

# Diseases of livestock in the Pacific Islands region: setting priorities for food animal biosecurity

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## ABSTRACT

Most Pacific Island Countries and Territories (PICTs) have developing economies and face a critical shortage of veterinarians with limited financial resources allocated to their animal disease surveillance programmes. Thus, animal health authorities have to set priorities for better focussing their scarce resources. The main objective of this study was to identify animal diseases perceived to be of importance by decision makers within selected PICTs, at the regional and national levels, to ensure better targeting of animal health resources. A second objective was to investigate whether the targeted surveillance programmes resulting from this rationalised approach would also benefit the local communities engaged in livestock production. A multi-criteria prioritization process was developed, involving local experts, to score and rank 132 animal diseases based on their priority at the regional and national levels for four PICTs: Fiji, Papua New Guinea, Solomon Islands and Vanuatu, which form part of a regional Food Animal Biosecurity Network. In parallel interviews with farmers and field animal health and production workers were conducted to assess their perception of animal diseases. The list of the top-twenty ranked diseases for the Pacific Islands region shows a mix of endemic zoonotic diseases (such as leptospirosis ranked first; brucellosis third; tuberculosis sixth and endoparasites and ectoparasites respectively eleventh and thirteenth) with exotic diseases (such as HPAI ranked second, FMD fifth and rabies ninth). There were different disease ranking lists for each of the four targeted PICTs, confirming different strategies of disease prevention and control may be required for each country, rather than a regional approach. Interviewed animal health and production workers were unfamiliar with most of the prioritized diseases and a majority acknowledged that they would not be able to recognise clinical signs if outbreaks were to occur in their area. Leptospirosis, which is endemic and identified as the top priority disease at the regional level, was never mentioned by any interviewed farmer. Farmers did not name any emerging infectious diseases as priorities. Instead, they identified endemic diseases (parasites, flu, coccidiosis and scabies) as the most important. While animal disease priorities appear to differ widely between the targeted regions and countries, it also varies significantly between experts and farmers. Better targeted surveillance programmes may thus result in more rational and transparent allocation of resources, and thus enhanced food security, but may not directly match the needs of the local communities.

## KEYWORDS:

Pacific Island; Tropical Diseases; Prioritization; Animal Health; Livestock; Food Animal Biosecurity.

## 1. Introduction

In the Pacific Island countries and territories (PICTs) zoonotic diseases such as leptospirosis, scabies, bovine tuberculosis and brucellosis are endemic ([Brioudes et al., 2014](#); [Kline et al., 2013](#)), but these island countries tend to be free of serious infectious livestock diseases such as highly pathogenic avian influenza, foot and mouth disease, classical swine fever and rabies ([Brioudes et al., 2014](#); [Newman and McKenzie, 1991](#); [Secretariat of the Pacific Community, 2009b](#); [Yarrow, 2008](#)). The potential introduction and/or dissemination of diseases threatens the development of the livestock sector and also represents a risk to humans who might be exposed to zoonosis, which account for about 75% of all emerging animal diseases. Veterinarians and field animal health workers are key players required to actively protect this favourable animal health situation but they are in severe shortage in the region ([Osborne, 1974](#); [Secretariat of the Pacific Community, 2006](#); [Williams, 2008](#); [Yarrow, 2008](#)). In this context of limited human and financial resources allocated to animal health and animal production programmes, a targeted, cost-efficient surveillance programme is crucial to protect the animal health status and to facilitate the trade of animals and animal products ([Cardoen et al., 2009](#); [Krause, 2008](#); [Phylum, 2009](#); [Woolhouse et al., 2011](#)). The decision-making process for identification of which disease to target as a priority is complex, as it involves the combination of, not only technical information, but also some value judgements ([Kurowicka et al., 2010](#)). The process of prioritization, defined as the listing of diseases into a hierarchy considering their respective impacts, is thus a tool to assist decision-makers in selecting diseases that are most worthy of being addressed by public policies. The result of this prioritization can then be used to determine which prevention and control measures to implement first ([Phylum, 2009](#)).

Transparent and documented disease prioritization processes have now been quite widely conducted across the world, mostly in Europe ([Balabanova et al., 2011](#); [Gilsdorf and Krause, 2011](#); [Havelaar et al., 2010](#); [Humblet et al., 2012](#); [McAnulty et al., 2003](#); [Simoes et al., 2012](#)), but also in Africa ([Uzochukwu et al., 2007](#)), in the Middle East ([Gibson, 2011](#)), and more recently in North America ([Ng and Sargeant, 2012a, b, 2013](#)). It appears that only a limited number of prioritization exercises have been implemented for animal diseases globally ([Humblet et al., 2012](#); [McKenzie et al., 2007](#); [Phylum, 2009](#); [Van der Fels-Klerx et al., 2002](#)). In the Pacific Islands region, a semi-quantitative prioritization process has been conducted by the public health sector of the Federate States of Micronesia for a revised selection of diseases to include in the National Notifiable Diseases List ([Pavlin et al., 2010](#)). Besides the initial steps taken towards a prioritization of livestock diseases in 1974 ([Osborne, 1974](#)) and the ranking of animal diseases during the GTADs conferences in 2009 and 2013 ([Secretariat of the Pacific Community, 2009b](#), [2013](#)), the rational and structured prioritization of animal diseases in the entire Pacific Islands region has yet to be conducted.

In 2010, a Food Animal Biosecurity Network (FABN) was established between Fiji, Papua New Guinea (PNG), Vanuatu and Solomon Islands (hereafter defined as “FABN countries”), with the aim of “delivering enhanced animal health field and laboratory capability to the Pacific islands, particularly in the area of animal disease surveillance, to allow assessment under OIE guidelines for trade in animals and animal products”. This paper focuses on the FABN countries which can be viewed as a well-defined cluster of Pacific Island countries representative of the PICTs.

## **2 Objectives**

The primary objective of this study was to prioritize the animal diseases of greatest importance within the Pacific Islands region, at both the regional and national levels, based on the opinion of animal health officials.

In addition, the study investigated whether targeted surveillance programmes based on the opinion of animal health officials would also benefit the local communities making their living from livestock production.

## **3 Methods**

This study comprises two components: first the rational and structured prioritization of animal diseases through an expert elicitation process, and secondly a field survey to capture the animal disease perception of farmers and field-based animal health and production workers (AHPW).

### *3.1 Prioritization of diseases by regional and national experts:*

#### *3.1.1 Eligible animal diseases:*

The first step in the prioritization of diseases was to create a comprehensive list of eligible diseases in order to avoid elimination *a priori* of any diseases of interest for the region. The list included present and exotic diseases that could potentially pose a risk to the study area. Because the surveillance of aquatic animal diseases fits into a very specific and generally different veterinary public health approach, the study list was limited to terrestrial domestic animal diseases only.

The selection of diseases for the list was based on Brioudes et al's work (Brioudes and Gummow, 2013; Brioudes et al., 2014) that provided a review of diseases within the Pacific Islands region. The list also included diseases that had been officially reported by neighbouring countries of the Pacific Islands countries (i.e. Australia, New Zealand and Indonesia) to the World Organisation for Animal Health (OIE) between 2008 (starting date of the World Animal Health Information Database ([OIE, 2013b](#))) and 2012. Since the detailed and extensive list of parasites presented in some of the references retrieved through the literature review could not be realistically included in the list of eligible diseases, these parasites were compiled under the generic terminologies of "endoparasites" and "ectoparasites" ([Martin, 1999a, b, c](#); [Martin and Epstein, 1999](#); [Owen, 2005, 2011](#); [Saville, 1994, 1996a, b, c, d, 1999](#)). In total, this selection process produced a list of 132 selected diseases for the prioritization exercise.

#### *3.1.2 Panel of experts:*

A two-stage expert opinion elicitation study was conducted to prioritize animal disease at the regional and national levels in the four FABN countries.

### *3.1.2.1 Regional experts*

The Secretariat of the Pacific Community (SPC) is an international organisation that works in various areas, including public health and agriculture to help the people from its 22 member countries and territories achieve sustainable development. While this organisation appoints experts from all around the world, a majority of them are from the Pacific Island region.

Regional experts used in the study were from the Animal Health and Production Team, Land Resources Division and from the Public Health Division of SPC as well as experts from the local representation of the World Health Organisation. They were invited to participate in two workshops conducted at SPC, in Suva, Fiji. In total, five technical staff from the Animal and Production Team of SPC participated in this prioritization of animal diseases of the Pacific Island region.

A Delphi technique was used to elicit expert opinion at the workshops held in May and July 2012. The first workshop started with a general presentation on disease prioritization processes. The list of diseases selected on the basis of the literature review was presented to the group of experts and a discussion was held on whether to include other diseases. The key results obtained from the literature review on domestic animal diseases of the Pacific Islands region were distributed for information to the experts to assist them with the most up-to-date data on the diseases to be scored. A list of 10 criteria was defined on the basis of the literature review and the needs for criteria modification and for inclusion or exclusion of some criteria were discussed among the group of experts. The scoring system for each of the selected criteria was presented and revised based on experts' suggestions. Experts were directed not to score a criterion if they felt insufficiently competent in relation to a particular disease. The option of attributing different weights to the criteria for taking into account their relative importance was discussed before starting the scoring of the diseases. The regional experts decided as a consensus not to apply any such weighting. The matrix for the scoring of each of the 132 diseases against the 10 selected criteria was then distributed to each expert.

Based on a review of published prioritization processes ([Cardoen et al., 2009](#); [Doherty, 2000](#); [IFAH-Europe, 2009](#); [Krause, 2008](#); [McKenzie et al., 2007](#); [World Health Organization, 2006](#)), six categories, divided into a total of 10 criteria, were considered for assessing the diseases:

- Animal health impact:
  - Criteria 1: Occurrence in live animals
  - Criteria 2: Severity of the disease for animals
- Public health impact:
  - Criteria 3: Occurrence in humans
  - Criteria 4: Severity of the disease for humans
- Epidemiology:
  - Criteria 5: Epidemic potential (threat of spread) among animals
- Prevention and control measures:
  - Criteria 6: Effectiveness of animal surveillance system
- Economic Impact:
  - Criteria 7: Economic impact of the disease on local / national trade
  - Criteria 8: Economic impact of the disease on regional / international trade

- Social Impact:
  - Criteria 9: Impact of the disease on farmers' livelihood
  - Criteria 10: Impact of the disease on the food supply for consumers / community

A semi-quantitative approach with a 4-tiered scoring system was adopted for assessing the diseases against each criterion with; 0 for an occurrence, an impact or a disease severity assessed as “Nil”; 1 for “Low”; 2 for “Moderate” and 3 for “High”.

After this first workshop, experts were given one month for the scoring of the 132 diseases. Tables were then sent back to the study coordinator who compiled the scores attributed by the experts using a Median function to rank the diseases from highest to lowest median score. Results obtained from the expert's scoring were presented during a second workshop and a discussion was then held among the experts to identify the diseases for which the total score was assessed as too high or too low within the ranking list. Diseases for which consensus was not reached regarding their ranking position had their scores revised. Experts were offered the option to re-attribute scores individually and send back their new scoring matrix within a 2 week-period, but they chose to handle it by a collective approach during a third workshop. A consensus was finally reached and the 132 selected diseases were then ranked according to their updated total score.

In addition to this regional priority setting and in order to take into account the specificities of the PICTs, this prioritization process was also carried out at the national level in the four FABN countries.

### *3.1.2.2 National experts*

The study coordinator engaged with the following institutions: the Department of Animal Health and Production of Fiji's Ministry of Primary Industries, the National Agriculture Quarantine and Inspection Authority (NAQIA) and the National Agricultural Research Institute (NARI) of PNG, the Departments of Livestock and Quarantine of Solomon Islands and of Vanuatu (named hereafter as “local counterparts”). These groups assisted with identification and invitation of the national experts for the prioritization process in each country. A total of 45 national experts (8 from Fiji, 21 from PNG, 11 from Vanuatu and 5 from Solomon Islands) participated in this study.

A similar Delphi approach was used however, to simplify the process and make it more practically manageable at the national level an arbitrary cut off was decided and only the top-twenty diseases from the regional prioritization were selected for national experts to rank. To ensure that no disease was missed that could be relevant for a particular country, prior to the scoring of diseases, the national experts were requested to name, according to their own experience and knowledge, the five most important livestock diseases for their country (being diseases currently present or diseases that could potentially be introduced to their country). When an expert suggested a disease that was not included in the top-twenty regional priority list the named disease was then added to the list of selected diseases to be scored by that expert.

Questionnaires for the scoring of the diseases against the 10 criteria listed above were completed by the participating national experts during the first round of workshops conducted in-country between July and December 2012. Results from the compiled scores were

presented, discussed and validated during a second round of workshops in each of the targeted PICTs between March and May 2013.

### *3.2 Perception of animal disease by communities involved in livestock production within the PICTs:*

#### *3.2.1 Field Animal Health and Production Workers' perception*

A short self-administered questionnaire was developed for collecting information from field animal health and production workers (AHPW) regarding their perception of the animal diseases representing the greatest risk in their locality; whether it be diseases currently present in the region, or pathogens that could potentially be introduced and propagate in the future.

Additionally, they were requested to document if they knew or had ever heard about the twenty top-ranked diseases and if they thought they would be able to recognize their clinical signs in the event of an outbreak within their locality.

Data was collected for three of the four FABN countries during the first round of missions between July and December 2012. Vanuatu is composed of an archipelago of small islands and does not have field animal health staff other than those of the Department of Livestock and Quarantine, who had already been involved as national experts in the prioritization process. For that reason no AHPW were included from Vanuatu in this part of the analysis. In total, 86 AHPW (19 from Fiji, 25 from Papua New Guinea and 42 from Solomon Islands) participated in this study.

#### *3.2.2 Farmer's perception*

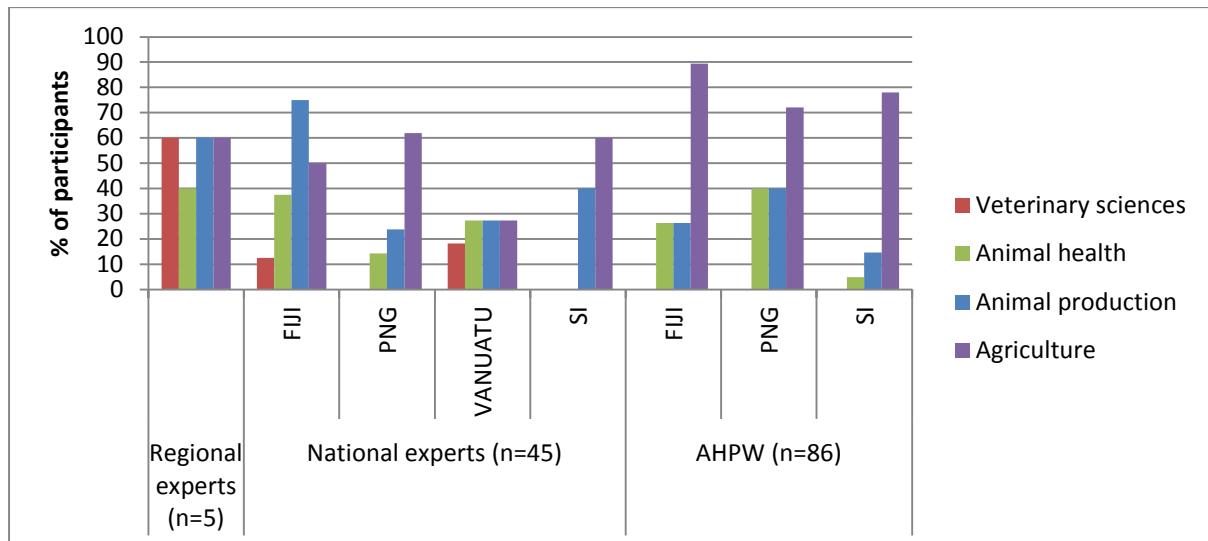
A multi-stage sampling strategy was developed to obtain a representative sample of farmers. First, a purposive selection of at least 2 provinces per country was performed in consultation with local counterparts from the four FABN countries, based on the importance of the pig and poultry sectors and on their accessibility to field staff conducting the survey. Then, for the second stage 2% of the total number of villages within these provinces was to be selected in PNG, 3% in Solomon Islands and 10% in Vanuatu and Fiji using a simple random sampling based on the list of villages within the four FABN countries. The sampling frames were provided by SPC. Once in the village, interviewers were required to randomly identify and interview 4 farmers (two pig farmers and two poultry farmers). A total of 801 farmers participated in the study.

Prior to the launching of the field survey, the questionnaire was tested by interviewing 10 pig farmers and 10 poultry farmers located within the Central division of Fiji and revised based on their feed-back before implementation. After consultation with SPC and local counterparts, a translation of the questionnaire in the respective local languages of the four FABN countries was judged to be unnecessary. Operatives from the local counterpart agencies were trained to perform the farmer's interview and the survey was conducted from July 2012 to July 2013 in the four FABN countries.

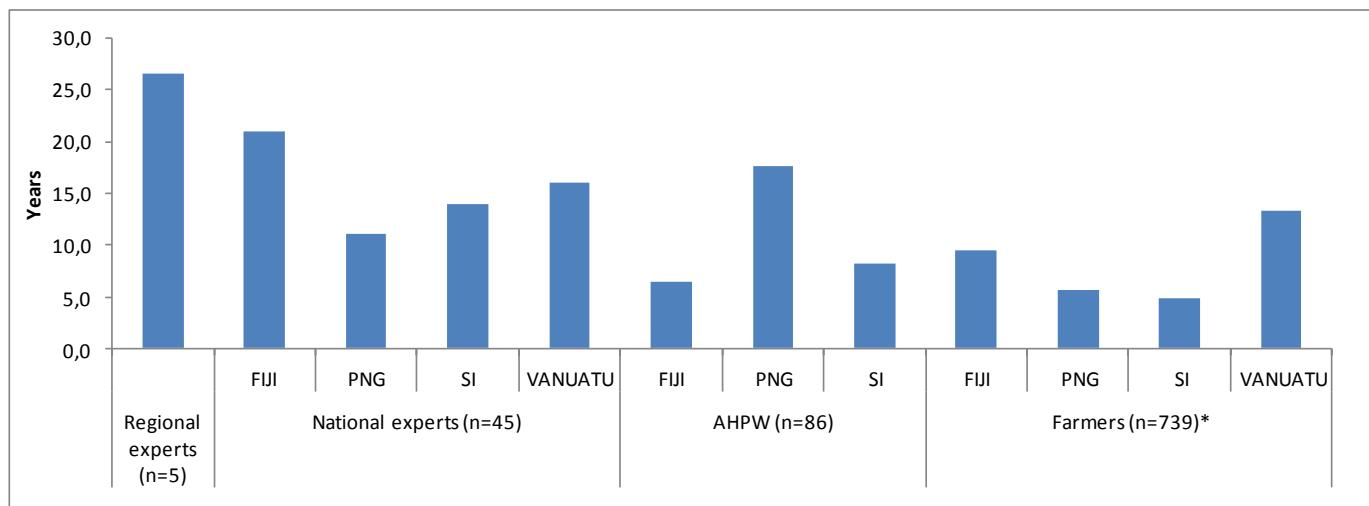
## 4 Results

### 4.1 Background and experience of participants

The educational background of the 5 regional, 45 national experts and 86 AHPW is presented in Figure 1. Figure 2 summarized the professional experience of the regional and national experts, AHPW and farmers. However, 739 out of the 801 participating farmers provided information on their professional experience.



**Fig. 1. Distribution of disease prioritization participants according to their educational background**



**Fig. 2. Distribution of disease prioritization participants according to their professional experience (\* only 739 out of the 801 participating farmers answered this question).**

### 4.2 Animal diseases rationally prioritized at the regional level

The final scores along with the ranking of each of the 132 animal diseases for this prioritization exercise are detailed in Table 1.

**Table 1**

List of the 132 scored and ranked animal diseases at the regional level (Diseases presented in rank ascending order)

<b>Animal diseases in the Pacific Islands region</b>	<b>Score</b>	<b>Rank</b>
Leptospirosis	23,5	1
Highly pathogenic avian influenza	23	2
Brucellosis	22,5	3
Newcastle disease	21	4
Foot and Mouth disease	20,5	5
Tuberculosis	20	6-8
Infectious bursal disease (Gumboro)	20	6-8
Fowl pox	20	6-8
Salmonellosis	19,5	9-10
Rabies	19,5	9-10
Endoparasites	19	11-12
Classical swine fever	19	11-12
Marek's disease	18,5	13-14
Ectoparasites	18,5	13-14
Varroosis	18	15-19
Porcine reproductive respiratory syndrome	18	15-19
Infectious coryza	18	15-19
Avian infectious laryngotracheitis	18	15-19
Anthrax	18	15-19
Vibrionic dysentery	17,5	20
Parvovirus	17	21-22
Enzootic pneumonia	17	21-22
Avian infectious bronchitis	16,5	23
Trichomonosis	16	24-33
Toxoplasmosis	16	24-33
Nosemosis	16	24-33
Mycoplasmosis ( <i>M. Gallisepticum</i> )	16	24-33
Hepatitis E virus	16	24-33
Fowl cholera	16	24-33
Fasciolosis	16	24-33
Contagious pustular dermatitis	16	24-33
Balantidium	16	24-33
American foulbrood	16	24-33
Tetanus	15,5	34-42
Swine erysipelas	15,5	34-42
Surra/Trypanosomosis	15,5	34-42
Q fever	15,5	34-42
Other avian salmonellosis	15,5	34-42
Johne's disease	15,5	34-42
Bovine ephemeral fever	15,5	34-42
Babesiosis	15,5	34-42
Avian mycoplasmosis ( <i>M. Synoviae</i> )	15,5	34-42
Porcine rotavirus	15	43-54
Myxomatosis	15	43-54
Mycoplasma spp.	15	43-54
Low pathogenic avian influenza	15	43-54
Enzootic bovine leukosis	15	43-54
Dermatophilosis	15	43-54
Coccidiosis	15	43-54
Chalkbrood (fungus)	15	43-54
Caseous lymphadenitis	15	43-54
Bov. genital campylobacteriosis	15	43-54
Avian spirochaetosis	15	43-54
Aujeszky's disease	15	43-54
Melioidosis	14,5	55-57
Filariosis	14,5	55-57
Botulism	14,5	55-57

Wax moth	14	58-66
Streptococcus suis type 1	14	58-66
Other pasteurelloses	14	58-66
Infectious bovine rhinotracheitis (IBR)	14	58-66
European foulbrood	14	58-66
Echinococcosis/hydatidosis	14	58-66
Bovine virus diarrhea (BVD)	14	58-66
Avian encephalomyelitis	14	58-66
Amoeba disease (Malpighamoeba)	14	58-66
Theileriosis	13,5	67-69
Japanese encephalitis virus	13,5	67-69
Bovine leukosis	13,5	67-69
Swine influenza	13	70-77
Small hive beetle infestation	13	70-77
Sheep mange	13	70-77
Pasteurella spp.	13	70-77
Inf. Bov. Rhinotracheit. (IBR/IPV)	13	70-77
Hendra virus[Henipavirus]	13	70-77
Enterovirus encephalomyelitis	13	70-77
Cysticercosis	13	70-77
Transmissible gastroenteritis (TGE)	12,5	78
Trichinellosis	12	79-90
Ross River virus	12	79-90
Henipavirus[Hendra and Nipah)	12	79-90
Equine Herpes virus	12	79-90
Enterotoxaemia	12	79-90
Chlamydiosis	12	79-90
Caprine arthritis/encephalitis	12	79-90
Blackleg	12	79-90
Avian malaria	12	79-90
Avian chlamydiosis	12	79-90
Anaplasmosis	12	79-90
Akabane virus	12	79-90
Clostridial infections	11,5	91
Shiga-like toxin I-producing E. Col	11	92-99
Bartonellae	11	92-99
Bluetongue	11	92-99
Commensal and opportunistic bacteria, including Salmonella spp.	11	92-99
Getah virus	11	92-99
Halfmoon disorder (nutritional /genetic?)disorder)	11	92-99
Plasmodium	11	92-99
Psittacosis	11	92-99
Avian leukosis	10,5	100-102
Equine infectious anaemia	10,5	100-102
Ovine epididymitis (B.ovis)	10,5	100-102
Actinomycosis	10	103-109
Black queen cell virus	10	103-109
Crocodylocapillaria longiovata	10	103-109
Kashmir bee virus	10	103-109
Sacbrood virus	10	103-109
Tropilaelaps infestation	10	103-109
Vesicular stomatitis	10	103-109
Canine distemper virus	9,5	110-111
Foot-rot	9,5	110-111
Heat-stable enterotoxin II-producing enterotoxigenic E. coli	9	112-114
Listeriosis	9	112-114
Murray Valley encephalitis virus	9	112-114
Ehrlichia canis	7	115-116
Equine Influenza A	7	115-116
Dirofilariasis	6,5	117-118
Rabbit haemorrhagic disease	6,5	117-118

Equine leucoencephalomalacia	6	119
Equine rhinopneumonitis	5,5	120
Chronic paralysis virus	Not scored	Not scored
Contagious ophthalmia	Not scored	Not scored
Entamoeba polecki	Not scored	Not scored
Epizootic haemorrhagic disease	Not scored	Not scored
Equine coital exanthema	Not scored	Not scored
Equine viral arteritis	Not scored	Not scored
Leishmaniosis	Not scored	Not scored
Rubulavirus	Not scored	Not scored
Serpulina pilosicoli	Not scored	Not scored
Simbu serogroup	Not scored	Not scored
Strangles	Not scored	Not scored
Subcutaneous filarial worm	Not scored	Not scored

#### 4.3 Animal diseases rationally prioritized at the national level

The scores and ranking of the prioritization process conducted in the four FABN countries are compiled in Table 2.

#### 4.4 AHWP's animal disease knowledge assessment

Table 3 presents results regarding the AHWP's knowledge and ability to recognise the clinical signs of the top-twenty prioritized diseases.

#### 4.5 Farmers' and AHWP's animal disease perception

Access to villages in the countries proved to be more difficult than expected because of their remoteness or in some cases security and none of the countries were able to survey the percentage of villages originally specified in the materials and methods. In particular, there was a poor return rate from the Western province of Solomon Islands, which led to the exclusion of the data from that province. In total, 491 poultry farmers (72 from Fiji, 273 from PNG, 93 from Solomon Islands and 53 from Vanuatu) and 310 pig farmers (60 from Fiji, 110 from PNG, 91 from Solomon Islands and 49 from Solomon Islands) finally participated in this survey.

Pig farmers were interviewed in eight provinces of Fiji, two of PNG and Vanuatu and one of Solomon Island. By the end of the survey, 3.1% (n=36) of the villages with pig farmers interviewed in the selected provinces had been surveyed in Fiji, 0.8% (n=60) of villages in PNG, 1.9% (n=46) of villages in Solomon Islands and 7.3% (n=29) of villages in Vanuatu.

With respect to poultry farmers, nine provinces were surveyed in Fiji and two in PNG and Vanuatu and one in Solomon Islands. By the end of the survey, 3.8% (n=44) of the villages with poultry farmers in the selected provinces had been surveyed in Fiji, 1% (n=74) of villages in PNG, 2% (n=47) of villages in Solomon Islands and 7.8% (n=31) of villages in Vanuatu.

Provinces surveyed for pig farmers in Fiji were Ba, Bua, Cakaudrove, Kadavu, Macuata, Nadroga/Navosa, Serua and Tailevu. Provinces surveyed for poultry farmers in Fiji were Ba, Bua, Cakaudrove, Kadavu, Macuata, Nadroga/Navosa, Namosi, Rewa and Tailevu. Pig and poultry farmers were interviewed in the provinces of Morobe and Eastern Highlands Province

**Table 2**

List of prioritized animal diseases at the national level (diseases presented in alphabetical order)

Animal diseases	Fiji Scoring	Fiji Ranking	PNG Scoring	PNG Ranking	Solomon Scoring	Solomon Ranking	Vanuatu Scoring	Vanuatu Ranking
Anthrax	13	15	18	12	8	19	18,5	3
Avian infectious laryngotracheitis	12	19	24	2	19,5	4	17	5
Brucellosis	21	2	16,5	19	16,5	9	10	20
Classical swine fever	13	15	21	6	X	X	15	8
Ectoparasites	10	21	16	20	13,5	16	10,5	19
Endoparasites	19	6	19	10	16	12	12,5	14
Foot and Mouth disease	23	1	20,5	7	13,5	15	17,5	4
Fowl pox	9	22	17,5	15	11,5	18	8	22
Highly Pathogenic Avian influenza	15	12	21,5	3	16	11	20	2
Infectious bursal disease (Gumboro)	14	14	21,5	3	X	X	13	12
Infectious coryza	X	X	20,5	7	X	X	14	10
Leptospirosis	19	6	17,5	15	20,5	2	13	13
Marek's disease	15	12	17	17	19	5	8,5	21
Newcastle disease	13	15	21,5	3	17	8	21	1
Porcine reproductive respiratory syndrome	10,5	20	19	10	X	X	11	18
Rabies	13	15	16	20	13,5	14	16	7
Salmonellosis	16	9	25,5	1	14	13	11,5	15
Tuberculosis	20	3	20,5	7	13	17	17	6
Varroosis	16,5	8	17	17	X	X	11	17
Vibrionic dysentery	X	X	15,5	22	16	10	7,5	23
Extra: American Fool Brood	20	3						
Extra: Bacterial Disease	20	3	18	12	18	6		
Extra: Blindness	16	9			20	3	4	26
Extra: Bovine Venereal Campylobacteriosis					21	1	11	16
Extra: Coccidiosis			18	12	17	7	14,5	9
Extra: Enzootic pneumonia			12	23	18	6		
Extra: Foot Rot	16	9						
Extra: Infectious Bronchitis					20	3		
Extra: Kidney Worm							13	11
Extra: Mastitis							7	24
Extra: Swine Erysipelas					21	1		
Extra: Swine Flu			10	24	17	7		

X: Disease not scored by any participants

Extra: Refers to diseases that were not part of the regional top-twenty prioritized diseases but which were suggested for the prioritization process at the national level by experts.

**Table 3****Animal health and production workers knowledge assessment on the top-twenty prioritised animal diseases**

Animal diseases known by AHPW	Total FIJI (out of 19)	Total PNG (out of 25)	Total SI (out of 42)	Total for the 3 PICTs (out of 86)
Brucellosis	17	18	33	68
Tuberculosis	17	17	29	63
Fowl pox	6	19	30	55
Foot and Mouth disease	13	20	21	54
Newcastle disease	11	20	17	48
Leptospirosis	15	15	17	47
Classical swine fever	5	18	20	43
Rabies	8	18	15	41
Salmonellosis	6	17	10	33
Anthrax	3	19	9	31
Marek's disease	3	17	11	31
Ectoparasites	9	12	8	29
Endoparasites	10	12	7	29
Highly Path. Avian influenza (HPAI)	6	13	10	29
Avian infectious laryngotracheitis	2	11	10	23
Infec. bursal disease (Gumboro)	4	8	4	16
Infectious coryza	0	7	8	15
Porcine reproductive respiratory syndrome (PRRS)	2	4	7	13
Varroosis	0	4	9	13
Vibrionic dysentery	0	3	2	5
Animal diseases AHPW would clinically recognise				
Foot and Mouth disease	6	18	22	46
Tuberculosis	9	14	19	42
Brucellosis	13	11	13	37
Fowl pox	0	13	21	34
Rabies	2	14	13	29
Leptospirosis	8	9	9	26
Newcastle disease	1	14	9	24
Ectoparasites	7	9	7	23
Endoparasites	7	8	7	22
Classical swine fever	0	11	10	21
Anthrax	0	11	5	16
Marek's disease	1	8	7	16
Highly Path. Avian influenza (HPAI)	2	9	4	15
Salmonellosis	2	9	4	15
Avian infectious laryngotracheitis	0	6	6	12
Infectious coryza	0	3	7	10
Varroosis	0	2	6	8
Infec. bursal disease (Gumboro)	0	3	4	7
Porcine reproductive respiratory syndrome (PRRS)	0	2	4	6
Vibrionic dysentery	0	1	3	4

(EHP) in PNG, Guadalcanal in Solomon Islands and Shefa (Efate Island) and Sanma (Santo Island) in Vanuatu.

The difference in the number of villages ( $n= 171$ ) with pig farmers compared to villages ( $n=196$ ) with poultry farmers is a reflection of the Seventh-day Adventist communities. The Seventh-day Adventist communities consider pork as unclean and thus don't have pig farmers in them. This resulted in fewer villages with pig farmers being included in the survey. To make up for this, interviewers in PNG interviewed more poultry farmers in the visited villages with on average 3.7 poultry farmers interviewed per village. The inability of interviewers to meet the desired sample sizes put forward in the methods was also due to the fact that in some small villages there was only one poultry farmer and/or one pig farmer and in a few of the villages interviewers could not find a second pig or poultry farmer willing to participate in the survey, thus highlighting the challenges of working in these countries.

Opinions of farmers and AHWP on the most important animal diseases are listed in Table 4. When interviewees didn't know the name of the disease, clinical signs were given instead and are also included in this table.

#### *4.6 Correlation between the top-twenty priority diseases identified at the regional level and Farmer' perception*

Table 5 shows which clinical signs enumerated by farmers match with each of the top-twenty prioritized animal diseases to demonstrate the potential correlation between the two sets of opinions.

## **5 Discussion**

### *5.1 Methodology limitations*

#### *5.1.1 The expert opinion elicitation procedure*

By using an expert opinion elicitation procedure with a semi-quantitative approach for the scoring of the diseases, the methodology of this study faced similar limitations to those pointed out in previous studies ([IFAH-Europe, 2009](#); [Krause, 2008](#)). The final results could be biased by the list of criteria that was ultimately selected, by the simple 4-tiered scoring system used, and by the choice of the regional experts not to apply any weighting. Also, as anticipated, it was a challenge for the participating experts to score each and every single eligible disease because of the complexity of scoring 10 criteria for 132 diseases at the regional level and 20 diseases at the national level; and secondly, because of the extensive workload that this prioritization process represents in terms of time needed for the Delphi technique.

The protocol originally planned for a multidisciplinary panel of experts and public health experts based in Suva, who were invited to participate in the regional priority setting. This format created a high level of interest in the study. However, despite numerous attempts that included postponement and date shifting of the workshops organized in Suva and in the targeted PICTs, no public health experts joined the workshop. This unfortunately reflects the difficulty of gathering veterinary and public health experts around the same table.

**Table 4****Animal health and production workers' and farmers' perception on diseases and clinical signs the most at risk**

Animal health and production workers' perception			Farmers' perception		
Diseases at risk	Frequency	Proportion	Diseases at risk	Frequency	Proportion
Brucellosis	22	11,96%	Parasites	37	24,03%
Tuberculosis	18	9,78%	Flu/Cold	20	12,99%
Fowl pox	15	8,15%	Coccidiosis	20	12,99%
Scabies	14	7,61%	Scabies	18	11,69%
Endoparasites	9	4,89%	Fowl pox	13	8,44%
Avian Influenza	8	4,35%	Round worms	7	4,55%
Ectoparasites	8	4,35%	Footrot	7	4,55%
Foot and Mouth Disease	8	4,35%	Coryza	7	4,55%
Newcastle Disease	8	4,35%	Lice	5	3,25%
Pneumonia	8	4,35%	Anthrax	5	3,25%
Anthrax	7	3,80%	Bacterial infections	3	1,95%
Coccidiosis	7	3,80%	Tetanus	2	1,30%
Leptospirosis	7	3,80%	Mites	2	1,30%
Parasites	6	3,26%	Iron deficiency	2	1,30%
Rabies	6	3,26%	Clostridium	2	1,30%
Round worms	6	3,26%	Asthma	2	1,30%
Flu/Cold	4	2,17%	Parvovirus	1	0,65%
Classical Swine Fever	3	1,63%	Marek's disease	1	0,65%
HPAI	3	1,63%			
Swine fever	3	1,63%			
American Foulbrood	2	1,09%	Clinical signs at risk	Frequency	Proportion
Bacterial infections	2	1,09%	Diarrhoea	221	28,37%
Chronic Respiratory Diseases	2	1,09%	Fluid in the joints/in the body	117	15,02%
Salmonellosis	2	1,09%	Paralysis	71	9,11%
Asthma	1	0,54%	Respiratory issue	41	5,26%
Avian Infectious Laryngotracheitis	1	0,54%	Loss of weight	37	4,75%
Mites	1	0,54%	Mortality	36	4,62%
Parvovirus	1	0,54%	Swollen body	30	3,85%
Trichinosis	1	0,54%	Itchiness	28	3,59%
Varroa mites	1	0,54%	Poor condition	27	3,47%
			Weak	17	2,18%
			Skin issue	17	2,18%
			Conjunctivitis	17	2,18%
Clinical signs at risk	Frequency	Proportion	White spots	11	1,41%
Diarrhea	36	33,03%	Loss appetite	11	1,41%
Skin issue	9	8,26%	Injuries/wounds	11	1,41%
Cough	7	6,42%	Blindness	11	1,41%
Weak	7	6,42%	Pecking	9	1,16%
Eye issue	5	4,59%	Nutrition issue	8	1,03%
Growth Issue	5	4,59%	Red body	7	0,90%
Fever	3	2,75%	Locomotion issue	7	0,90%
Lameness	3	2,75%	Growth Issue	6	0,77%
Respiratory issue	3	2,75%	Scaly legs	5	0,64%
Anaemia	2	1,83%	Vomiting	4	0,51%
Blood in stool	2	1,83%	Lameness	4	0,51%
Injuries/wounds	2	1,83%	Eggs/laying issue	4	0,51%
Loss appetite	2	1,83%	Lumps' head	3	0,39%
Loss of weight	2	1,83%	Hair falling off	3	0,39%
Mastitis	2	1,83%	Caught	3	0,39%
Mortality	2	1,83%	Still birth	2	0,26%
Nutrition issue	2	1,83%	Salivary mouth	2	0,26%
Poor condition	2	1,83%	Fever	2	0,26%
Swollen body	2	1,83%	Eye issue	2	0,26%
Blindness	1	0,92%	Stress	1	0,13%
Constipation	1	0,92%	Straight neck/legs	1	0,13%
Fluid in the joints/in the body	1	0,92%	Sun burnt	1	0,13%
Hair falling off	1	0,92%	Cryptorchidism	1	0,13%
Itchiness	1	0,92%	Blood in stool	1	0,13%
Nose discharge	1	0,92%			
Paralysis	1	0,92%			
Pecking	1	0,92%			
Salivary mouth	1	0,92%			
Sore body	1	0,92%			
Vomiting	1	0,92%			

Table 5

Correlation between the twenty top-priority diseases ranked by regional experts and the symptoms reported by farmers

Top ranked diseases (columns) / Symptoms reported by Farmers (rows)	Leptospirosis <sup>a</sup>	HPAI <sup>a</sup>	Brucellosis <sup>a</sup>	Newcastle disease <sup>a</sup>	FMD <sup>a</sup>	Tuberculosis <sup>a</sup>	IBD (Gumboro) <sup>a</sup>	Fowl pox <sup>a</sup>	Salmonellosis <sup>a</sup>	Rabies <sup>ab</sup>	Endoparasites <sup>a</sup>	Classical swine fever <sup>a</sup>	Marek's disease <sup>a</sup>	Ectoparasites <sup>c</sup>	Varroosis <sup>a</sup>	PRRS <sup>a</sup>	Infectious coryza <sup>a</sup>	Avian infect. Laryngo. <sup>a</sup>	Anthrax <sup>a</sup>	Vibrionic dysentery <sup>d</sup>
Anaemia														x						
Blindness	x																			x
Blood in stool									x			x								
Conjunctivitis												x								
Constipation												x								
Cough		x				x												x		
Cryptorchidism																		x		
Diarrhoea		x				x			x			x					x			x
Eggs/laying issue		x						x									x	x		x
Eye issue	x																x			
Fever									x			x				x			x	
Fluid in the body																				x
Growth Issue							x				x	x		x						x
Hair falling off																				
Injuries/wounds																				
Itchiness																				
Lameness																				
Locomotion issue																				
Loss of appetite	x					x						x				x	x	x		x
Loss of weight						x						x								
Lumps' head							x													
Mastitis				x																
Mortality	x		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	
Nasal discharge	x															x	x	x	x	
Nutrition issue																				
Overweight																				
Paralysis											x			x						
Pecking		x																		
Poor condition																				
Red body															x					
Respiratory issue	x		x		x			x	x							x	x	x		
Salivary mouth										x										
Scaly legs																				
Skin issue										x						x				
Sore body																				
Still birth/abortion	x		x							x							x			
Straight neck/legs												x							x	
Stress																				
Sun burnt																				
Swollen body			x														x		x	x
Vomiting																				
Weak	x	x						x					x			x	x	x	x	
White nodules									x											

<sup>a</sup> (QIE, 2013b)<sup>b</sup> (Ballweber, 2006)<sup>c</sup> (Hoplà et al., 1994)<sup>d</sup> (Duhamel et al., 1991)

While all regional experts had an education in veterinary sciences and / or in animal health, national experts had mostly an animal production or agricultural background with limited or no background in animal health. This represents a serious limitation for the national animal disease prioritization exercise. Nevertheless, they had on average from 11 to 21 years of working experience in their country and therefore had valuable knowledge of what is currently happening in their country. To limit the impact on the accuracy of the scoring of the criteria, which requires a high level of expertise in veterinary / epidemiology sciences, the scoring system included the option “no scoring”. This was a precaution against random scoring of the criteria by experts when they did not know enough about a particular disease. The consequence is that for some diseases the total ranking was the result of the scoring of very few experts.

The Mode function was originally chosen for compiling the scores attributed to each criterion in order to reflect the “majority opinion” i.e. what the majority thinks, and therefore reflecting the experts’ consensus. However, due to the limited number of experts involved at the regional level and the limited number of experts having scored some of the listed diseases, the compilation of scores with this function was providing aberrant and inconsistent results. It was thus replaced by the Median function that gives instead an “overall opinion”, i.e. it takes into account minorities’ opinion. With this data analysis approach, peer-pressure is thus less likely to bias the results.

Although the Pacific Islands region has a critical shortage of veterinarian and animal health workers ([Yarrow, 2008](#)), it was intentional to exclusively involve experts at the regional and national levels that are from and / or working in the Pacific Islands region. Within the group of regional experts only one was not originally from the PICTs but had been working for SPC for the last five years and two within the group of experts in Papua New Guinea are Australian but working on projects implemented in the targeted PICTs. In fact, experts involved in the four FABN countries occupied key positions in the different local counterpart agencies and advised decision-makers at a higher level with regard to the disease prevention and control programmes.

The methodology used followed the standards developed in other international studies but had been purposively kept as simple as possible in order to fit the local context and to achieve practicality. Considering the critical lack of up-to-date information (and in particular the lack of quantitative data) ([Brioudes et al., 2014](#)), and despite the methodology limitations described here above, expert opinion elicitation still appears to be the best tool for setting animal disease priorities within the Pacific Islands region.

### *5.1.2 The farmer’s interviews*

The lack of accurate data makes it difficult to quantify the extent of the livestock production in the region but some of the PICTs have the highest pig and chicken densities in the world. These densities reflect the importance of livestock cultivation in the Pacific region where pigs and poultry in particular play a major role in cultures and traditions of the Pacific communities ([Manueli, 2005; Secretariat of the Pacific Community, 2007a, b, 2009a](#)). Only pig and poultry farmers were targeted for the survey of animal disease perception at a community level. This was because these species were the most prevalent and economically important species within these communities and provided a better focused survey. No diseases specific to other species (such as cattle, sheep and goats for instance) were to be cited by the interviewed farmers. In hind site this made direct comparison with the regional

and national experts less reliable as they were not limited to pig and poultry diseases. However it could be argued that diseases that affect these species should have higher priority at a village level because of that importance in village economy and culture.

## 5.2 Emerging infectious disease threats versus endemic tropical diseases of the Pacific Islands region

The Pacific Islands region presents the unique status of being free of the most severe trans-boundary animal diseases such as highly pathogenic avian influenza (HPAI), foot and mouth disease (FMD) and rabies. In contrast these diseases are officially reported in South East Asia, a neighbouring region of the PICTs with, in particular, Papua New Guinea sharing a common land border with Indonesia. The results of this study reflect the concern for the potential of emergence of new infectious diseases within the Pacific Islands region with HPAI ranked second, FMD ranked fifth and rabies ranked ninth.

But the results also demonstrate the high importance of some tropical diseases that are endemic in the region such as leptospirosis, ranked as the top priority disease; brucellosis ranked third; tuberculosis ranked sixth and endoparasites and ectoparasites ranked respectively at eleventh and thirteenth place.

With this mix of exotic and endemic animal diseases among the top-twenty priority list, results show evidence of the complexity of discriminating between diseases. Decision-makers have to make this very sensitive choice. On the one hand there are chronic infectious diseases that are affecting their country and generally do not cause drastic or immediate losses but can heavily affect communities from an economic and social perspective. On the other hand, there are the emerging diseases that are not present in the country but if they were to be introduced, would most likely have a very high economic impact among livestock producers. And in the particular case of zoonosis like HPAI and rabies, the emergence of such diseases within the Pacific Islands region could also impact drastically on tourism which is a key economic sector for a number of PICTs.

The differences in disease ranking between the four FABN countries confirms that despite their similarity and their commonality of belonging to the Melanesian sub-region, they have different societies and different livestock production systems with different animal disease priorities. Our results allow a better focused sharing of resources and training at regional and in-country level.

Based on the results of the regional prioritization, leptospirosis is ranked first and is thus considered to be the most important disease within the Pacific Islands region. Many studies have demonstrated its endemicity among domestic animal populations of the PICTs ([Desvars et al., 2011](#); [Lupo, 2003](#); [Martin, 1999a, b, c](#); [Martin and Epstein, 1999](#); [Perolat and P.A., 1992](#); [Saville, 1994, 1996a, b, c, d, 1999](#); [Simms, 1997, 1998](#); [Thevenon et al., 1990](#)). Recent studies conducted in American Samoa have demonstrated the link between the number of piggeries near homes and human cases of leptospirosis ([Lau et al., 2012a](#); [Lau et al., 2012b](#)). However, an interesting point is that none of the pig farmers interviewed have mentioned this disease. Despite its endemicity within the PICTs, a majority of farmers may plausibly not know the name of that disease. But the fact that only one farmer in the survey cited one of the typical symptoms (i.e. stillbirth) of that disease tends to show that it might not be a production limiting disease for pig farmers. Recent studies on leptospirosis in the western Indian Ocean islands confirm the role of rats as the major reservoir host for the bacteria on all

islands, but asserts also that all mammals can be a source of contamination ([Desvars et al., 2013](#)). Leptospirosis was ranked 7<sup>th</sup> on the prioritization list of human infectious diseases of the Federated States of Micronesia ([Pavlin et al., 2010](#)). In light of the results presented in this study, further research on leptospirosis within the PICTs would be required in order to provide more up-to-date data on the level of infection among the domestic animal population. Such further research would enable assessment of its real impact on livestock production and thus its financial impact on farmers and local communities.

Not surprisingly, farmers didn't name any transboundary animal diseases when they were asked about the diseases representing the highest risk in their area. Instead, the majority identified some endemic tropical disease (parasites, flu/cold, coccidiosis and scabies). Parasites and flu are quite generic terms that could match with the top-prioritized ecto and endoparasites and HPAI from the regional priority setting. However, coccidiosis and mange are ranked in the middle-bottom part of the experts' regional priority list.

Therefore, results from this study show that farmers' perception varies from the expert opinion and that targeted surveillance programmes resulting from the rationalised veterinary public health approach may not match the expectation of the local communities.

### *5.3 Implication for the disease prevention and control programmes within the PICTs*

Most of the Pacific Islands are developing countries, with only limited resources allocated to their disease prevention and control programmes. Few active disease surveillance programmes are currently being conducted within these countries, such as tuberculosis and brucellosis testing in infected zones of Fiji ([Secretariat of the Pacific Community, 2013](#)). Therefore animal disease detection in these countries relies mostly on a passive surveillance system. Farmers and AHPWs (as an extension of private veterinarians in the PICTs) are defined by OIE as two of the main actors of the "key tripod" for effective surveillance ([OIE, 2013a](#)) and are thus at the front line in the field of disease detection. The results of the disease perception survey show that only four diseases out of the top-twenty list (i.e. brucellosis, tuberculosis, FMD, fowl pox and Newcastle Disease) are known by at least half of the interviewed AHPW. Furthermore, only FMD would be clinically recognised by a majority of interviewed AHPW (51%) if it was to emerge within the FABN countries. These results are coherent with the fact that a majority of AHPW do not actually have an animal health background and confirms the need for more capacity building in animal disease awareness with a particular focus on these prioritized top-twenty diseases.

Results obtained from this study reflect only the animal disease priorities at the time of the study. The disease priority setting is intended to be repeated as often as required; usually whenever there is a change in animal health status within the studied area.

The framework developed for this prioritization process could also benefit the remaining 18 PICTs, with further adjustments as required.

## **6 Conclusion**

Leptospirosis, HPAI and Brucellosis are the top three prioritized diseases of economic and human health significance for the Pacific Islands region. However, the same disease

scoring process conducted in four pilot countries of this region resulted in significantly different disease ranking lists. Therefore, these results show that a regional approach should take into account country specific needs.

Farmers did not name any emerging infectious diseases as priorities but identified instead endemic diseases (parasites, flu, coccidiosis and scabies) as the most important. This study therefore demonstrates that the consensus reached through expert opinion does not agree with the farmers' perspective. Therefore, better targeted surveillance programmes may result in more rational and transparent allocations of resources for enhancing food security but might not directly match the needs of the local communities.

Interviewed Animal Health and Production Workers were unfamiliar with most of the top-twenty prioritised diseases and a majority acknowledged that they would not be able to recognise clinical signs if outbreaks were to occur in their area. This highlights the need for further capacity building for improving the animal disease knowledge in this region.

## 7 Acknowledgements

This research work was conducted in partnership between the Animal Health and Production Team, Land and Resources Department of the Secretariat for the Pacific Community (SPC) and the School of Veterinary and Biomedical Sciences of James Cook University (JCU), Townsville, Queensland, Australia as part of the Food Animal Biosecurity Network. The project received funding support under the Public Sector Linkages Program, Department of Foreign Affairs and Trade of the Australian government.

We are most grateful to the regional and national experts and to the field animal health and production workers and the farmers who agreed to participate in this study.

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