarships to youth and women interested in livestock farming and livestock business. The training will aim to result in skills for business planning, financial management and qualification for loans from FDB and commercial banks*" (Fiji Ministry of Agriculture, 2016).

Box 11. The farmers' view: The role of women in sheep and goat raising

With respect to how much farm work women do, and how hard they work compared with men, a male Indo-Fijian farmer stated that:

"Women farmers work extra hard. Even harder than the men because my wife looks after the goats, sheep, poultry (chicken and duck) and also does all the housework, as well as helping me with harvesting 10 tonnes of rice."

From a male farmer in Northern Division:

"For a [male] farmer to be successful, his wife needs to be very hard working too and always push her husband to work harder."

Survey respondents were asked who in their households contributed the most labour to each of their agricultural and/or income earning activities. Due to the under-representation of women in the survey and FGD, the reliability of these results needs to be critically assessed as one household member must not necessarily be able to evaluate another household members activities accurately. Also social expectations on reporting workload could limit the reliability of these figures.

Most household survey participants were (male) household heads. In all participating households they were also the decision makers concerning the different aspects of goat and/or sheep production: Buying and selling (respondents deciding alone in 91.7%), breeding (85.5%), feeding (87.5%) and disease management (72.9%). On 8.3% of farms respondents stated that others decide on disease management.

Across all six fieldwork sites, labour for the management and care of small ruminants is provided mostly by both adult male family members and adult male hired labour. Of the male survey participants, 55-60% reported that they contributed the most labour on their farm to SR production, and 10-15% reported that women in their family contributed the most labour. This contrasts with cattle production, where 3% of men reported that women contributed the most labour in their households, and poultry production, where 79% of men reported that women contributed the most labour. Respondents were not asked to apportion labour amongst the household members, only which household members provided *the most* labour. Women are engaged in grazing, feeding, supervising animals, caring for lambs/kids, and GIN drenching (Box 11). The data reveals that women are much less likely than men to be involved in buying and selling animals and record keeping. Constructing and repairing fencing is mostly done by men.

More detailed time budget research may reveal interesting patterns in the share of household labour for SR. For example, in Indonesia, socioeconomic surveys indicated that the women's share of involvement in rearing small ruminants increased as more animals were reared (Devendra 1999). Further research is needed to understand how women perceive their roles, what their aspirations are for SR enterprises, and what benefits SR bring to women. LS/2017/033 is researching the costs, benefits and motivations for men and women farmers to make improvements to small ruminant production systems in Fiji and Samoa.

The role of MoA in the selection of participants led to a certain bias towards farmers already cooperating with the Ministry, excluding representation of marginal groups. Target households for fieldwork participation were those who were actively pursuing sheep and goat farming as a livelihood strategy, which would likely have excluded subsistence farmers from the sample, and this could have had a disproportionate impact on the gender balance of the fieldwork. The social structure of farming communities (see section 7.1.10 below) meant that fieldwork participants were engaged with for this activity on a individual by individual basis, relying on existing MoA networks, rather than recruiting participants through a village hierarchy. Despite having a female local coordinator for the household survey on the SRA team, and requests for farmers (including women) to attend interviews, individual households made the decision about which household members participated in the fieldwork, with most households represented only by the male household head. Where women did participate, they usually attended with their husbands. With only one female survey participant and four female focus group participants, the sample was far from

gender balanced, which has an implication for the reliability of results illustrating the participation of women in goat and sheep production.

There do not appear to be any social, cultural or religious taboos or restrictions for either women or men to engage in small ruminant farming. However, the small number of women who participated in fieldwork may indicate several things: 1) women are currently poorly engaged with the MoA support and extension networks used to identify and recruit participants for this fieldwork, and/or 2) women do not have leadership and decision making roles in their households with respect to SR production, and/or 3) women are not chosen to represent their households in an activity such as this. This experience has demonstrated that more creative strategies are required to engage with women directly in SR research in Fiji. If current SR support networks do not effectively engage with women, new methods of engaging with women involved in SR production, perhaps derived from other women-focussed agricultural, social or religious networks, will need to be established. A strategy for undertaking this engagement and inclusion, informed by local women, will be necessary for any future research.

Sheep and goat farming by poor farmers

Thirty-two percent of farmers participating in our fieldwork reported that their total household annual income was F$ 5,000 (AUD$ 3,200) or less. An additional 25% of participating farmers reported that their total household annual income was between F$ 5,001 and 10,000 (AUD$ 6,385) (Figure 2).

Farmers believe that livelihood activities are fairly similar across different wealth groups, but better-off farmers tend to do both livestock (including small and large ruminants) and vegetable farming at a larger scale. Farmers in Western Division stated that better-off farmers are more able to produce and participate in markets because they have farm assets such as tractors, land, and building materials. They also have more access to government assistance than poorer farmers, because MOA gives assistance to more established/bigger or better-off farmers. Farmers in Western Division identified that poorer farmers have limited land, and they don't have access to grants or loans or help from outside sources, such as government and NGOs compared with wealthier farmers who are given first choice in assistance.

Box 12. The farmers' view: Poor farmers

"If we have finance then our farm work will not be impacted, we can continue to make changes. But a poor farmer has to wait for the finance. A rich farmer can increase his flock size easily, a poor farmer has to sell out the flock in order to look after the household." - 40 y.o. married Indian-Fijian farmer

A harsher view of poor farmers was also aired, believing that their disadvantage was due to their own attitudes and behaviour. In Bua, farmers were of the view that poor farmers are lazy to cultivate the land or do farm work activities:

"Poor farmers depend on the government for everything, but once they are assisted they do not bother to work hard, they tend to be lazy because everything is given to them. There's no such thing as poor. If you work hard, then you won't be poor. Rich farmers work hard and they spend most of the money from their pocket." - 81 y.o Indian Fijian male married farmer

The role of young people in sheep and goat farming

In the households participating in FGDs, children often assisted their families in SR farming. Boys provide family labour for grazing, feeding, drenching, fence repair, caring for lambs/kids, cleaning sheds. Girls do all of the same tasks as boys except fence repair, but the use of their family labour is less common. Farmers do not commonly hire the labour of boys and girls or young adults.

Farmers across all six research sites believe that older people are farming more than younger people, and that young people show less interest in farming than in the past. Older people in rural areas are looking after the household and farm while younger people tend to be out working in non-agricultural jobs, or have migrated to Fiji's large urban centres (Suva, Lautoka, Nadi) for employment.

Farmers in western division discussed the fact that the rise in children's rights has affected the conventional family structure. They felt that parents have difficulty communicating directly with their children and being able to influence their children's future, in particular, their career choices. A couple of farmers were of the view that they should try to teach their children farming activities, and to do this from an early age, otherwise the children are more likely to opt for white collar jobs or higher education.

With discussions centred on older farmers, one farmer (41 year old iTaukei male married farmer) noted that most i-Taukei farmers cease work when they reach a certain age compared with Indo-Fijian farmers who work until they can no longer walk.

7.2.10 Community structures and forms of farmer cooperation

Community structures

Most farmers interviewed lived on and operated extensive grazing or sugar cane farms, and did not live in a village. While having a sense of local community, the Indo-Fijian farmers (the most significant group in Fijian SR farming) do not have a physical or notional village community structure, with a village head or council, and instead behave as individual actors, geographically distributed on their independent farms. iTaukei farmers belong to a *mataqali* (clan or landowning unit). Despite playing a role in allocating family-owned land, the mataqali sometimes play little role in communal organising or action regarding the use of an individual farmer's land. Some iTaukei farmers live in a village and travel out to their farms to work, but many live remotely, on their farmland.

Religion plays an important role in multicultural Fiji, and religious gathering places and communities (whether church, temple or mosque) are an important organising force in communities.

This dispersed community structure has implications for the engagement of farmers in, and implementation of, future farming systems research projects. Farmers would likely need to be recruited into the project on an individual basis, relying on existing networks (MoA, perhaps church-based), and word of mouth, rather than through a village head. This could bias the sample (as observed in the fieldwork in this project), and slow the rate of recruitment. Similarly, because farmers do not live in a group village, field workers would need to travel significant distances on poor roads between individual farms, limiting the number of farmers that a single field worker could engage effectively with, in a month.

Livestock and labour exchange

Some forms of cooperation exist between small ruminant farmers within their communities. Most farmers stated that they exchange male and female breeders with other farmers in order to improve their stock. Farmers loaning their male sheep and goat breeders to other farmers regularly occurs. Local practice is that farmers do this to help other farmers, without any payment required.

In all locations, forms of labour exchange are fairly limited, with labour mostly paid as cash wages. In rare cases, if farmers don't have enough cash they pay for goods and services, including hired labour, in sheep and/or goats. Another example is a farmer in western division who said he once exchanged his goats (and cattle) for one of his relatives' funerals and later his relatives supplied their labour on his farm. Sometimes farmers exchange their own or their family's labour for fencing and building pens/houses, but more commonly they share information to coordinate the supply of hired labour to surrounding farms.

Some exchange of sheep and goats occurs, for example, for horse saddles and for beef cattle with neighbouring farmers, and for farm labour provided by relatives. Sometimes farmers graze their livestock (including sheep and goats and/or cattle) on mataqali land and exchange their livestock for grazing rights.

Neighbourly assistance, informal arrangements and farmer groups

Despite the sense from surveyed farmers that communities were not as close and supportive as in the past, farmers do assist each other in small ways, as good neighbours tend to do everywhere. For example, farmers help out by monitoring their neighbours' sheep and goats if they cross their fence line, in order to prevent damage to vegetable farms. If damage does occur, informal compensation arrangements are usually made to avoid having to report the incident to police. Generally small ruminant farmers don't share their land for other farmers to graze, however, some land owners allow neighbouring farmers to graze their stock on their land, in return for those stock they *keep the land clean*. Farmers may also allow neighbouring farmers to access their land for grazing their animals while their neighbours' fences are under repair or their grazing land is under recovery.

Box 13. The farmers' view: Farmer cooperation

A 41 y.o. indigenous Fijian male married farmer believed that with so many young people migrating and with changes in the family structure, that the i-Taukei family bonds are slowly eroding. He believed that struggling individually in farming is a more common occurrence than in the past. He lamented that community attitudes have also changed:

"Before farmers used to do more things for each other, and they didn't charge each other money. Now almost every job requires payment, even if you have a good relationship with your neighbours."

Land is also accessed via informal agreements, i.e. outside of any legal agreement. In Northern Division, some sheep and goat farmers who have small amounts of land, and sometimes with the permission of others who have 'idle land' they can graze their animals on their land. In Northern Division some lands in the interior mountainous areas that are considered 'idle lands' are shared for open grazing, with some farmers using expired lease lands. Other farmers ask permission from landowners, and in lieu of payment landowners allow grazing in order to keep their land maintained. This includes reserve lands and a small number of farmers access 'idle lands' of other farmers and landowners in the mountains.

In Western Division, farmers stated that they discuss market prices for sheep and goat and share market information with their neighbours. This could be during a kava session, or in a religious place. Farmers stated that they link buyers and traders to farmers. For example, if a buyer or trader requests a certain type or size of goat or sheep from one farmer or needs more stock and that farmer can't supply it, that farmer would likely put them in touch with another farmer in the area who can.

In all six locations no farmers are part of a production or marketing group for sheep and/or goats. A few farmers mentioned belonging to other groups – dairy, rice and beekeeping – and one farmer in Central Division was part of sheep farm association about 15-16 years ago. A few farmers in Northern Division had established an informal monthly discussion group for sheep and goats in the past, but had not been successful in keeping the group going.

MoA is beginning to establish 'farmer clusters' (since 2017). These groups of farmers began firstly in the dairy sector, around cooperative milk collection and processing. MoA recognised that their own regulatory requirement for a supervised farm to have a minimum of 20 breeding females excluded smallholders and semi commercial farmers from accessing government grants and other assistance. To overcome this, MoA has encouraged smaller farmers to arrange themselves into 'clusters' so that they can surpass the 20 head threshold. Few SR clusters have established themselves to date, and none which included our surveyed farmers.

7.2.11 Environment

Major changes that farmers discussed which had impacted on their farms in the last 3-5 years include natural disasters, such as cyclone Winston (western division affected).

Cyclone Winston killed entire flocks of goats and farmers had to start again (24 year old male hired labourer, on 1700 acres in western division). Human induced disasters such as bush fires from sugarcane burning are a threat, as they can spread to other farms.

More generally, the weather and climate change has affected farmer's cash crops. In Dreketi area, one farmer said that he bought land which was swampy but over time it had dried up because of drought. One positive outcome of climate change is that the swampy area which could not be used for a farming enterprise can now be used. Another farmer had converted his rice plantation into grazing land due to the same issue. Yet another farmer had 5 tonnes of rice ruined due to drought and extreme heat. Every farmer in the Dreketi research site agreed that the seasons have been disrupted. It now rains during the dry period and there is more extreme heat in the dry season. This overall affects the pasture growth rate. Farmers in Northern Division, Dreketi area, observe that drought persists for longer periods and there is heavier rainfall during the wet season. Because of longer drought seasons a major change for Dreketi farmers is switching from rice farming which is no longer viable, to small ruminant farming, highlighting the important role that livestock play in climate resilience.

Land degradation, caused by traditional slash and burn farming practices, extensive land clearing and farming of steep slopes, is widespread in Fiji. Consequences include reduced soil fertility, excessive erosion and in some cases, landslides and flooding. According to MoA, Government spends millions of dollars annually desilting rivers in Fiji because of excessive erosion. This also has impacts for the marine environment which affects tourism and fisheries. On-farm pasture assessments in July (early dry season) found that across 12 farms, 40% of measurement points had pasture 3cm or shorter. This is likely to lead to significant areas of bare ground as the dry season progresses. On many farms, an increase in stocking rates would likely lead to land degradation. A more sustainable strategy would be to improve the flock productivity per head, rather than flock size. LS/2017/033 will monitor key indicators of land degradation under SR production systems and provide training to project partners on monitoring and managing the environmental impacts of livestock. That project will also research strategies to increase productivity without increasing the size of the breeding flock, including: improved flock structure (based on culling and selection); improved reproduction rate; reduced lamb/kid losses; and weaning (which is practiced commonly in Samoa, but not Fiji). The project will use flock monitoring data to model the impacts of fulling and selection decision on enterprises and livelihoods and will assess farmer motivations and decision-making around culling and flock size.

7.2.12 How to reach farmers: sources of agricultural information

We inquired which information sources and media Fijian small ruminant farmers use to access agricultural information. Government extension, family and neighbours as well as radio and TV are the top three information sources. This emphasises that it is even more important to increase the capacities of extension officers on the ground to enable them to become real multipliers of technologies and knowledge on improved small ruminant production systems.

The use of social media is not very common amongst farmers surveyed. Unlike in southeast Asia, mobile data is expensive and service is poor. 63% of survey participants did not use any social media, 30% used Facebook, 17% email and 15% access YouTube. Other social media channels used by 2 farmers each are Instagram, Twitter and WhatsApp.

7.3 Vanuatu Sheep and Goat sector

Goats are generally in low numbers on most islands with the exception of Tafea province, the most southerly province of Vanuatu. There are small flocks of sheep on Efate and a very small flock on Santo (Table 16: Vanuatu livestock census data 2009

Table 16: Vanuatu livestock census data 2009

Province Species	Torba	Sanma	Penama	Malampa	Shefa	Tafea	Total
Cattle	2729	91830	22284	16082	21868	19344	174137
Goats	19	1348	85	976	2104	4260	8792
Pigs	2934	9645	24210	15763	14765	21378	88695
Poultry	12606	75182	87252	71502	54593	67116	368251
Sheep	0	293	0	0	1340	2	1635

Goats are kept on coastal low lying rocky areas (coral outcrops) with sandy soils. Original attempts to keep goats on the black soils typical of areas higher in the landscape were plagued with footrot. There are records of one larger goat farmer (700 head) in the north western area of the island at Big Bay, which would be more typical of the drier eco-agricultural zone on the western side. The western side of Santo is difficult to access. The only transport is by boat. All goat farms visited on Santo were on the south and east sides which are the wetter areas of Santo.

No farmers have detailed management. Goats are free grazed in extensive fenced areas during the day and return (are called in) to yard areas at night. Some farmers administer available anthelminthics (there is one vet supply business in Port Vila) as needed due to visual inspection (shiny coat, active and jumping, etc). Several semi-commercial farms were visited and many others were reported in more outlying areas.

There is no market except for farm gate sales of live animals for home slaughter and consumption at the numerous Kustom and religious festival occasions throughout the year (e.g. birthdays, circumcision, etc.). Prices quoted by producers on Santo ranged from 6000vt to 10000vt (AU$75 to AU$125) for a large young buck. Government staff interviewed said that prices on Tanna and Erromango (Tafea province) ranged from 10000vt up to a quoted top price of 21000vt (AU$250). This reflects a strong demand for goat meat on Tanna, higher population density and therefore less available land, and presumably less available other (substitutable) livestock. Prices of other livestock are also higher.

Small farms visited typically had about 20 goats as well as similar small numbers of cattle, pigs, and poultry. Most said they were currently not selling any animals as the Department of Livestock have introduced a policy to increase livestock numbers.

7.3.1 Institutional and policy environment

Vanuatu Agriculture Sector Policy 2015-30 is largely concerned with the larger export industries including copra, coca and kava, as well as staple root crops such as Taro, yam and cassava. Vanuatu released its first Livestock policy in early 2016. The policy addresses a variety of issues around livestock management but has no strategy elements specific to small ruminants. The policies aim to build the national cattle flock to 500,000.

The Vanuatu Department of Livestock has 17 staff across the country. They recently split from the Department of Biosecurity and so are short staffed. They advertised 17 new positions last year that required a range of skills including breeding, production and forage, however they couldn't fill the positions. Five young officers are recent Bachelor of

Agriculture graduates from USP in Samoa, but have little hands-on livestock experience. No other staff have qualifications.

There is a small livestock restocking program to offset a ban on female cattle slaughter to aid in achieving targets. This year they will also distribute 500 pigs, 500 goats, 1500 chickens, and 1000 ducks working with 2 projects (one German) and multiplier farms. The department had a proposal to buy 100 ewes and 10 rams from Fiji but the money was diverted post-cyclone for cattle on Tanna.

On Efate (Tafea province), Department of Livestock facilitates sales of goats for farmers. They conduct a live goat market, and can sell goats for farmers (passes on money later) and organise transport to abattoir. The farmers set the price for goats at 10000vt – 15000vt depending on condition. Numbers are very small, some goats come from nearby island of Ambrym, but most from Epi (47 last year) and Efate (10).

The goats are all local breeds and crossing between islands is practiced. All goats are extensively grazed with only a couple of farmers having improved pasture and none drenching. There is a farm with a pasture nursery and improved pasture cuttings are supplied to farmers.

There are 5 staff on Santo and they work on geographic areas. All staff must do multiple tasks, including paravet work, however this year they are concentrating on reaching restocking targets. According to one of the officers, the problem with farmers is they don't concentrate on one thing: "*Everyone is planting kava*".

7.3.2 Research capacity

There are no research facilities with goats or sheep. VARTC (French agriculture research institute) on Santo previously kept some small ruminants and there are currently 2 livestock field/technical staff. They have demonstration plots of pasture species and a small slaughterhouse under construction. Vanuatu Agriculture College provide certificate 2 level training in Livestock and have a lecturer in livestock (Sandy Mael).

Until last year there was a Vet on Santo from Solomon Islands, however the Department of Biosecurity funded contract ended. There is a private vet on Efate, the only one selling drugs in Vanuatu.

7.3.3 Slaughter facilities

Vanuatu Abattoirs (VA) near Port Vila on Efate, is majority owned by several land owners on Efate. They bought it from the government who still retain a 20% share. All meat destined for retail outlets in Port Vila must use a registered facility and be inspected. They process 100 sheep per year from one shareholders farm around Christmas (from one of 2 commercial sheep farms on Efate). All goes to butcher shops and the supermarkets and sells for about 1000vt per kg. VA only processed 20 goats last year and they are difficult to process.

Cattle is the main business and comprises 50% fee kill for butchers and 50% from shareholder farms for export. Systematic problem of females being killed resulting in the government 5 year ban on females being killed and trying to build numbers in small livestock to compensate. There was inter-island barge transport of cattle in the past but this hasn't happened for 3-4 years. Cattle quality from other islands is not good enough, except for Santo (and there are 2 abattoirs on Santo). The barge transport cost was 10000vt per head, with 70 head per trip. A previous trip the barge sank and lost all stock, so now the only transportation is abattoir owners new barge that has yards on top (no mortality) to bring cattle from nearby island of Epi.

Although there are two abattoirs on Santo, no goats (or sheep) are slaughtered there.

7.3.4 Goat farmers

There are several semi-commercial scale farmers, the largest is in the northwest, which is a drier agro-ecological zone. One grower near Ban Ban adjacent to the airport Madame Claire reportedly has 150 goats, and not enough land to feed them. These can be seen free grazing on the roadside. There are many smaller growers with 20-30 head and many with just a few. For example, some farmers use goats for weed control.

7.3.5 Case Studies

1. **Male farmer, Luganville**. Owns a large lease (800ha). His family has had goats on the property since he was a young. He owns 220 goats that are kept in a 100 ha fenced-off area. Since the goats were moved to the low coastal country he has experienced few foot rot problems. He has purchased bucks from different sources, one being Meauvaison on Efate (Part owner of the abattoir and largest sheep flock - see below on Efate). He doesn't use any controlled mating or separate any animals, but does castrate males. He has also recently bought two Dorper sheep from Navota farm.

This farmer is still improving the fencing on his property. He experiences no problems with dogs – he has a gun. He drenches the goats with Panamax (and other available brands) approximately 6 monthly when animal condition looks poor. He wanted to go organic but found it was too expensive, and the abattoir is not accredited. All animals are locally killed. He sells cleaned neutered young male carcass for AU$100, mainly to Chinese and Indian customers. However local growers in port Orly (30km north) undercut him and sell for AU$60.

2. Local staff at **Freshwater Plantation** on Aore are keeping approximately 20 goats under young coconuts and building a business producing goat cheese. They milk the goats (see figure with constructed milking apparatus) and produce cheese which is sold at the restaurant on the plantation. The plantation offers farm tours and a restaurant experience with local produce for tourists. Tourists can milk the goats, then eat the cheese as part of the tour. They originally acquired 10 goats and several months ago another 12, (4 does and 8 kids) from a goat farmer on Ratoua Island. The NZ owner of Freshwater Plantation advised them to rotationally graze the animals and to drench with anthelminthics available locally.

Figure 26: Freshwater plantation purpose built milking apparatus (Vanuatu) (Photo Geoff Smith)

3. Navota Farm Rural Training Facility, South Santo, is a 551 ha property adjacent to the Vasuvi river, owned by the Presbyterian church, and is now 40 years old. The farm was a partner for an ACIAR project on Sandalwood and Whitewood and has seed orchards of both species. They own 47 goats and 35 sheep (Dorper), both flocks stay out most of the time without shepherding, returning at night. The sheep are the only flock on Santo. They started sheep in approximately 2006 with 10 sheep purchased from the Catholic Mission Farm on Efate (Syndicat Agricole). Due to the situation there is no experience or information about goat or sheep management. Goats are selling live for 6000vt (AU$75) and sheep for 10000vt, although none are on the market.

The training centre is not certified and they are looking to return it to the Vanuatu Quality framework.

4. **Experienced male farmer**, inland from Luganville. We spoke to his son who has taken over the goats and other aspects of farming. As well as goats he has gardens, pigs, and milling timber for sale to Santo Veneer and a cattle property.

He currently has more than 150 goats and is building his flock to a target of 300. He sells for 500vt/kg live weight but has a target of 700vt/kg. As the property is on the banks of the River there are no rocky outcrops (although soil may be sandy). Therefore he uses old engine blocks for goats to stand on. He also cuts and uses peroxide to clean /treat feet. He injects antibiotics and drenches every 6 months. Castrates young males at 7 months, has previously purchased young male bucks.

5. Male government livestock officer. His approximately 5 ha property is located at Belaru outside Luganville (hobby farm). He has about 10 paddocks, 3 improved with signal grass. He has to water all stock every weekend from the river, about 1km away. He is currently running 8-9 cattle as well as some pigs and approximately 20 goats, which graze freely. This farmer only started livestock farming in 2015 and is currently building his flock.

7.3.6 Involvement of women in sheep and goat farming

Agriculture is the main occupation of almost all Vanuatu residents. Of all wage earning agriculture workers, 56 % are men, and 44 % women. (Vanuatu National Statistics Office, 2011). For women, the overall trend is moving away from jobs in agriculture. In 1988, 23 % of women were employed outside of agriculture. The 2009 census shows that 39 % of women are employed in non-agriculture jobs (Vanuatu National Statistics Office, 2011). The government has a stated goal for women to have equal access to agricultural development resources (Vanuatu Department of Agriculture & Rural Development, 2015). In Vanuatu, Women in Business Development is an organization of and for women farmers, providing training, local market distribution of products, and organic certification advice which has led to product export for international markets. However, at this time livestock farming is not part of the program (Women in Business Development Inc, n.d.).

7.4 Samoan sheep and goat sector

Samoa has a small (approximately 1300 head) but actively growing sheep flock which is being managed by the Animal Production and Health Department (APHD) within the Ministry of Agriculture and Fisheries and a key group of multiplication farmers. The program would greatly benefit from research collaboration and assistance. As with Fiji, the potential impact from import substitution is large. There are no goats in Samoa.

Samoa's population is 180,000 of which 97 % of the population are involved in agriculture in some way, either growing some crops and/or owning some livestock (Samoa Bureau of Statistics, 2016). This is an increase from 2009, which saw 16 % of the population not participating in agriculture (Samoa Bureau of Statistics, 2012). Of the total land mass 13 % is used for agriculture, which is about 57 % of arable land. A total of 85 % of farms are on customary land (Samoa Bureau of Statistics, 2016). This is slowly changing, with a movement towards freehold land. The 2009 census found 86 % of land to be customary, down from 90 % in 1999 and 94 % in 1989. Around 4 % is leased land, which has remained fairly consistent throughout the years. Freehold land use in agriculture has risen from 3 % in 1989 to 11 % in 2015. However, 90 % of freehold land is "small parcels in peri-urban areas (Samoa Bureau of Statistics, 2016). The majority of rural agricultural land continues to be customary land. As for Fiji, the customary entitlement of Samoan people to *aiga* land means that landless farmers are few, (most landless being urban) , and so sheep farming is not a strategy for landless farmers.

Historically agriculture played a more prominent economic role, however the contribution of agriculture to GDP is decreasing, contributing less than 10 % of the GDP in 2010 (Samoa Bureau of Statistics, 2012). The majority of agriculture is subsistence or for home consumption. Livestock farming is based in villages, with minimal commercial livestock production. Livestock raising households earn an average of WST$ 645 monthly from their animals. 99 % of this income is from cattle, milk, pigs and chickens; less than 1 % of the income is attributable to other livestock (Samoa Bureau of Statistics, 2016).

7.4.1 Government

The Animal Production and Health Department (APHD) within Ministry of Agriculture (MAF) is enthusiastic about the project and offered full support. The new MAF CEO was formerly a research scientist at USP and the head of APHD has a background in food technology and a strong interest in meat quality and processing. There are four divisions including: Animal Health, (5 staff: headed bya qualified veterinarian, Research (8 Staff), and Extension.

The government continues to be involved in sheep, providing extension services and distributing genetic stock to farmers (Ministry of Agriculture and Fisheries Samoa, n.d.-a). At this time, the government's only specific goal for sheep industry is to improve farmer's access to better breeding stock (Ministry of Agriculture and Fisheries Samoa, n.d.-a). The end goal is to promote food security and increase nutrition (Ministry of Agriculture and Fisheries Samoa, n.d.-b). Currently there are 4 government sheep stations, and 6 private multiplier farms (Renee Orange, personal communication 29th September 2017).

There is an active development program for sheep that has been boosted by the World Bank Samoa Agricultural Competitiveness Enhancement Program (SACEP) project (see below). This project has funded the Dorper imports and various other livestock activities as well as crops. A most important activity from a value chain perspective is the commissioning of two slaughter facilities, one mobile and one stationary. These are the first in the country and in the first instance are focused on cattle. There is a new meat act that will direct any commercial slaughter into these abattoirs with a 3 year transition period. The project also has a matched grant scheme that would be very appropriate to sheep. Although the sheep program is small, there has been good progress in the last few years in increasing flock size after introducing FFS stud stock and new Dorper genetics to breed with FFS. The program is conducted over three government farms on

Upolu. All the farms have good infrastructure with housing and sufficient small paddocks for rotation. The main farm has three separate mobs. The other farms contain crossbreds and FFS stock. The SACEP project is nearing completion (March 2018).

Animal Health services are provided by APHD and there is good data and provision of health services. On government farms there is a monthly muster and count to improve security and health monitoring. As well as foot treatment, the health monitoring includes WEC and subsequent drenching as required. Both health and research divisions have spreadsheets with data on health surveillance and multiplication program. Weight data is problematic, they have two sets of portable electronic scales however these are in high demand and there are problems with breakdowns. APHD has comprehensive and well planned standard operating procedures and guidelines for sheep production which it promotes and supports on all farms. It has an effective research and monitoring program which it implements on supported sheep farms. APHD would have good capacity to implement a research for development program, building on its on-farm research experience, and close relationships with the (relatively small) sheep sector in Samoa.

7.4.2 Research capacity

University of South Pacific has an active animal production department and teaches as part of Bachelor of Agriculture, There is no ruminant nutritionist in country since the university ruminant production academic moved to Fiji. They have small flocks for teaching purposes. USP staff strongly recommended ACIAR focus research on, or include, pigs and/or chickens. This misses the point of the large amount of underutilised grassland, as in Fiji, but is understandable given the dominance on mongastrics in PIC diets and in the skill sets of USP Samoa Staff.

Science Research Organisation of Samoa were recently amalgamated with MAF. Most importantly they have lab facilities. Ken Newton has used these for measuring crude protein levels of pasture species and cross checked using an overseas lab. There are no lab facilities for animal disease testing. The APHD veterinarian is keen to develop a "roadmap" for Animal Health in Samoa.

7.4.3 Production/management systems – farmer case studies

Multiplication farmers

The sheep multiplication program is at an opportune stage to get involved in a research project. There are 6 multiplier farmers variously approaching commercial size flocks (100 breeding ewes) and who are crossing recent Dorper introductions over FFS. These farmers are selling excess sheep to other farmers and for slaughter. They have formed an active group within the Farmers Federation of Samoa, which is making plans for the development of the industry, lobbying the government and beginning to market product (they have a logo, letterhead etc). The multiplication farmers encountered have useful and interesting combinations of skills. Farmer 1 is a businessman with diverse interests that is conducting his own research on pastures and is driving the marketing. Farmer 2 is retired from 30 years in the development bank, while Farmer 3 is a horticulturalist. There are also a range of management systems being used, more and less intensive. More details of the operations are presented below.

1. Farmer 1 – a businessman with several retail outlets, two car dealerships, coffee production and marketing, Noni Juice, and a strong interest in sheep farming. He is a very advanced and innovative farmer. He has conducted his own research on pasture, disease management and is developing a market for his animals. He owns two properties for sheep, 2 ac next to his house in Apia where he runs 30 breeding ewes in an intensive operation, and 200ac on Savai'i currently running 150 head with plenty of space for expansion. In Apia, he keeps breeding stock under closer supervision in Apia and manages intensively with supplementary feed (brewery spent grain, Noni fruit pulp, Ca_2PO_4, mineral salt block, $ZnPO_4$). The Apia property is comprised of several small

experimental pasture plots where he is testing establishment methods and combinations of Setaria, Albizzia, Vetch and guinea grass under cell grazing type arrangements. He has tested all these for crude protein etc. at the National Science Research Organisation Lab in Apia and verified at an overseas lab. He also has detailed data on reproductive performance, although no financial data. Like other farmers there is no controlled mating (there is weaning at 80 days) but lambing appears to be settling into a pattern with a peak in June to November. He has improved reproductive performance over several years to achieve rates of 145% and average intervals of 39 weeks. However, he is frustrated by growth rates of available genetics and the conformation of FFS and would like to import Australian White Dorpers, which appear to have better all-round genetics and resistance to foot scald problems in particular.

He has recently "cracked the market": a local supermarket chain is taking two carcasses per week. The supermarket said this is to assist local business but it is also the case that prices from Australia and NZ are very high. To facilitate this Farmer 1 has built a small slaughter facility on his property. Transport between islands is expensive (relying on a government-owned corporation) and requires careful planning for full loads in both directions. Currently animals must be inside a van (it is unclear why) and it costs 100WST for a return trip for a normal sized van. The mobile slaughter unit costs 600WST per trip.

2. Farmer 2 – is using an intensive system with supplementary feeding using spent brewery grain and other ingredients. He is approaching capacity of his shed with close to 100 breeding animals. He is retired from a career in the Development Bank.

3. Farmer 3 - is currently a project officer on a horticulture project. Another of the seven multiplier farmers, he has 97 head in 12 paddocks, reasonably close to Apia.

Smallholders

Several smallholders were visited. These farmers are building flocks by buying from multiplication farmers and others and breeding. They have generally only been farming sheep for several years, which are only recently becoming available in numbers from multiplication farmers and government. Typical flock sizes were 10-20 but had facilities suitable for, and were aiming to reach flock sizes of 40 upwards. Most had lower levels of knowledge and management skills, starting from a low base on a new enterprise with little assistance. The APHD Research Division inspects farms before authorizing sales of sheep (including from multiplier farmers) to smallholders, ensuring the infrastructure is adequate, if not the knowledge. The quality of pastures, etc. is quite variable. Unlike multiplication farmers, they don't receive subsidized health assistance and would benefit from extra assistance in the form of extension and training. Responsibility for extension to these farmers currently rests with Research Division.

Some smallholder famers have approached APHD repeatedly to purchase stock, but were redirected to multiplication farmers, only to return saying multiplication farmer prices were too high. This appears to indicate a healthy demand for stock as many farmers are building flocks.

The minimum wage in Samoa is WST 2.00 (A$1.02)/hour. More research is needed on the livelihoods of sheep farmers in Samoa, and the benefits brought to their households by sheep farming.

7.4.4 Existing Value Chain

Demand and supply of sheep and goats and their products

The 2009 census found 249 sheep on private farms. In 2014 the Animal Production and Health Division conducted a national sheep census and reported a sheep population of 827 sheep. (Ministry of Agriculture and Fisheries Samoa, 2014). The 2009 census found 128 goats in 7 households, but there are now no known goat farms in Samoa. There is an increasing Indian-Samoan population that provide demand for a small number of goats,

however it is not clear how big this market is. These same consumers would be a market for sheep carcasses, along with ethnic Samoans. There is a possibility that goat meat could be imported as the demand is very high at festival times. At this time, there are no Government plans to increase goat production.

In contrast, mutton is widely consumed throughout the country. Like Fiji there is huge potential to replace imported mutton and lamb. From 2008-2014, the amount of mutton imported has been decreasing, but still provides the majority of mutton consumed, at 755,738 kg imported in 2013, down from 2.8 million kg in 2008 (Ministry of Agriculture and Fisheries Samoa, n.d.-b). The sheep industry is new to Samoa, with the first 44 sheep imported by the government within the framework of an FAO program in 2004 (FAO, 2008). The FAO was also involved in a project to increase sheep numbers, "Sheep Integration into Traditional Farming," from 2007-2010 (Lee, 2012). Sheep were imported, housed, and multiplied at government research and breeding facilities, and eventually distributed to farmers (Fong, 2009). Education for farmers was also provided.

Sheep value chain

As in Fiji, the majority of sheep in Samoa are currently sold as whole animals at the farm gate for festival uses and cultural obligations, but (in addition to expanding SR market share for cultural uses) the greatest opportunities for development of the sector also lie in import substitution in retail meat markets. There are currently no well-developed market chains for local sheep meat within Samoa. Until recently there were no slaughter facilities, however there is a recent Slaughter and Meat Supply Act that requires cattle (in the first instance) to be slaughtered in a registered facility, with a 3-year period for transition. The APHD Health division is responsible for the mobile slaughter facility. Similar plans for the modular facility on the outskirts of Apia are that it will initially be government owned. Case study farmer 1 has built a small slaughterhouse on his property for the sheep he is selling to a supermarket.

Visits to several supermarkets didn't find any evidence of local meat. Supermarket prices were highly varied for different meats. Imported lamb was WST$ 30 – 40 (A$ 15 – 20) /kg; the cheapest meat was US chicken legs for as low as WST$ 4 (A$ 2) /kg. Due to the small market, supermarkets often buy directly from famers who slaughter on farm. There is therefore little coordination and quality control.

Agricultural inputs are very limited in Samoa, with only one supplier in Apia but they don't supply equipment. All anthelminthic drenches are supplied by APHD.

Samoa Meats is the only meat distributor in country and is a butchery, wholesaler and distributor. They are a partner for the new mobile slaughter unit and will be audited by an Australian company (Hasset of Albury). They mostly deal with beef and pork and also exports to Tokelau. Samoa meats previously tried selling some local sheep meat, but stopped it as there were problems with quality and consistency and the business wasn't willing to risk its reputation with customers, mostly hotels and restaurants. Farmers selling were mostly smallholders and lack knowledge. Markets are quite specific. The expat community is 5% of their market for which they try to supply niche products/cuts (including imports). An example is that locals only like 10kg suckling pigs, but won't buy pork steaks. However, they will buy a variety of beef cuts. They said there is a good market for imported lamb shanks (WST$ 40-50 to a resort).

Due to the small scale the monitoring of MF and government farms is very good. There are quarterly musters of all stock to monitor health and to deter theft.

7.4.5 Involvement of women in sheep farming

The Samoa 2009 census found that 23 % of farm operators are women. A farm operator is defined as a "person or persons exercising managing control over the operation of the agricultural holding" (Samoa Bureau of Statistics, 2012). Women contribute 3 % of "labour intensive activities" to the subsistence agricultural work force, and 4 % of labour in

commercial agriculture (Ministry of Agriculture and Fisheries Samoa, n.d.-a). When considering women's activity on farms, women participate more with livestock than with crops; "36 % of household members normally engaged in livestock activities were women" (Samoa Bureau of Statistics, 2016). The limitations of census data in fully capturing women's contributions is discussed above in section 7.2.9. The Government of Samoa is committed to promoting women in agriculture, recognizing that women's agricultural contributions increase production and overall food security (UN Women Pacific, 2012). Secondary data does not provide any information explicitly on the role of women in sheep farming.

7.4.6 Other projects

The Samoa Agricultural Competitiveness Enhancement Program (SACEP) and the Samoa Agriculture and Fisheries Productivity and Marketing (SAFPROM) Project.

These are large World Bank projects. SACEP ended in March 2018, and will be followed by SAFPROM, commencing late 2019 or early 2020. Several main activities took place for livestock in SACEP. The project developed breeding in 4 livestock species including sheep – imported Fiji Fantastic breeders in 2015. SACEP offered a matched grants program (50/50 with landholder 50% being cash or loan). This program is very relevant for SR which are capital intensive to start up (mainly fencing, housing and water infrastructure audited by MAF before stock are sold to landholders). Those wanting assistance need to match the grant amount and can use their own funds or apply for a loan under the Development Bank or SBEC (Small Business Enterprise Corporation). The project was very broad and included capital for one mobile and one stationary abattoir. One mobile unit is up and running and a stationary unit is being planned. These will focus on cattle at first.

The follow-on project SAFPROM will commence at the start of 2020. As part of this program, 55 sheep farmers will receive infrastructure upgrades. These will be offered in a matching grant program, where applicants need to show evidence of innovation. Further nucleus flock breeders may be imported, although the Dorpers imported by the SACEP project were not well adapted to the Samoan climate, so Barbados Black Belly sheep are being considered instead. A study program to Australia or California is likely and dependent on the breed of sheep imported.

8 Assessment of key constraints and potential interventions and research

This project was commissioned to make a brief assessment of market potential in Samoa and Vanuatu, and a more detailed rapid rural appraisal of production systems and value chains in Fiji. More detail regarding constraints, researchable issues and potential interventions is thus available for Fiji than for Samoa or Vanuatu, but at a joint SRA workshop with MAF Samoa and MoA Fiji it was agreed that many of the key constraints are common to the two countries. The key factors encountered in Fiji which are constraining farmers from gaining improved income from small ruminants are inefficient production, lack of infrastructure, poor access to retail markets, policy regulations around the slaughter and transport of SR, and the inclusion of women farmers.

8.1 Development potential by country

Fiji is the largest producer of SR animals and market for SR meat in the Pacific, outside of Papua New Guinea. The strong demand, which is currently supplied by imported product, presents a strong opportunity for domestic production. There are currently no value chains for local production to enter domestic retail value chains, but supermarkets and local (non-tourist) restaurants are recommended first targets for new value chain development. Existing value chains for locally produced beef may offer a model for SR marketing. Fiji is the first choice of location for additional SR R4D investment in the South Pacific region. The regions of Fiji which have the greatest potential for development are the Western Division (on Viti Levu Island) and Northern Division on (Vanua Levu Island).

The SR sector in Vanuatu is mostly subsistence-based, with few commercial or semi-commercial enterprises. Demand for SR meat is small. The sector is geographically isolated and transportation is problematic. Local capacity to support and develop the SR sector is limited. The potential for developing the SR sector in Vanuatu is currently low.

In Samoa, there is a small but thriving sheep sector, which is characterised by innovative, market-focussed producers, supported by effective and well-planned government backing. The small scale of the Samoa sector has permitted greater oversight, support and direction by government, and as a result, farmers and APHD in Samoa seem to be technically more advanced than in other countries we examined in this SRA. While not large enough to warrant a SR R4D project on its own, by participating in a regional project with Fiji, there would be valuable opportunities for cross learnings in both directions.

8.2 Key constraints and researchable issues

Inefficient production

It is clear that most SR farms in Fiji are underperforming in terms of productivity of breeding and growth. While this report has not conducted primary data collection on production efficiency in Samoa, it is likely that similar issues apply, although benchmarking needs to be conducted there. This is likely driving a high cost of production and poor margins for farmers, hindering local product effectively competing with imported mutton. GIN management and feed gaps are the major technical issues facing farmers in both countries. The importance of both are recognised but the technical capacity and knowledge to manage them effectively are lacking. There is a good body of scientific knowledge of how to manage GIN, some of it conducted in Fiji in the past, but it is clear that this is not being applied on farms, or on government research stations. In part, this seems to be due to loss of institutional knowledge: some knowledge is lacking or misinterpreted by users and extenders. Just as important, is the likelihood that many of technologies developed in research settings or even on-farm overseas do not fit well to

the cultural and livelihood constraints of Pacific farmers. There is potential to greatly increase on-farm productivity with interventions of existing technologies appropriate for farmers and farming systems in Fiji and Samoa.

Current drenching protocols for GIN are expensive in terms of labour and drench, are likely to be promoting drench resistance, and are clearly ineffective in reducing WEC. More information is needed on the scale, severity, causative factors and impact of anthelminthic drench resistance on semi-commercial and smallholder farms in Fiji and Samoa. There is no knowledge of the extent of current production losses caused by GIN on farms in Fiji or Samoa, nor of the interactions between season and stock classes, which could inform the development of appropriate interventions. GIN management needs to move from a routine, whole-herd drenching cycle to an IPM approach that encompasses improved and strategic drenching treatments along with non-chemical management strategies in a 'basket of options', that can reduce productivity loss due to GIN, without increasing anthelmintic resistance.

Poor nutrition is a cross-cutting constraint, likely affecting growth and reproduction rates, the impact of GIN on animals, and lamb and kid mortality. Suitable strategies need to be developed to better match feed availability (quality and quantity) to animal requirements and manage dry season feed gaps. Improved grazing management strategies, use of improved pasture and FTL species, and intensive feeding and supplementation are potentially useful nutritional technologies which all need to be tested to determine their value proposition for farmers and the opportunities and barriers for adoption.

Both the Samoan and Fijian governments are making significant investments into upgrading and multiplying national nucleus flock genetics. On-farm research in semi-commercial and smallholder production systems could add significant value to those projects by assessing whether different genotypes have different performance and management requirements, identifying key genetic traits which are of greatest benefit to farmers. This information could inform nucleus flock breeding strategies so that they are targeted towards the production of genetics which will thrive in local environments and production systems to meet the needs of producers and purchasers in the value chain.

Capacity and resourcing of Government technical staff

MoA Fiji and MAF Samoa provide a wide range of services in animal production and health including; testing and supply of improved genetic material, testing and supply of improved pasture species, supply of animal health products and provision of animal health clinics and extension services. They also administer grants available to farmers for infrastructure. They perform inspection and biosecurity services including; slaughterhouse inspection and certification, animal inspection and issuing of animal movement permits.

In Fiji, capacity of extension services has historically been limited by a lack of veterinary, agronomy and husbandry expertise and equipment. However, since 2015, the Government of Fiji has made very large investments in the small ruminant sector, appointing consultants to improve the management and strategic breeding of the government nucleus flocks, and allocating several million dollars (FJD) over the last few years to projects to improve on farm production, feed resources and (potentially) slaughter facilities, especially on commercial-scale farms.

In the three countries examined in this project, few government staff had Bachelors degrees and even fewer had post-graduate qualifications. Staff training is therefore a high priority in the project. Since 2015 in Fiji, there has been substantial staff self-initiative, and organisational support for MoA staff in DAHP to undertake tertiary and post graduate education, which will strengthen research capacity. In particular, there is great enthusiasm among staff to initiate and undertake research projects, and deliver on this remit of the MoA. Human and financial resources for research and extension to the SR sector were limited, but were greatest in Fiji and Samoa. Extension approaches applicable to PIC development and training will need to be implemented around key on-farm technologies.

Lack of infrastructure

Farmers in Fiji and Samoa identified that their most pressing priorities were improved fencing, government support and water supply. However, most farms had reasonable animal housing and were actively developing their infrastructure. Animal housing had already been prioritised due to the prevalence of dog attacks. Due to the importance of this key on-farm infrastructure, farmers who already have animal houses are more prepared to begin upgrading their production system to a market-focus. Road infrastructure and inter-island transportation costs to access markets are important constraints in all three countries, but most significantly in Vanuatu.

Access to retail markets

In both Fiji and Samoa, there is strong domestic retail demand for SR meat, but this is almost entirely supplied by imported product. The majority of local SR production goes to festival markets, which in Fiji, are approaching saturation. Many farmers, especially those more isolated, had problems with marketing as most households relied on farm gate sales. Many farmers relying on unsolicited purchases said these were unreliable, especially on Vanua Levu. There were some farmers that had regular supply arrangements with traders and accepted lower prices. While spot sales can be good for farmers through higher prices, supply into retail outlets requires consistent quality and sometimes pricing. The on-farm economics of regular supply arrangements with improved on-farm production vs spot sales with current systems needs to be investigated.

Working with groups of farmers (that have trouble reaching the maqiti market) and processors supplying the retail market will require research on market preferences for local product and product specifications, and analysis of the competitiveness of local smallholders given improved production systems.

An example that is often quoted is high value lamb cuts into the tourist market. While this can be high value it is low volume, and usually can only take the primal cuts from a carcase. Much higher volumes will go into lower value markets (domestic supermarkets and butchers, and local restaurants) and it would be crucial for profitability of the value chain to develop these.

Further research is required to understand what production, distribution and marketing systems in Fiji and Samoa would enable local producers to better compete against imported product; how to develop and implement sustainable value chains; and increase the participation of semi-commercial and smallholder farmers.

Abattoir access and regulations on live animal and cold chain transport

The situation with abattoirs and cold chains in Fiji is complex and presents several constraints for supply into the retail market. Any retail sales must use registered abattoirs which on Viti Levu must be one of two FMIB facilities. These facilities provide a service that has problems with availability for businesses such as restaurants and supermarkets due to the low throughput. On Vanua Levu there are several small slaughterhouses that provide services that are more flexible and therefore acceptable, however there are issues around cold chain connection to these slaughterhouses. These providers are working towards a resolution. Animal movement requires obtaining a permit from MoA, although it appears the ferry crossing between Vanua Levu and Viti Levu has recently come under Biosecurity Authority of Fiji. The transport of cold products from Suva to Vanua Levu supermarkets in refrigerated trucks offers an opportunity for slaughtered carcases to be transported back from the Northern Division to the urban market of Suva. Research is required to understand any policy or other impediments to establishing this as a new value chain, before identifying partners for piloting.

In Samoa, farmers are working with the Government to establish slaughter and cold chain infrastructure. Developing production systems which can support a value chain by

supplying consistent volumes and quality of product will be important in both Fiji and Samoa.

A detailed analysis of the policy environment is needed to inform debate and development of solutions, particularly to the function and regulation of SR movement and slaughter. This will be conducted under LS/2018/183. Research is required to develop an understanding of how the Fijian national policy environment provide incentives and disincentives for local small ruminant value chain development and whether they are effectively targeted to current and future small ruminant production systems.

Bringing benefits from sheep and goat production to marginalised people

Despite specifically aiming to capture the perspective of women in this project, we were unable to achieve this, indicating that different approaches and methodologies are required in this space. Our fieldwork indicated that, in Fiji, there do not appear to be any social, cultural or religious taboos or restrictions for either women or men to engage in small ruminant farming. The situation in other PIC is unquantified at the moment.

We recommend that any future R4D projects in this field develop a social inclusion strategy, using participatory methods, to ensure that interventions are appropriately designed and extended so as to include women, young people and people from marginalised groups. Such a strategy should be based on existing evidence, and the views, experience and input of all project partners in facilitated workshops. First tasks could include a situation analysis of gender equality and social inclusion of smallholder farmers that synthesises published and unpublished research, and key government strategy, planning and policy documents. It would need to consider the institutional and policy environment for gender sensitive and socially inclusive research, extension and education/capacity building; and key opportunities and constraints for realising gender equality and social inclusion. The strategy should make recommendations for intervention; devise an implementation plan; and formulate a gender and social inclusion impact pathway framework (to be streamlined with the overall project impact pathway).

The findings of this research emphasise the importance of small ruminants as part of a diversified livelihood strategy in Fiji. More detailed research would expand our understanding how sheep and goat production systems can be developed in an appropriate direction so that they can contribute to diversified, sustainable, and climate resilient livelihood strategies for the rural poor in the PIC.

9 Potential impacts of further ACIAR investment

9.1 Potential scientific impacts

Most constraints in this project could potentially be addressed with interventions and technologies which have already been tested successfully in research settings (including in Fiji in the past) and in some production systems overseas. The challenge of future ACIAR investments will be in finding ways that these (or new) technologies can be adapted to the production systems, social and livelihood constraints of (so as to lead to adoption in) smallholder and semi-commercial farmers in Fiji and Samoa. Mixed methods approaches will likely be needed in any the technical research in the Pacific.

9.2 Potential capacity impacts

Capacity building will be an important impact of future ACIAR investments in this field. Activities to build capacity should be targeted at three groups: front-line extension officers, farmers, and other government officers or researchers. There is a critical shortage of researchers and government officers with post graduate qualifications in livestock science. If ACIAR were to invest in this field, then scholarships would become available for post graduate study in animal science through ACIAR-USP scholarships and JAF scholarships. The involvement of local university and government researchers and other government officers in an ACIAR R4D project will strengthen local research capacity and understanding of the constraints to adoption of research findings on-farm, and the importance of participatory research approaches.

9.3 Potential community impacts of future development of the sheep and goat sector in Fiji

9.3.1 Economic impacts

Based on the results reported above, and projections of increased productivity, estimated potential economic impacts of the development of the SR sector in Fiji are possible. Current lambing and kidding rates are approximately 0.6 kids/lambs per year per doe/ewe. Anglo Nubian goats have demonstrated kidding rates of approximately 1.5 kids/doe in Indonesia (Praharani and Krisnan 2016), and Thailand (Restall *et al.* 1988). The Fiji Livestock Sector Strategy proposed a 'fair potential' of 1.5 lambs per FFS ewe in its 'indicators of productivity'. Thus we have used a conservative estimate for potential lambing/kidding rate of 1.4 kids/lambs per year per doe/ewe. Based on herd structure of surveyed farmers, breeding females were assumed to make up 60% of the national herd of 260,000 head goats. We have used a working assumption that under increased national SR productivity, lambs/kids would be sold at 35kg at a live weight price of F$5 per/kg. This price is half the current farm gate maqiti price (F$ 10/kg liveweight), and 20% lower than the lowest price farmers were receiving in Vanua Levu. This price is approximately equivalent to current Australian prices and is more appropriate for the retail market into the future when production increases.

It is estimated that only 5% of Fijian SR production enters the formal market, with the remainder supplying the maqiti market, for which there are no records of volumes or values (Proand Associates Australia 2012). A report on the Fijian Livestock sector prepared for the European Community (EC) delegation estimated total ex-farm volume of SR product in 2012 at 100 t/yr, with a value of F$12.7 million/yr, of which the maqiti market formed F$12.4 million (Proand Associates Australia 2012).

These assumptions result in a return of nearly F$ 21.8 million per year from increased lambing and kidding rates. A significant proportion of this could be expected to be import

substitution, although such a scenario also assumes markets are developed for the increased production. If local production captured only 20% of the existing market for imported sheep and goat meat, it would represent F$14.5 million per year distributed throughout the value chain. Most farmers are building herds and aiming for herds of on average double to triple 2017 numbers. This could be achieved with a national herd size increase of 10% per annum over 10 years and would result in approximately triple the benefit of F$ 75 million per year.

Samoa has the potential for similar improvements to productivity. Samoa currently imports WST17.5 million in mutton each year, offering a very large opportunity for import substitution, albeit from a much smaller base. Relative to the population size there are large potential benefits in Samoa.

For individual farmers, the potential benefits are large: for a semi-commercial farmer with 100 head this improvement in productivity equates to an extra F$16,000 annual income, and for a smallholder with 20 head, F$4,760 per year extra income. This is significant where unskilled labourers, such as sawmill hands, earn F$2.68 (A$1.71) per hour (minimum wage). The minimum wage in Samoa is WST 2.00 (A$1.02)/hour.

Sheep and goats may offer the greatest potential benefits to individual farmers as part of a diversified livelihood strategy. This research has shown the importance of having a range of income sources for household income, and SR have been identified by other funders and industry bodies, eg World Bank, Fiji Sugar Cane Growers Council, as being an important buffer against variable returns from cropping.

9.3.2 Social impacts

Healthy eating, and the consumption lean meat is a public health policy priority due to the large incidence and impact of secondary diseases in Pacific communities. The majority of imported mutton, both canned and frozen, is of lower quality, and contains large amounts of fat. As people and governments in the PICTs become more conscious of the health impacts of obesity, many consumers prefer to purchase locally produced sheep and goat meat, which is leaner. This is a key attractant of locally produced, lean sheep and goat meat in urban markets. The importation of lamb flaps has already been prohibited, as these are one of the highest fat lamb cuts. Although this measure removes one source of very high animal fat meat, it also takes out a cheaper cut, increasing the average cost of imported mutton.

In the smaller PICs, nutritional security is an important issue, especially with the threats to staple agriculture and fisheries caused by climate change. The larger countries such as Fiji, Vanuatu and Samoa are generally considered food secure, but the FAO and others acknowledge the threat of food insecurity lasting several weeks when devastating cyclones wipe out staple crops (Sharma 2006). In such circumstances, moveable livestock can increase resilience in disaster-related food insecurity, although they may also suffer large losses during these events. The narrow resource base and increased urbanisation (especially in Fiji) has reduced subsistence farming and increased dependency on imported foods. This dependence on food imports make the PICs vulnerable to price shocks in global food prices. The World Bank estimates that the average niVan household spends 15% of its income on imported rice, and only 6% on locally grown crops.

9.3.3 Environmental impacts

One of the major impacts of the project could be less land degradation caused by poor land management, especially overgrazing. Encouraging the use of sustainable pasture and grazing management to minimise erosion and land degradation will be essential to protect an environment that is already made vulnerable by the more direct impacts of climate change. The less acute impacts of climate change include secondary impacts on the sustainability of agricultural practices, including soil erosion and leaching, land degradation and desertification, declining crop yields, new pests and diseases, reduced water supply, changed cropping seasons, and impacts on traditional cultural practices and totems.

Figure 27: Climate change and its effects are one of the most important policy, social and economic issues facing the South Pacific Islands. Controlled grazing is identified by MoA Fiji as a sustainable land management mitigation strategy for climate change adaptation (Photo Fran Cowley).

10 Workshop report - Small Ruminant production and marketing in Fiji and Samoa

A workshop was held at Pacific Community, Narere, Suva, Fiji, 23-24 Nov 2017

10.1 Meeting participants

- University of New England (Armidale, NSW, Australia) – Commissioned Organisation
- Ministry of Agriculture, DAHP, Fiji
- Ministry of Agriculture and Fisheries, APHD, Samoa
- University of the South Pacific
- Pacific Community LRD

10.2 Meeting objectives

- Livestock policy, priorities and programs for GoF, GoS, and ACIAR
- Current issues in sheep and goat health, production and breeding
- Results from recent survey of small ruminant production systems in Fiji
- Rapid market chain assessment for sheep and goats in Fiji and Samoa
- Targeting end users and potential impacts in sheep/goat-based enterprises
- Needed research for the sheep and goat sectors
- Objectives and strategy for a sheep and goat research project in Fiji and Samoa

10.3 Current Government of Fiji policy, priorities and projects on SR production and marketing in Fiji

As reported to the workshop by Mr Tomasi Tunabuna, Director of Animal Health and Production, Fiji Ministry of Agriculture, agriculture's contribution to GDP in Fiji is declining with urban migration and restricted access to land. However, 80% of the population rely on subsistence agriculture. Current production of sheep meat is 78 tonnes per year, with 5000 tonnes imported. To achieve Objective 1 (Strengthening food security) of the Ministry of Agriculture 5-year plan, MoA targets a production increase to 1000 tonnes of locally produced mutton in the next 5 years. Goat and sheep meat are estimated by the MoA to have a growth potential of 100%, far in advance of beef (50%), pork (25%) and poultry (negligible) growth potential. Sheep have been calculated by the Ministry of Agriculture to be 6.5x more profitable than beef cattle in Fiji. This is in part due to the significant potential for import substitution, compared to other livestock industries, which have well developed local production well linked with formal markets. The mission statement of the Fiji Livestock Sector Strategy is Mission statement of the Sector is: "*The livestock sector, led by industry and government, will comprise modern competitive value chains that are sustainable, resilient and diverse, providing livelihood opportunity for youth and women, and contributing to economic growth and food security*".

10.4 Current Government of Samoa policy, priorities and projects on SR production and marketing in Samoa

Similarly to Fiji, the contribution of agricultural to Samoan GDP is declining, with the share from livestock declining more than from that crops and fisheries, as a result of lack of investment in this sector. The Ministry of Agriculture and Fisheries has a comprehensive Agriculture sector plan which informs the livestock division goal "*To undertake research,*

development and provide advisory services to improve animal health, meat inspection services and livestock production for subsistence and commercial producers, processors and marketers." The key outcomes from the Samoa Development Strategy 2016/2020 are:

- Increase private sector investment in production systems
- Improve domestic market production and food nutrition
- Increase volumes in value adding and exports
- Agriculture sector 100% compliance with climate, disasters and biosecurity policies

APHD has comprehensive policies and regulations dealing with small ruminant production. These have been informed by a series of projects beginning 2004 (funded by FAO and World Bank) which have provided support to the sheep industry through infrastructure upgrades and importation of new genetics.

10.5 Current sheep and goat breeding programs and major animal health issues in Fiji and Samoa

The major constraints to sheep and goat production in Fiji and Samoa are similar, being:

1. Inbreeding, or natural selection producing smaller, less productive animals of poor quality
2. Poor management of stock
3. Nutrition, low quality pastures and insufficient feed in the dry season
4. Internal parasites

However, there are significant opportunities in this sector; sheep are estimated to be 6.5 times more profitable than beef production in Fiji. Comparable estimates for goat production have not been made (there is no goat sector in Samoa). Imported lamb is one of the most expensive meats in the supermarket. Imported goat meat is expensive in Fiji but now almost entirely unavailable due to the emergence of alternative markets in Asia for Australian goat meat.

Recent investments by the GoF and GoS into imported sheep and goat genetics have aimed to address the first of these constraints.

The most significant issues in animal health for sheep and goats are reported to be intestinal nematodes (*Haemonchus contortus*), and anthelmintic resistance. These two issues are exacerbated by routine drenching with no refugia, overgrazing caused by overstocking, and lack of record keeping to all strategic decisions about herd and pasture management.

There is a need for systemic approaches to pasture management, lack of high quality and high yielding pasture resources, concerns about worm burdens and anthelmintic resistance and the challenges associated with a low-input smallholder production system.

Being a smaller and younger industry, the sheep and goat sector in Samoa has the benefit of greater government regulation and guidance over on-farm management, with a comprehensive suite of policies addressing a wide range of management and other practices.

10.6 Major barriers, opportunities and researchable issues

The workshop split into regional groups (Samoa, Viti Levu and Vanua Levu) to identify barriers, opportunities and researchable issues. In reporting back to the whole workshop several consistent research themes emerged (detailed notes from each group are in Appendix 3); being nutrition, worms, breeding, capacity building, marketing and policy.

10.6.1 Nutrition and feed management

In all regions, farmers are constrained by access to land, and this has led to overstocking and under nutrition. This is exacerbated in the dry season, with few pasture resources available for drought and dry season feeding. There is a need for a systematic approach to improved grazing management that increases feed quality with the introduction of improved pastures, and better manages feed gaps, and rotational grazing and rest, and increases dry matter yield.

One approach to managing these issues is the use of fodder banks for semi-, seasonal- or fully-intensive management and feeding of stock. Research into this approach would require economic analysis of its profitability (research in the 1980's indicated that fully-intensive feeding was uneconomic). Suitable species of feed for fodder banks would need to be trialled.

Viti Levu does have some by-products available for supplementation, but purchased supplements are not widely available in Samoa or on Vanua Levu.

Overgrazing is associated with large herds on small farms. However farmers are not able to make decisions about herd size, management or culling since they do not keep stock records.

10.6.2 Intestinal nematodes

Very high worm burdens are common, and drench resistance is suspected to be widespread in Fiji, although incidence on smallholder farms is not known in Fiji or Samoa. A lack of refugia and strategic approaches to drenching, including integrated parasite management, are two important issues which need to be addressed in the control of anthelmintic resistance. Intensive and overstocked grazing systems on small land areas complicate grazing and IPM approaches to this issue.

10.6.3 Breeding

The governments of Samoa and Fiji have both made significant investment into improved sheep (Dorper) and goat (Boer) genetics, and both are pursuing a strategy of nucleus and multiplier farms to increase and distribute these improved bloodlines. However, information is needed on the performance of imported genetics both on-farm, in semi commercial and smallholder systems, and post-slaughter, and the benefits they bring to small farmers and others in the value chain. Research questions include 'How well adapted are imported bloodlines to Fijian and Samoan production systems?' 'What do producers, butchers and consumers think of these breeds?' 'What are the different market chains willing to pay for improved breed-types?' 'Under what current or improved management conditions do different breed types express their genetic potential?' 'How much breed upgrading should occur before the advantages of cross-breeding are lost?' This research will inform the best use and management of these breed resources by semi-commercial and small farmers, their place in the value chain and future development of the genetic improvement program.

10.6.4 Capacity

There is a lack of capacity and expertise among farmers and extension staff in Fiji and Samoa. There are few government researchers or officers with post graduate qualifications in livestock, and support for further education and training is essential for long-lasting impact in this sector.

Many of findings from the research that was conducted in the 1980s and 1990s has had variable implementation, and key messages have been lost or distorted with time.

Many problems in sheep and goat production are exacerbated by lack of record keeping. Record keeping by farmers is uncommon, and appears to be a poor cultural fit to many

uneducated and poor farmers. Innovative approaches to encouraging and assisting farmer record keeping are needed.

10.6.5 Markets and value chain

There are two market chains of interest to this project: supply of whole animals for customary and festival slaughter, and supply of domestic demand through retailers including import substitution. The festival and customary markets are highly significant and expanding in Fiji and Samoa. The retail sector is currently a minor market, but with large potential to substitute for low quality imported product, which is in high demand.

A value chain approach is essential in this research project to ensure that the sheep and goat sector can bring profits for all participants. However, most details of the value chains in Fiji and Samoa are currently unknown (the ACIAR SRA LPS/2016/021 has conducted rapid market chain assessments of markets in Viti Levu, Vanua Levu and Samoa). Market information on supply and demand, preferences, logistics, willingness to pay, and target market gaps all needs to be described. Value chains for supply of inputs do not exist in many places, apart from via the government. An improved understanding of what market opportunities exist and how farmers can take advantage of these is essential to ensure a profitable sector.

Significant issues on Vanua Levu were bushfires and transport costs due to its more severe dry season and isolation from major markets.

10.6.6 Policy

A critical appraisal of government and institutional policies is required to assess the impact of government bureaucracy, incentives, support and regulation on the development of a thriving sheep and goat market.

10.7 Next Steps

A 4-year research project (Fiji – 85%, Samoa – 15%), LS/2017/033 'Improving small ruminant production and supply in Fiji and Samoa', has been initiated in October 2019. The total budget is AUD $1.8 million.

The project goals are:

- Increasing on-farm efficiency and productivity
- Building capacity, including extension and support services
- Helping people to equitably benefit from sheep and goats
- Growing market chains for local sheep and goat meat

The project objectives were developed from the list of researchable issues identified above from this workshop.

An output from this workshop was a 'Phase 1' project proposal, which was submitted to ACIAR in February 2018. This proposal presented the 'business case' for project. UNE worked together with DAHP Fiji and APHD Samoa to develop a 'Phase 2' full project proposal, submitted to ACIAR in June 2018.

11 Conclusions and recommendations

11.1 Conclusions

In both Fiji and Samoa, the two largest value chains for small ruminant product are: a formal retail market that is dominated by imported frozen product from Australia and New Zealand, sold through formal retail outlets; and a festival market for locally produced whole animals sold at farm gate for backyard slaughter, mostly for religious holidays and customary uses. In Fiji, the maqiti festival market has strong demand, but appears saturated for some growers. However, the quantity of imported meat for retail sale is approximately 10 times local production (7500 tonnes per year). In Samoa the trade imbalance is even greater due to the lower local production. The retail market therefore represents a huge for smallholders' opportunity in both countries via import substitution.

In Fiji, demand for locally produced animals and butchered meat is high, with live animals selling for approximately F$8-10/kg at the farm gate on Viti Levu, and as low as F$6/kg on Vanua Levu, where produce must be transported to the major urban centres on Viti Levu. Local goat meat sells in butchers for F$21/kg (compared to F$14/kg for low quality imported lamb cuts). Returns for farmers are generally good and margins for traders and middlemen are not excessive. There are however several regulatory and policy issues around movement of animals, slaughter, and imports that make participation in the formal retail market more difficult. Most farmers currently sell the majority of their stock at the farm-gate for the festival market to take advantage of the higher prices, or to traders who sell on the roadside in major urban markets during peak seasons such as Christmas, Easter and Qurbani. Most farmers interviewed said they were planning to increase herd size and many were looking for new markets. However, in both Fiji and Samoa, human capacity and animal productivity in local production systems are low, and the role of women and youth restricted.

A household survey identified numerous on-farm constraints to productive and profitable sheep and goat enterprises for smallholder and semi-commercial farmers in Fiji, and many of the technical issues are similar in Samoa. Poor productivity per breeding female and per hectare are likely causing a high cost of production for these farmers. Feed gaps caused by seasonal deficiencies and mismatching in the supply of home-grown feed compared to demand from livestock are the main issue, and overgrazing is also common. Feed shortage causes loss in liveweight or growth rate of growing stock, and declines in BCS, which can inhibit reproductive efficiency (including lamb and kid mortality) in breeding females. There is large scope to increase turn-off and income from existing breeders without increasing herd size.

Parasite management is also an important constraint. Farmers are aware of the importance of GIN control and drench at regular intervals (3-4 weekly is common), but without information on current worm burdens. This practice contributes to the high cost of production, and drench resistance is likely to be significant, although currently unquantified. Sampling revealed very high WEC for both goats and sheep. To limit the effect on animal productivity and cost of production, strategic approaches to GIN management need to be assessed for their suitability to current farming systems and cultural appropriateness.

Women make a significant contribution to labour in household farming systems but it was clear that women are not well engaged in the existing support networks and structures for livestock farming, nor in the decision making processes related to both the production and marketing of sheep and goats.

The large retail market for sheep meat in supermarkets, butchers and restaurants is almost all imported, frozen meat. Imported frozen mutton is perceived as being of lower quality, and containing very large amounts of fat. Key informant interviewees preferred

locally grown small ruminant meat, but said it had become harder to source, with prices increasing and availability becoming severely restricted since tropical cyclone Winston in 2015. Although demand for fresh local sheep and goat retail meat appears to outstrip supply, the high price also reflects a high cost of production, and poor production efficiency.

11.2 Recommendations

Future research should be undertaken in Fiji and Samoa due to the strong market for small ruminant meat as well as current government programs committed to improving small ruminant farming. This needs to address the low on-farm productivity and underdeveloped retail value chains for local sheep and goat meat. Both Fiji and Samoa need to increase technical capacities, productivity, market participation and improve livelihoods of smallholders and semi-commercial farmers, in order to fulfil the strong domestic demand for small ruminant meat with locally produced product. Research will also be needed in Fijian value chains supplying the major urban markets in Viti Levu to investigate market and consumer preferences for locally produced meat, and to analyse policy issues affecting market access.

There are a range of technical solutions available for many of the on-farm issues, however the challenge of future research will be finding ways that these technologies can be adapted to the production system, social and livelihood constraints of smallholder and semi-commercial farmers in Fiji and Samoa.

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13 Appendixes

13.1 Review of Literature:

Scientific review of research on sheep and goat production and marketing in the South Pacific Community

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With the increase of human population there is a need for food security efforts globally. Worldwide, 795 million people are food insecure and an estimated 12.9 % of the population of developing countries is undernourished (World Food Programme, 2017). Island countries in the Pacific face additional challenges, with climate change and extreme weather events. Samoa is a Pacific country that serves as an example of the importance of agricultural diversification: a 1993 blight completely devastated the taro export market, a daily dietary mainstay worth ST$ 9 million annually (Macfarlane, 1998). A common approach to mitigating food insecurity is to implement agricultural strategies that aim at improving livestock productivity for rural families. Agricultural growth for smallholder farmers plays a vital role in poverty alleviation, particularly in comparison to non-agricultural sectors (FAO, 2009). Small ruminants are a well-established agricultural option for the smallholder, performing well in marginal lands (Macfarlane, 1998), and under heat stress (Skapetas and Bampidis, 2016). In countries with poor infrastructure and limited access to capital by farmers, sheep and goats are less costly to invest and maintain, and an easier transport option than larger livestock such as cattle.

Due to the many benefits of sheep and goats, countries in the South Pacific have introduced these ruminants to help diversify and strengthen their farm outputs. However, many farmers still face deterrents to sheep and goat farming. Issues affecting regional agriculture include farmers migrating to city work, lack of access to investment capital, land tenure issues which lead to lack of available land, and lack of infrastructure and transport. Issues specific to livestock include lack of adequate management of imported genetic breeding stock (P Tabuaciri 2017 personal communication, 29 May), poor nutrition and disease of livestock, and poor management skills, and a limited number of trained personnel and veterinarians (Brioudes et al., 2015). These obstacles must be overcome if sheep and goats are to become an integral part of the farming industry. The lack of management of high quality breeding stock is being addressed through the development and implementation of breeding programmes. For many farmers, sheep are a new venture, so there is a pressing need for training. Some of these needs are being met by the ministries of agriculture in each country through the extension department of the Ministry of Agriculture.

This review will examine published literature for Sheep and Goat production in Fiji, Samoa, and Vanuatu from the period of 1990-2017. There is great variation in reported population numbers of sheep and goats in literature pertaining to Fiji, Samoa, and Vanuatu. Therefore, this review chose to use government census data as the source of population size. Another challenge is that often agricultural information has been collected by governments but not published, thus it is difficult to obtain this information without in-person interviews. This study relied primarily on published data.

Fiji: An overview

Fiji's estimated population in 2016 is 880,400 (SPC, 2017). Sixty percent of people living in rural communities are involved in agriculture which provides 12 % of Fiji's GDP (Fiji Ministry of Agriculture, 2016). Fiji has a land lease system, with the majority of land being clan or government owned. Land can also be leased, but expired leases need not be renewed. Only 16.7 % of land is freehold (Fiji Ministry of Agriculture, 2016). Goats and sheep are kept for meat production, favoured by the Indo-Fijian populations who may avoid pork or beef for religious reasons (Fiji Ministry of Agriculture, 2009). Of the countries

considered, Fiji has the most established small ruminant production. The most recent agriculture census was held in 2009, showing a goat population of 101,196 in 9,408 farms. The goat population has declined since 1991, when 187,235 goats were recorded (Fiji Ministry of Agriculture, 2009). The sheep population was 14,068 in 818 farms (Fiji Ministry of Agriculture, 2009). The sheep and goat population fluctuates without close monitoring, as animals are often sold directly to consumers and slaughtered without tracking (Fiji Ministry of Primary Industry, 2009). However, production statistics rely on information from slaughterhouses as well as personal communications from farmers, and therefore may not be accurate. From 1995-2008, goat production held steady, with an average of 842 tonnes of goat meat produced annually. The year 2009 saw a sharp decrease in production, at only 238 tonnes. The production has not recovered, with the 2009-2014 yearly average being 171 tonnes. Sheep meat production has increased from 2008, when production was 60 tonnes. The year 2011 saw 134 tonnes produced (Fiji Bureau of Statistics, 2014), 2012 170 tonnes (Fiji Bureau of Statistics, 2015b) , 2013 150 tonnes (Fiji Bureau of Statistics, 2015a), and 2014 105 tonnes (Fiji Bureau of Statistics, 2016).

Demand for sheep and goats, as measured by imports of meat, is steadily increasing, with a predicted 4 % demand increase a year for all non-poultry meats. The majority of sheep meat consumed is imported (Fiji Ministry of Agriculture, 2016). Due to concerns about unhealthy effects of imported fatty cuts of mutton, in 2000 Fiji imposed a 15-year ban on mutton flap importation, and placed a high tariff on imported mutton, as high as 32 % in 2010 (Ravuvu et al., 2017). The 2017 import tax for sheep or goat meat ranges from 15 % to 32 %, depending on the cut (Fiji Revenue and Customs Service, 2017). Even so, 88 % of meat is imported (Fiji Ministry of Agriculture, 2016). Between 13-15 million USD annually of sheep and goat meat was imported from 2008-2013, with a high in 2014 of 19 million USD (World Trade Organization, 2016). Most demand for goat meat is met locally; yet from 2000-2008, between FJD $100,000-200,000 annually was imported (Fiji Ministry of Agriculture, 2016).

The major challenge facing producers is lack of supply to meet market demand. Other considerations include consumer demand only for certain cuts of meat, and for monitoring of food safety. These are likely to sustain the importation trend, since local farms and processors do not meet production demand or food safety criteria. (Fiji Ministry of Agriculture, 2016).

Historically, the government has focused on sheep and goat multiplication to substitute locally produced product for imports, but projected goals have not been obtained (Fiji Ministry of Primary Industry, 2009). Issues specific to sheep and goat industry in Fiji include lack of protective facilities that lead to animal loss from predators and weather, poor nutrition, and loss from parasitic infections (Fiji Ministry of Agriculture, 2009). The goals for 2020 stated in the Fiji Livestock Sector Report focus on the use of sheep and goats for poverty reduction of small farmers, to decrease imports through improved production, and to promote food security (Fiji Ministry of Agriculture, 2016). A total of 91.2 million FJD has been requested for the strengthening of all aspects of the livestock trade over the next 5 years. The Fiji government is directly involved in small ruminant production, and imports sheep and goats that are retained on 4 government farms for propagation and research (Fiji Ministry of Primary Industries, 2011). Government funding is provided to these stations for research in breed improvement, and feed and forage research (Fiji Ministry of Agriculture, 2015). The government also partners with private multiplier stations to produce breeding stock (Fiji Ministry of Agriculture, 2014), which have successfully exported sheep to Samoa and Tonga (Fiji Department of Information, 2014). For a comprehensive review of goat production in Fiji prior to 1983, see “Goat Production and research in Fiji,” by SW Walkden-Brown.

Samoa: An overview

Samoa’s population is 180,000 of which 97 % of the population are involved in agriculture in some way, either growing some crops and/or owning some livestock (Samoa Bureau of

Statistics, 2016). This is an increase from 2009, which saw 16 % of the population not participating in agriculture (Samoa Bureau of Statistics, 2012). Of the total land mass 13 % is used for agriculture, which is about 57 % of arable land. A total of 85.3 % of farms are on customary land (Samoa Bureau of Statistics, 2016). Historically agriculture played a more prominent economic role, however the contribution of agriculture to GDP is decreasing, contributing less than 10 % of the GDP in 2010 (Samoa Bureau of Statistics, 2012). The majority of agriculture is subsistence or for home consumption. Livestock farming is based in villages, with minimal commercial livestock production.

Livestock raising households earn an average of $645 SAT monthly from their animals. 99 % of this income is from cattle, milk, pigs and chickens; less than 1 % of the income is attributable to other livestock (Samoa Bureau of Statistics, 2016).

The 2009 census found 128 goats in 7 households, a decrease from the 1989 census counting 1094 goats in 159 households. Goats are used for meat, and the decline in numbers is attributed to lack of demand for goat meat by consumers (Samoa Division of Animal Production and Health, 2003). At this time, there are no Government plans to increase goat production.

In contrast, mutton is widely consumed throughout the country. From 2008-2014, the amount of mutton imported has been decreasing, but still provides the majority of mutton consumed, at 755,738 kg imported in 2013, down from 2.8 million kg in 2008 (Ministry of Agriculture and Fisheries Samoa, n.d.-b). The sheep industry is new to Samoa, with the first 44 sheep imported by the government within the framework of an FAO program in 2004 (FAO, 2008). The FAO was also involved in a project to increase sheep numbers, “Sheep Integration into Traditional Farming,” from 2007-2010 (Lee, 2012). Sheep were imported, housed, and multiplied at government research and breeding facilities, and eventually distributed to farmers (Fong, 2009). Education for farmers was also provided. The 2009 census found 249 sheep on private farms. In 2014 the Animal Production and Health Division conducted a national sheep census and reported a sheep population of 827 sheep. (Ministry of Agriculture and Fisheries Samoa, 2014). The government continues to be involved in sheep, providing extension services and distributing genetic stock to farmers (Ministry of Agriculture and Fisheries Samoa, n.d.-a). At this time, the government's only specific goal for sheep industry is to improve farmer’s access to better breeding stock (Ministry of Agriculture and Fisheries Samoa, n.d.-a). The end goal is to promote food security and increase nutrition (Ministry of Agriculture and Fisheries Samoa, n.d.-b). Currently there are 4 government sheep stations, and 6 private multiplier farms (Orange, R. personal communication 29th September 2017).

Vanuatu: An overview

Vanuatu’s population as of 2016 is 272,459 (Vanuatu National Statistics Office, 2016), with 80 % of the population relying on subsistence agriculture (Vanuatu Ministry of Agriculture, 2013). 68.8 % of households are involved in livestock production (Vanuatu National Statistics Office, 2016). Agriculture contributes 20 % to GPD (Vanuatu Ministry of Agriculture, 2013), and provides the biggest source of household income. Ninety percent of land is custom owned, and the remaining 10 % is government land or leased (Vanuatu Ministry of Agriculture, 2013). Only 40 % of Vanuatu’s land mass is useful for agriculture(Vanuatu Ministry of Agriculture, 2013). The first record of goats in Vanuatu is in 1806, and the current local goats are descended from stock brought in the 1840’s (Ministry of Education Vanuatu, 2000). Small livestock are kept by smallholders, and are largely used for meat, primarily for celebrations and ceremonies (Vanuatu National Statistics Office, 2008). Goats are also sold, and are used as gifts (Vanuatu National Statistics Office, 2008). The 1993 census reported 15,000 goats, kept by 26 % of smallholders. 250 tonnes of goat meat was produced in 1993 (Welegtabit, 2001). The goat population as of 2016 is 16,288 in 2,450 households (Vanuatu National Statistics Office, 2016). The 2007 census was an outlier, reporting 8,792 goats. The 2010 household expenditure survey show goats provide a small monthly income, less than earned by cattle, pigs or chickens. 540 households each earned a monthly average of

$6,900 Vatu from goats ($15 USD) (Vanuatu National Statistics Office, 2012). The most recent data on sheep is from the 2007 census; 27 households were recorded to own sheep, with 258 total sheep. For many years, the government agriculture strategy has remained broadly focused, with no specific objectives for sheep or goat production (Vanuatu Ministry of Agriculture, 2013). The 2015-2030 national livestock policy continues the trend. Beef plays the majority role in livestock farming in Vanuatu. The government acknowledges the value of small livestock production, and that there is plenty of opportunity in the sector. However, there are no improvement plans aimed specifically at sheep and goat production (Vanuatu Agriculture Policy Bank, 2015). The government does intend to promote goat production in marginal lands, where other livestock cannot be maintained (Vanuatu Agriculture Policy Bank, 2015).

Land use planning and Land allocation

Fiji, Samoa, and Vanuatu operate with a system of customary land. Customary land is held by indigenous groups, such as tribes or families. The complexities and issues of each country's system is outside the scope of this article. No literature concerning small ruminant production and land use was found for the considered countries. A general understanding of land allocation can be obtained from census statistics.

In Fiji, 35 % of farm land is mataqali (clan owned/ customary), which is 65.4 % of all farms, 31.4 % is customary land under lease (NLTB lease), and 12.4 % of land is leased from the government (crown lease). 16.7 % is freehold; only 7.7 % of farms in total. Since 1991, the percentage of mataqali land has increased, while leased customary land has decreased. This is due to land leases not being renewed. The amount of government lease land has remained consistent. The government acknowledges the non-renewal of land leases is a problem for livestock production; "It has been evident that the expiry of land leases has significantly reduced the amount of agriculture land available for livestock and to the decrease in livestock numbers." (Fiji Ministry of Agriculture, 2009).

Samoa's 2015 agricultural survey found 85.3 % of agricultural land is customary. This is slowly changing, with a movement towards freehold land. The 2009 census found 86 % of land to be customary, down from 90 % in 1999 and 94 % in 1989. Around 4 % is leased land, which has remained fairly consistent throughout the years. Freehold land use in agriculture has risen from 3 % in 1989 to 11 % in 2015. However, 90 % of freehold land is "small parcels in peri-urban areas (Samoa Bureau of Statistics, 2016). The majority of rural agricultural land continues to be customary land.

Vanuatu is 90 % customary land and 10 % government owned or leased (Vanuatu Ministry of Agriculture, 2013).

Livestock farming and gender

The issue of gender roles in agriculture in Pacific countries is an ongoing area of concern. From the UN report, Rural Pacific Women and Agriculture:

Women continue to be constrained by persistent and near universal gender discrimination. This manifests itself most clearly in women's unequal access to land, which is frequently held communally in ways that do not always provide women with adequate decision making powers even when they perform the vast majority of agricultural work. Women also suffer from more limited access to training, credit, and job opportunities than their male counterparts, as well as an unequal time burden in which women are expected to engage in agriculture as part of their normal household responsibilities (UN Women Pacific, 2012).

Gender roles in farming have not been studied for the considered countries, but information can be compiled from government reports. It is important to remember the limitations of data that is gathered without this specific question in mind. For example, the 2009 agriculture census in Samoa identified 23 % of farm operators as women. This is a much higher percentage than was seen in previous census results. However, the increase may only be a result of the phrasing of census questions; prior to 2009 the

responder was asked to identify only one farm operator per household, but in the 2009 census responders could identify one or more farm operators per household.

The Fiji 2009 agriculture census reports 96.4 % of farmers are men, and 3.6 women. "Farmer" is defined as the head of operations and decision making on the farm. However, farming households are almost evenly divided by sex, with 53.8 % of the household comprised of males, and 46.2 % female. Women participate in the performance of livestock tasks, including the daily feeding, milking, and grazing of sheep and goats, but at slightly less percentages than men in the households. The census tallied three types of farms: crops, livestock, and mixed. Out of all women farmers, 12 % are livestock- only farmers, and 53 % have mixed farms. This differs from male farmers, out of whom 3 % farm exclusively livestock, while 59 % farm mixed livestock and crops. Fiji is specifically interested in growing the role of women in livestock farming, and includes this as one of the 4 goals to attain in the next 20 years in the Fiji livestock sector strategy 2016 (Fiji Ministry of Agriculture, 2016). The goal is to increase the proportion of women in all areas of livestock farming by 2020. Fiji also aims to increase the amount of women working in the Ministry of Agriculture, with a special focus on training women as extension officers to work with women farmers (Fiji Ministry of Agriculture, 2016). "The Strategy will provide training scholarships to youth and women interested in livestock farming and livestock business. The training will aim to result in skills for business planning, financial management and qualification for loans from FDB and commercial banks" (Fiji Ministry of Agriculture, 2016).

The Samoa 2009 census found that 23 % of farm operators are women. A farm operator is defined as a "person or persons exercising managing control over the operation of the agricultural holding" (Samoa Bureau of Statistics, 2012). Women contribute 3 % of "labour intensive activities" to the subsistence agricultural work force, and 4 % of labour in commercial agriculture. (Ministry of Agriculture and Fisheries Samoa, n.d.-a). When considering women's activity on farms, women participate more with livestock than with crops; "36 % of household members normally engaged in livestock activities were women" (Samoa Bureau of Statistics, 2016). The government is committed to promoting women in agriculture, recognizing that women's agricultural contributions increase production and overall food security (UN Women Pacific, 2012).

In Samoa, Women in Business Development is an organization of and for women farmers, providing training, local market distribution of products, and organic certification advice which has led to product export for international markets. However, at this time livestock farming is not part of the program (Women in Business Development Inc, n.d.). Agriculture is the main occupation of all Vanuatu residents. Of all wage earning agriculture workers, 56 % are men, and 44 % women. (Vanuatu National Statistics Office, 2011). For women, the overall trend is moving away from jobs in agriculture. In 1988, 23 % of women were employed outside of agriculture. The 2009 census shows that 39 % of women are employed in non-agriculture jobs (Vanuatu National Statistics Office, 2011). The government has a stated goal for women to have equal access to agricultural development resources (Vanuatu Department of Agriculture & Rural Development, 2015).

Genetics

Vanuatu goats are descendants of stock brought in the 1800's (Ministry of Education Vanuatu, 2000). There have been a few attempts to improve local genetics with importation of stock. In the early 2000's, Saanen and Boer goats were imported (Struthers, n.d.). Sheep improvement has been attempted with the import of Fiji Fantastic, Border Leiscester, South Suffolk, and Texels (Struthers, n.d.). There is no national breeding program, breeding stock, or national records of breeding (Vanuatu Ministry of Agriculture Livestock Forestry Fisheries and Biosecurity, 2015).

Sheep production in Fiji was initially based on imported breeds using conventional husbandry practices of progressive countries (Manueli 1997). The success rate was unsatisfactory, and as a result a breeding program was started in the early 1980's. The

development of Fiji Fantastic sheep started with a cross between the Barbados Black Belly and the Wiltshire (Fiji Ministry of Primary Industries, 2011). This program aimed at producing an animal that would grow well under Fijian conditions (35 kg live weight within 6 months), would breed year round and be fecund, exhibit good confirmation, and have "reasonable tolerance to internal parasites and footrot" (Manueli, 1997). The extent to which that goal was achieved is unclear. What is well established is that the resulting crosses lead to the Fiji Fantastic sheep population that is regionally recognized for its hardiness, adaptability and comparative internal parasite resistance.

Fiji is targeting further genetic sheep and goat improvement. A goal stated in the 2010-2012 Strategic Development Plan is to increase the quality of genetic stock of sheep and goats (Fiji Ministry of Agriculture, 2009). To this end, periodic imports of genetic stock have occurred. In 2016, 153 pure bred sheep and goats were imported from Australia. This shipment consisted of 28 Boer goat bucks, 36 Boer goat does, 5 Boer X Toggenburg bucks, 3 Boer X Toggenburg does, 3 Toggenburg bucks, 32 White Dorper rams, 3 Australian White rams, and 42 White Dorper ewes (Tikomailepanoni, 2016). The government will multiply the stock, and provide better quality breeding stock to farmers. The government also continues to upgrade the Fiji Fantastic sheep population with the goal of decreasing mutton imports and increasing local sheep production.

Sheep production started in Samoa with 44 Fiji Fantastic base stock imported in 2004. Improvements continue, with 110 Fiji Fantastic brought in 2014, and Dorpers imported in 2016 through the World Bank Samoa Agriculture Competitive Enhancement Program (World Bank, 2014). Currently, experimentation is underway with a Dorper x Fiji Fantastic cross. The desired outcome is a sheep with decreased foot rot, increased growth, birth rates, and heavier weight gain.

Nutrition

There has been considerable research done into small ruminant nutrition over the past few decades, the bulk of which was conducted at the sheep and goat units of the University of The South Pacific in Samoa. The emphasis of these studies was on digestibility of forage and by-products and growth performance of sheep and goats.

The majority of farmers use free grazing on either communal, leased or private property. Rotational grazing is practiced but few farmers practice cut and carry to supplement free grazing and even fewer use stall or confined feeding (Aregheore, 2005b). Commonly available pasture species include Batiki (*Ischaemum aristatum var. indicum*), Guinea grass (Panicum maximum), *Brachiaria decumbens*, Guatemala grass (*Tripsacum andersonii*) and Setaria (*Setaria sphacelata*).Some common creeping legumes found in the Pacific Islands include Centro (Centrosema pubescens), Hetero (*Desmodium heterophyllum*), Mimosa (Mimosa pudica) and Puero (*Pureraria phaseoloides*). . In Vanuatu 50 % of farms have native pasture species (Mullen, 1998) compared to Samoa where sheep graze on pastures predominantly Batiki (79.3 %) (Ministry of Agriculture and Fisheries Samoa, 2014)unpublished).

A number of browse species are also available. These include Leucaena (Leucaena leucocephala), Erythrina spp, Mulberry (*Morus alba*) and Glyricidia (*Glyricidia sepium*) (Aregheore, 2005b). Use of coconut plantations for grazing is increasing due to the decreasing value of copra (Aregheore, 2005b). The stocking rate under these conditions is influenced by the grass specie and its tolerance to shade under coconuts. The age of coconut trees also influences stocking rates; the older trees allow more light penetration and grasses tend to perform better thus increasing animal productivity.

Forage:

Sheep and goat production in the region is based on grazing. Given that perennial grasses in the tropics tend to lose palatability and nutritional value during the dry periods it is important to have feed stuffs that can either replace or substitute these for sustained production. Fiji cultivates small amounts of corn, but grain is not cultivated in Samoa

which makes concentrate-based diets costly due to high importation costs (Aregheore, 2002a). As such, it is important to determine what available forages are best suited for optimal performance of sheep and goats. Batiki Grass (*Ischaemum aristatum var. indicum*) is the most widely propagated pasture species in the region (Aregheore et al., 2004). Its nutritional composition and compatibility under various agronomic systems has been evaluated. As such, much literature on sheep and goat performance using Batiki as the basal diet is available. Aregheore et al. (2004) supplemented Batiki fed growing goats with *Gliricidia sepium* and *Leucaena leucocephala* at four dietary levels and found an inclusion rate of 50 % both browse species produced best results. At an inclusion rate of 80 % of the browse species voluntary intake was unaffected but growth rate was negatively affected. Aregheore (2004) found the intake and digestibility of Batiki and Erythrina variegata var. oriental could be fed to young goats at various proportions but there was no significant difference over a Batiki diet alone. These results are likely due to the relatively high crude protein content of Batiki. In another trial, Batiki in combination with Moringa oleifera at various proportions fed to growing goats it was shown that inclusion rates of 80 % Moringa resulted in inferior dry matter intake in comparison to diets containing either 20 % or 50 % Moringa (Aregheore, 2002b). Furthermore, at inclusion rates of 20 % or 50 % Moringa is reported to be an inexpensive protein supplement for growing goats on a basal diet of Batiki (Aregheore, 2002b).

Guinea grass is also well adapted and propagated in the South Pacific. In a trial evaluating the ability of growing goats to subsist in Guinea grass dominated pastures Aregheore (2003a) concluded it can sustain goats during the dry season when tropical pastures tend to have lower protein content. When goats on the Guinea grass basal diet were supplemented with either cassava peel flour (210 g voluntary intake) or cocoyam peel flour (206 g voluntary intake) these improved animal performance with cassava supplement being superior (Aregheore, 2003a). In this study peels were sun dried prior to milling to facilitate mixing with other feed ingredients.

The use of browse species has also been investigated. Aregheore and Yahara (2001) investigated the potential of *Leucaena leucocephala, Gliricidia sepium, Erythrina variegata* and *Spondias mombin* as basal diets in yearling goats and reported daily weight gains (g/head/day) of 75, 72, 62 and 61 for Leucaena, Glyricidia, Erythrina and Spondias respectively. Additionally, the authors reported no evidence of toxicity, feed refusal or digestive disturbances in the form of diarrhea after an eight week trial period (Aregheore and Yahara, 2001). In another trial Aregheore (1999b) reviewed the nutritive and anti-nutritive values of common tree legumes (*Calliandra spp, Gliricidia sepium, Leucaena luecocephala* and *Erythrina* spp) in the region and found their protein content to range from 15.8 to 36.6 %. These species are known to contain anti-nutritive substances in the form of saponins, tannins (hydrolysable and condensed), phenols, toxic amino acids and protease inhibitors that may lead to reduced voluntary intake and cause health problems such as hair loss, inappetence and reduced fertility in cows. However, the advantages of these species include high protein content, ability to grow well in a range of soil and moisture conditions, remain green and palatable during drought periods, relatively inexpensive, low in fibre and high biomass production outweigh their disadvantages. Furthermore, farmers can easily and inexpensively adopt techniques to reduce the anti-nutritive value of these species. These techniques include wilting the foliage, drying, soaking and incorporating them in a diet rich in fermentable carbohydrates (Aregheore, 1999b).

Leucaena has received much attention as a ruminant protein supplement in many regions including the South Pacific. Aregheore et al. (2006) investigated the effect of supplementing maize stover and dried brewer's grain (both feedstuffs milled and unmilled) with Leucaena foliage and determined its inclusion improved nutrient digestibility of all diets. The study does not state the inclusion level of Leucaena however and therefore recommendations on its use with similar by-products is not possible. Aregheore (2002c) also investigated the inclusion levels of fresh, wilted or dried Leucaena on a basal diet of Guinea grass and reported it is best fed fresh or wilted. Dry Leucaena should not exceed

20 % of the diet in growing goats. It may constitute up to 40 % of the diet in a fresh or wilted form. At this level of inclusion it improves voluntary dry matter intake and growth rate. Furthermore, no toxic effects of Leucaena were observed. In conclusion, Leucaena should form part of ruminant nutrition programmes in this region (Aregheore, 2002c).

By-products

The South Pacific region has many by-products that are underutilized as livestock feed either because farmers are unaware of their value or their potential as livestock feed is largely unexplored. A review of such by-products revealed cassava (*Manihoc esculenta Crantiz),* taro (*Colocasia esculenta* (L.) Schott, Tannia (*Tannia xanthosoma*), Cowpea (*Vignia unguiculata* (LI) Walp), banana/plantains (*Musa* spp.), cocoa by-product meal (*Theobroma cacao*), coffee by-product meal (Coffee Arabica) and copra cake (*Cocos nucifera*) all have potential as ruminant livestock feed (Aregheore, 1999a). What is highlighted are the underlying impediments to high inclusion levels; notably the presence of anti-nutritive factors including tannins, saponins, high dietary fibre, high alkaloid concentrations, potential rancidity problems, low crude protein content among others. If unresolved these anti-nutritive factors limit the value of these by-products because they cause reduced palatability, toxicity, reduced voluntary feed intake and reduced growth rate of livestock. Fortunately, there are methods of reducing the anti-nutritive factors of many of these by-products. These methods include processing, heat treatment, soaking, fermenting, sun drying, wilting and germinating (Aregheore, 1999a). Further studies of taro as a feed source for goats were undertaken. Aregheore et al. (2002) observed that taro, fed as small whole taro flour or taro peel flour, resulted in daily weight gains of 63 g in does and 54 and 32 g for kids fed whole taro flour or taro peel flour respectively. The lower weight gain in kids on the taro peel flour might be explained by the lower energy content of the peel flour in comparison to the whole taro flour (Aregheore et al., 2002). The authors further suggest these values should serve as indicators and warns the results should not be used as recommendations due to the short duration of the trial. Similar trials were conducted using cocoa by-products (Aregheore, 2002a). In the said study cocoa dust and cocoa shell were added to a dried brewer's grain basal diet of growing goats. Daily weight gain for control (dried brewer's grain), dried brewer's grain + cocoa shell and dried brewer's grain + cocoa dust were 110, 95 and 80 g/hd/day respectively. The lower voluntary dry matter intake of the treatments is potentially due to their low palatability or toxicity factors. These by-products are hence recommended as goat feeds but not as the basal diets (Aregheore, 2002a).

Given that coconuts (Cocos nucifera) are integral to South Pacific cultures their potential as ruminant feedstuff has been determined. In a trial with growing goats Aregheore and Tunabuna (2001) tested increasing levels of desiccated coconut waste meal (0, 38.5, 48.5 and 58.5 % of diet) and reported daily weight gains of 116, 160, 90 and 66 g/hd/day respectively. Results indicate a "negative linear trend" with increasing desiccated coconut waste meal levels (Aregheore and Tunabuna, 2001). Though diets with 48.5 % and 58.5 % desiccated coconut waste meal had high energy levels, voluntary intake favoured forage intake; providing a possible explanation for the lower daily weight gains. A similar trial evaluating the substitute level of dried brewer's grain in a copra cake (Cocos nucifera) based concentrate in growing goats on a Guinea grass (Panicum maximum) basal diet determined that dried brewer's grain can replace 75 % of the copra cake (Aregheore and Viulu, 2006). It is suggested that this level of substitution can satisfy the maintenance and growth requirements of goats without negative effects. Caution in the interpretation of these results is suggested given the small number (4) of goats in the trial and its short duration (Aregheore and Viulu, 2006). However, in the event that dried brewer's grain can inexpensively substitute copra cake and its availability is not a constraint it is a promising by-product for goat production in the region.

The use of Noni (*Morinda citrifolia*) juice extract waste as a supplement for growing goats was evaluated (Aregheore, 2005a). The trial substituted Noni waste in a dried brewer's grain, whole breadfruit flower, and banana peel flour diet at either 25 % or 35 % of the

diet. The live weight gains (g/kg0.75/day) for control, 25 % inclusion and 35 % inclusion were 58, 43 and 36 respectively. The poor palatability and suggested poor nutrient digestibility of Noni waste nutrients are reasoned to cause a decrease in weight gain in relation to increasing inclusion rates (Aregheore, 2005a). However, given that a large volume of Noni waste is produced in the South Pacific region, more research on manipulating this waste to increase palatability and nutrient availability in ruminant nutrition is warranted (Aregheore, 2005a).

Various forms of breadfruit (*Artocarpus altilis*, Park) preparations as feedstuffs for growing goats were investigated (Aregheore and Gibson, 2003). All forms--; whole breadfruit flour, breadfruit pulp flour and breadfruit peel flour–, resulted in adequate daily gains of 82, 175 and 114 g/hd/d. Interestingly, breadfruit pulp flour had the best feed conversion ratio (4.8). However, given the relative importance of breadfruit in human diets in the Pacific its use as ruminant feed is unlikely, except perhaps as a temporary supplement during peak harvest seasons. The breadfruit peel, however, if available from processing plants, may prove to be a valuable supplement in ruminant nutrition. Notably, this trial was conducted over an 80 day period and no deleterious effects due to breadfruit were reported in the goats.

Sweet potato (*Ipomea batatas* (L) Lam) is another staple in the diet of South Pacific islanders. Generally, it is cultivated for its tubers but nutritive the value of its foliage in ruminant nutrition requires more study. Due to its high biomass production, palatability and crude protein content (Aregheore, 2003b) investigated its effects as a supplement to Batiki grass on growing goats in Samoa. Results indicate that a ration of 75 % sweet potato : 25 % Batiki grass yielded highest average daily gain (82 g/hd/d) in comparison to only 36 and 61 g/hd/d in 100 % Batiki grass or 100 % sweet potato forage respectively. The higher weight gain at the ratio stated is likely due to its higher nitrogen and energy content (Aregheore, 2003b). As such, sweet potato can inexpensively complement low quality grass based diets in growing goats in Samoa. A potential limitation of its use however might be its unavailability during periods of pasture scarcity (Aregheore, 2003b).

As with any technology the keys to farmer adoption include availability of by-product, cost of by-product, access to information and processing technology and the relative benefits of these in comparison to conventional feed stuffs. It is important to note that the bulkiness of many of these by-products may pose a challenge to livestock farmers; particularly small scale farmers who may lack transportation, road access and capital to make such investments. Generally, these by-products also require more storage space than conventional feed stuffs which may be a hurdle for the small-scale farmer. Access to information is vital. Though the technology for processing the by-products is relatively easy to implement it first requires the farmer to learn the process. This is often accomplished by the extension branch of the Ministry of Agriculture. If this avenue is preferred it mandates that such service be vibrant and proactive in promoting the use of by-products. Finally, the relative economic benefits of including by-products must be measured. If economic benefits in animal output outweigh the acquisition, transportation, time and processing costs, then the use of by-products will likely be favoured by farmers. Studies on these issues were not located and as such it is difficult to draw conclusions about the realized benefits of by-product inclusion by farmers in the regions of interest.

In summary, much work on the potential use of forages and agricultural by-products has been conducted. The value of these forages and by-products however is limited to their availability and farmers' ability to access them. Forages seem to be the better option for farmers since these can be planted and maintained relatively inexpensively and their availability made constant throughout the year. In contrast, by-products may not be readily and inexpensively available particularly to small holders who may not have access to transport of bulky feedstuffs. Furthermore, as seen in many published data, the nutritional value of many by-products varies according to season and processing techniques. It is unlikely small holders will have the initiative and capital to undertake a proximate analysis

of the feedstuffs to determine ideal inclusion levels in the diet of sheep and goats. A further limitation to the published data is the small number of animals and short duration of trials in some instances (Aregheore and Viulu, 2006). In addition, evidence on the effect of milk yield and carcass qualities are lacking. The effects of long term use of these by-products on animal performance is difficult to determine given some of the limitations stated. Finally, as stated by Aregheore and Gibson (2003) conflicting use of a resource with human nutrition will result in the diversion of such a resource for human consumption as is the case for breadfruit.

Disease and parasite management of sheep and goats in the Fiji, Samoa and Vanuatu

Disease and parasite management play an important role in the successful implementation of sheep and goat farming in the region. Given the warm, moist environment it is not surprising that internal parasites are among leading causes of economic loss to farmers. The prominent internal parasites in Fiji and Samoa include *Haemonchus contortus* and *Trichostrongylus colubriformis* (Banks et al., 1990, Manueli, 1997, Petaia, 1989). Under ideal conditions infective larvae of *Haemonchus contortus* have been observed to emerge within 4 – 5 days (Iqbal et al., 2000, Taylor et al., 2016). Though no data on economic loss due to internal parasites was available it has been identified as a major setback to sheep and goat farming in Samoa (Orange, R. personal communication 29th September 2017) and Fiji (Manueli, 1997). Given the similar environmental conditions, it is likely Vanuatu experiences a similar situation. Hence the need for alternatives to chemotherapy has been identified in the region (Manueli, 1997). In Fiji, Manueli (1997) suggests that rotational grazing on a 28 day cycle with 8 paddocks reduces the need for drenching. In addition, the inclusion of Barbados Black Belly sheep, known for its internal parasite tolerance, was used as the foundation stock of Fiji Fantastic sheep in Fiji. The Fiji Fantastic sheep is reported to have a heritability of 30 % in terms of internal parasite resistance (Manueli, 1997). Samoa has also reported the Fiji Fantastic sheep performed better than Dorpers comparing their resistance to internal parasites (Ministry of Agriculture and Fisheries Samoa, 2016). However, the trial was prematurely terminated, because a high number of Dorpers were required to exit the study due to parasitic loads surpassing safe levels. Further limiting the reliability of the results was an unequal number of gestating ewes per observation group. In Samoa, recently imported Dorpers have been affected by fly strike. There is no published data on the incidence or severity of this condition. Affected animals have been treated with Malathion solution. In more severe cases antibiotics have been administered to the animals along with nutritional supplementation where there is depressed grazing (Orange, R. personal communication 29th September 2017). For an extensive review of Fiji specific studies in sheep and goat parasite studies refer to Manueli (2004).

In Fiji, the use of urea-molasses blocks resulted in improved performance and a lower faecal egg count in sheep (Knox and Steel, 1996). Furthermore, urea-molasses blocks infused with anthelmintics proved beneficial for maiden ewes (Knox and Steel, 1996). The authors further indicate that urea plus 100 g cotton seed meal fed daily improved performance of confined goats. In Fiji, biological control of infective stage larvae using an imported strain of Duddingtonia flagrans reduced cultured larvae populations by 90 % (Australian Centre for International Agricultural Research, 2004). At the time of on-going field trials the efficacy of *D. flagrans* was highly variable (Australian Centre for International Agricultural Research, 2004). Data on the final outcome of these trials was not located.

Another condition observed in sheep and goats in Fiji is foot rot and inter-digital foot scald (Manueli et al., 2001). Samoa has also reported foot rot but no published data has been found on its incidence nor economic loss due to this condition.

Market

Small stock production in the selected countries focuses on supplying the domestic market. Marketing systems tend to be hindered by small scale production, “marketing skills, market structure and demand for goods and services” (FAO, 1998). No market studies were located, yet based on projected import substitution and relatively small flock size it can be noted that there is great potential for the local producers. The government of Fiji estimates the growth potential of sheep and goat production at 100 % (Fiji Ministry of Agriculture, 2016). However, local production will have to compete with low prices of imported cheap cuts of meat. In Fiji the Agriculture Trade Unit is responsible for marketing studies (FAO, 1999). There have been attempts to discourage the importation of specific mutton cuts by imposing import tariffs. This measure however has been controversial and specific data on its effect was not located.

In Samoa the goat population is dwindling due to a lack of market demand. The sheep population on the other hand is increasing and there is greater emphasis on this species by the Ministry of Agriculture. As of this time, local production cannot meet market demand for mutton.

Conclusion

The majority of information about sheep and goats in Fiji, Samoa, and Vanuatu is collected as part of larger censuses, not primarily for the improvement of the industry. There is need for research in every area of sheep and goat production, with the overall goal of increasing and improving production to fill the local consumer’s desire for sheep and goat meat and providing food security.

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