

# **THE ANIMAL HEALTH STATUS OF TOKELAU**

by

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## **ABSTRACT**

A cross-sectional serological survey for diseases of pigs and poultry in Tokelau was conducted in 1998. This was the first investigation into the animal health status of the Tokelau islands. Clinical observations were also recorded, and some parasites identified. This document presents the findings of the survey.

Tokelau is free of the contagious livestock diseases of serious socio-economic or public health significance (OIE List A diseases). The pig population is also free of the viral diseases transmissible gastroenteritis and porcine reproductive and respiratory syndrome, and the serological findings suggest it is free of brucellosis and trichinosis. The prevalence of leptospirosis is very low.

Aujeszky's disease and porcine parvovirus are present on all three atolls at high prevalence.

Viral infections present in the free range poultry population include infectious bronchitis, infectious bursal disease, infectious laryngotracheitis and Marek's disease.

## **Résumé**

Une enquête sérologique transversale portant sur les maladies des porcs et des volailles a été réalisée à Tokelau en 1998. Il s'agissait de la première enquête sur la situation zoonositaire des îles de Tokelau. Des observations cliniques ont été enregistrées et certains parasites identifiés. Le présent document expose les résultats de cette enquête.

Tokelau est indemne des maladies contagieuses du bétail de grande importance sur le plan socio-économique ou de la santé publique (maladies de la liste A de l'OIE). Le cheptel porcin est également indemne des maladies virales suivantes : gastro-entérite transmissible et syndrome dysgénésique et respiratoire du porc, et les résultats sérologiques donnent à penser que le pays est également indemne de brucellose et de trichinose. La prévalence de la leptospirose est très faible.

La maladie d'Aujeszky et la parvovirose porcine sont présentes sur les trois atolls; leur prévalence est forte.

Au nombre des infections virales présentes chez les volailles figurent la bronchite infectieuse, bursite infectieuse, laryngotrachéite infectieuse et maladie de Marek.

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- WHO Arbovirus Reference and Research Laboratory, Queensland Health Scientific Services
- Koronivia Veterinary Pathology Laboratory, Ministry of Agriculture, Fisheries and Forests, Fiji

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**MAP**

## INTRODUCTION

This report presents the findings of a serological survey of livestock diseases in Tokelau. This survey was carried out in 1998, and was funded by the Veterinary Epidemiology project of the Secretariat of the Pacific Community (SPC). The survey was carried out by the SPC veterinary epidemiologist and staff of the Tokelau Department of Natural Resources and Environment. The objective of the survey was to demonstrate the presence or absence of selected livestock diseases of public health or economic importance. The results may be used as a basis for control programmes for livestock diseases, and also for public health initiatives. Where the absence of an infection is confirmed by the survey it is important that this be interpreted with the stated confidence limits.

## PREVIOUS RECORDS AND STUDIES

There are no records of previous investigations or diagnoses in Tokelau. Clinical observations, particularly of poultry deaths, were made in the 1990s, but there has been no formal investigation.

## LOCATION AND TOPOGRAPHY

Tokelau is a New Zealand protectorate, comprising 3 atolls and lying due north of Samoa. The atolls are:

- Fakaofu, located at 9°23' S, 171°15' W. Approximately 600 people live on two islets, Fale and Fenuafala
- Nukunonu, 38 nm WNW of Fakaofu, at 9°12' S, 171°51' W. Approximately 600 people live in a single village
- Atafu, 56 nm NW of Nukunonu at 8°33' S, 172°30' W. Approximately 600 people live in a single village.

All three atolls have numerous uninhabited islets around the reef, but all people and livestock live in the one location (2 in the case of Fakaofu).

Travel to and among the islands of Tokelau is by boat.

## AGRICULTURE AND LIVESTOCK

Agricultural production is for local consumption, and is typical of Pacific atolls. Pigs are the only domestic mammals except for a few cats, and together with free range village poultry make up the Tokelau livestock population. Populations of each species on each atoll were determined by a household survey in 1996:

	<b>Atafu</b>	<b>Fakaofu</b>	<b>Nukunonu</b>	<b>Total</b>
Pigs	558	824	594	1,976
Chickens	940	1,085	961	2,986

Of the pigs, about 55% are female and 45% male.

There are very few cats, and no dogs or herbivorous mammals.

Tokelau does not export any livestock products, but does occasionally import porcine

establish small poultry units using improved breeds, but the dependence on imported feed and unreliable transport has led to their demise.

Traditionally, both pigs and poultry have been free range, and poultry still are, although many owners provide roosting perches, and some provide shelter for their birds. In 1987 all pigs on Atafu were moved to a communal pig-raising area. This large pig pen is surrounded by a substantial wall, and is about 200 m x 100 m. Within the communal pig pen each household is responsible for penning its own pigs; most are confined, but some roam freely within the walls of the communal pen, which is well shaded, and is outside the village. Food and water are carried daily to their pigs by each owner. Pigs are generally fed on coconut and household scraps.

This Atafu pig management system was introduced to confine pigs, thereby keeping them away from gardens, and minimising the human health hazards associated with living in close proximity with pigs. It was perceived to be a success, and in 1996 a similar step was taken on Nukunonu: all pigs were confined in a communal pen outside the village.

On Fakaofu the pig population is split, with the human population, between the two islets of Fale and Fenuafala. Fale is small, and for many years pigs have been kept on the bare coral reef, exposed to the elements and kept separate from the village by a wall and fence. This pig accommodation comprises a substantial area that stays dry at high tide, and an area that is flushed by the tide. Pigs supplement their rations of coconut and household scraps with fish and shellfish. Fenuafala is a larger islet, and a walled pen has been built there on the Atafu model, but this is barely used. Most pigs are kept penned in the village, while some roam free.

## **SURVEY DESIGN**

### **Populations**

On each atoll, pigs and poultry intermingle extensively, and were considered for the survey to form single homogeneous populations. The exception to this is Fakaofu, where both pig and poultry populations are divided between Fale and Fenuafala. Exchange of pigs and chickens between atolls occurs, but not extensively; so each atoll was considered to have separate populations of livestock.

Each livestock population was assumed to be homogeneous with regard to disease exposure, so that a random sample of animals taken from the population would be representative of the population, and estimates of the prevalence of antibodies to different infectious agents in the population could be made from such a sample.

### **Sample sizes**

Each livestock population was to be tested for the presence of antibodies to a variety of infectious agents. If present, the likely prevalences of these agents in the population vary considerably, from perhaps <1% for trichinosis in pigs to >50% for classical swine fever. In addition the likely sensitivity and specificity of different serological tests vary from poor to very good. In order to determine sample size for either demonstration of disease freedom or estimation of prevalence of exposure to disease, the critical information needed is:

- Population size



- Likely prevalence<sup>1</sup>
- Acceptable error levels in the estimation
- Test sensitivity<sup>2</sup>
- Test specificity<sup>3</sup>

Apart from the acceptable error levels, all of the above vary from one infection to another for all populations. We aimed to collect serum from 30 animals in each population (15 each for the two Fakaofu populations), to test them all for each infection, and then interpret the results appropriately for each infection, depending on the values for each of the variables listed above. The figure of 30 was chosen because this allows demonstration of freedom from exposure to disease with 95% confidence, given a likely prevalence if present of

- 30% for a test with reasonable sensitivity and specificity, or
- 20% for a test with excellent sensitivity and specificity.

Actual numbers of animals sampled are shown in Table 1.

**Table 1. Livestock populations and sample numbers for a serological survey in Tokelau, 1998**

Atoll	Island	Species	Population	Blood samples	
				Planned	Taken
Atafu		Pig	558	30	30
		Poultry	940	30	30
Fakaofu	Fale	Pig	412	15	15
		Poultry	543	15	15
	Fenuafala	Pig	412	15	15
		Poultry	542	15	15
	Kalevalio*	Poultry	2	0	1
Nukunonu		Pig	594	30	27
		Poultry	961	30	30

\* cemetery islet

The figures quoted above and the procedures used to interpret laboratory results assume random sampling from the population. Truly random sampling was not achieved in this survey, but populations were sampled to give geographic representation. Only adult pigs and chickens were sampled, so as to increase the probability of finding antibodies (adults have been around longer to be exposed to infections).

Within communal pens on Nukunonu and Atafu, individual household pens were selected from all parts of the communal pen, one pig was sampled from each selected household pen, and some of those roaming freely within the outer wall were included. On Fakaofu, Fale pigs (on the reef) were caught based on convenience, and for Fenuafala pigs one was sampled per household.

<sup>1</sup> The proportion of animals infected (prevalence of infection), or with antibodies to the infectious agent (antibody prevalence)

<sup>2</sup> The proportion of those animals that have been infected with the disease agent that give positive results with the test

<sup>3</sup> The proportion of those animals that have not been infected with the disease agent that give negative results with the test

Poultry were sampled based on convenience: on each island we caught one or two birds per household at night, then the following morning the numbers were made up in areas not visited at night by catching birds with a net – again, one or two per household. For each village, the birds and pigs sampled gave good geographic representation of the village populations.

Within each poultry and pig population considered we attempted to sample a representative selection of animals, although this was not done randomly. In presenting the results, confidence and prevalence estimates are given that assume random sampling, although this is not strictly valid.

### **Selection of diseases**

Infections for serological testing were selected based on potential public health risk, potential economic importance and regional epidemiological significance.

Classical swine fever has occurred twice in Pacific Island countries and territories (PICTs) this century, but otherwise there have been no outbreaks or observations of OIE list A diseases in any of the 22 PICTs, including Tokelau. No vesicular disease has been seen in pigs in Tokelau, and these infections were not included in serological testing. Classical swine fever was included, and for the poultry the two list A diseases were included: Newcastle disease and avian influenza.

Serological testing for the mycoplasmas and salmonellas of poultry has poor specificity when preserved (frozen) serum is used; we therefore did not include these infections in the serological survey.

### **Blood samples**

Blood was collected from pigs using evacuated 9 ml tubes. Poultry were bled using 3 ml syringes and 23 g needles, and the blood was immediately transferred to a 5 ml evacuated tube. After standing at ambient temperature for a few hours, serum was separated using disposable pipettes. We attempted to keep the serum frozen thereafter, but the power supply only operates intermittently in Tokelau, and freezers on board the two transport ships did not operate effectively. Consequently it was 4 – 18 days after samples were taken before they were consistently frozen. This treatment of the serum resulted in bacterial growth in many of them.

Blood samples were then taken to Suva, Fiji for distribution to laboratories. The laboratories and tests used for the serum samples are given in Appendix B.

### **Analysis of results**

Confidence levels for assertions of freedom from disease were arrived at using *FreeCalc*<sup>4</sup>.

Where prevalences in different populations are compared in the text, they are stated to be different when found to be so with a probability of 95% using the *chi-square* test. If they are stated not to be different, this means the probability of them being significantly different was less than 95%, again using the *chi-square* test.

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## RESULTS AND DISCUSSION

### Pigs

#### *Parasites*

- *Ascaris suum* is seen frequently in Tokelau, often as aberrant worms in the liver.
- *Globocephalus* sp., a fairly common hookworm of pigs, was identified following its collection at slaughter from a 9-month-old pig. The animal had a burden of about 100 worms.
- *Metastrongylus* sp. was collected from the same pig, and subsequently identified.
- Ectoparasites did not appear to be as prevalent as elsewhere in the Pacific, except perhaps on Atafu, where mange is fairly widespread.

#### *Vesicular diseases (foot and mouth disease; swine vesicular disease; vesicular stomatitis)*

No vesicular diseases have been observed in Tokelau, and they are not present in surrounding countries. Tokelau only imports animals and animal products from neighbouring countries free of vesicular diseases. No serology for these viruses was done in this survey. Tokelau is almost certainly free of vesicular diseases.

#### *Serology*

A summary of serological results is presented in Appendix C; results for individual diseases are given below.

#### *Classical swine fever*

(ELISA at CAHL)

No antibodies were found in any of the samples tested. This is a highly infectious disease, and if present one would expect antibody titres in a high proportion of adult pigs (note the very high antibody prevalences for AD and porcine parvovirus in Table 1). We can be almost 100% confident that antibodies to CSF are not present at a prevalence of 50% in any of the pig populations of Tokelau, and 95% confident that they are not present in 5% of Atafu or Nukunonu pigs, or 15% of pigs on either of the Fakaofu islets. This amounts to virtual certainty that CSF is not present in Tokelau.

#### *Transmissible gastroenteritis*

(ELISA at CAHL)

This is another highly contagious viral infection that would be present in a high proportion of pigs in each population if it were present. Pig owners encounter problems with diarrhoea and death in young pigs, and TGE would be one possible cause, but our failure to detect any antibodies gives great confidence that the infection is not present in Tokelau.

#### *Porcine reproductive and respiratory syndrome*

(ELISA at CAHL)

All sera gave negative results, and as with TGE and CSF, we can be confident that this infection is not present in Tokelau.

#### *Brucella*

(RBPT at FVPL)

All sera gave negative results. The RBPT using *Brucella abortus* antigen also reacts with *Brucella suis* antibodies in pigs, with a sensitivity of 79% and a specificity of 98% (Rogers *et al.*, 1989). All results were negative for Tokelau pigs, and as a result we can be 95% confident that brucellosis is not present with a prevalence of 10% on any of the islands, but our confidence of detecting a lower prevalence with these sample numbers is not great. These results provide good evidence that Tokelau pigs are free of brucellosis, but to be certain we would need to test many more animals on each island repeatedly.

*Aujeszky's disease / pseudorabies*

(ELISA at CAHL)

Population	No. of samples		Apparent Prevalence %
	Tested	Positive	
Atafu	31	27	87
Fakaofu	30	30	100
Fale	15	15	100
Fenuafala	15	15	100
Nukunonu	27	19	70
Tokelau, all pigs	88	76	86

This viral infection is clearly present on all 3 atolls. The differences in prevalences among the atolls are not significant. Most if not all pigs are infected with this virus during their lives, and the end result will be illness and deaths in young pigs, with adult pigs affected less frequently. Mortality could be reduced by regular use of vaccine, but this would not eliminate the infection.

*Trichinosis*

(ELISA at CAHL)

We did not find antibody to TS in any of the pigs tested, and this confirms that the infection is not present at high prevalence. However, TS can affect a very low proportion of pig populations (<1%), and we did not test enough pigs to be sure that none are infected. Low prevalences of seropositive pigs have been found in other countries in the region.

*Porcine parvovirus*

(ELISA at CAHL)

Population	No. of samples		Apparent Prevalence %
	Tested	Positive	
Atafu	31	31	100
Fakaofu	30	29	97
Fale	15	15	100
Fenuafala	15	14	93
Nukunonu	27	26	96
Tokelau, all pigs	88	86	98

This infection is present throughout the world, including the Pacific. It causes primarily reproductive failure, and is to be found on all three atolls. Interestingly the ELISA test results were mainly *weak positives* on Atafu (30/31), while both Nukunonu and Fakaofu pigs gave stronger *positive* reactions to the ELISA (25/27 and

## *Leptospirosis*

(MAT at QHL)

Tokelau pigs are remarkably free of leptospirosis. Eighty-eight serum samples were tested against 21 leptospiral serovars, and only 3 positive titres were obtained: 2 against *cynopteri* (1:50 and 1:100; both on Atafu) and one against *zanoni* (1:50; Fenuafala, Fakaofu). The serovars tested, their serogroups and a summary of the results are presented in Table 2. The absence of leptospiral titres in samples from Nukunonu, while 1 was found on Fakaofu and 2 on Atafu, does not mean that there is no leptospirosis on Nukunonu while there is on the other atolls – clearly the prevalence is low on all 3 atolls, and we did not sample enough pigs to give reliable estimates of such low or zero prevalences.

Low leptospiral MAT titres (50 or less) may be associated with cross reactions (with another serovar), poor serum quality, natural agglutinins which are not induced by leptospiral infections, as well as early serological response, declining titre or vaccination (not applicable in Tokelau).

**Table 2. Leptospiral serovars used in the microscopic agglutination test, and the number of positive reactions: 81 pigs from Tokelau, 1998**

Serogroup	Serovar	No. of positive titres
Australis	<i>australis</i>	0
Autumnalis	<i>bulgarica</i>	0
Ballum	<i>ballum</i>	0
Bataviae	<i>bataviae</i>	0
Canicola	<i>canicola</i>	0
Celledoni	<i>celledoni</i>	0
Cynopteri	<i>cynopteri</i>	2
Djasiman	<i>djasiman</i>	0
Grippotyphosa	<i>grippotyphosa</i>	0
Hebdomadis	<i>kremastos</i>	0
	<i>szwajizak</i>	0
Icterohaemorrhagiae	<i>copenhageni</i>	0
Javanica	<i>javanica</i>	0
Panama	<i>panama</i>	0
Pomona	<i>pomona</i>	0
Pyrogenes	<i>robinsoni</i>	0
	<i>zanoni</i>	1
Sejroe	<i>hardjo</i>	0
	<i>medanensis</i>	0
Shermani	<i>shermani</i>	0
Tarassovi	<i>tarassovi</i>	0

## *Other diseases*

Diseases of pigs not listed here have not been recorded or tested for in Tokelau.

## **Poultry**

### *Parasites*

Ectoparasites have been observed but not identified.

The only nematodes found during careful *post mortem* examination of 3 hens on Atafu were *Oxyuris* sp. from the conjunctival sac.

### *Serology*

Ninety-one sera were collected and tested for antibodies to ND, AI, IB, IBD, ILT, AE and MD, with results as shown below and summarised in Appendix C.

### *Newcastle disease*

(HI at CAHL)

All samples were negative. The HI test for antibodies to ND is highly specific (close to 100%) but not very sensitive (79% (Miers, Bankowski & Zee, 1983)). If this highly contagious infection were present, the prevalence of antibodies would be high (at least 25%). Despite the poor sensitivity of the test, the absence of antibodies allows us to be 99.9% confident that the virus is not present on Nukunonu or Atafu, and 96% confident that it is not present on either of the Fakaofu islands. There are lentogenic strains of the virus present in some PICTs, but Tokelau appears to be free of all strains of the virus. The poultry are therefore 100% susceptible to ND, and a velogenic strain could wipe out the poultry population if introduced.

### *Avian influenza*

(AGID at CAHL)

All samples tested negative. As for Newcastle disease, Tokelau is almost certainly free of this virus, and a virulent strain could wipe out the poultry population if introduced.

### *Infectious bronchitis*

(ELISA at CAHL)

<b>Population</b>	<b>No. of samples</b>		<b>Apparent Prevalence %</b>
	<b>Tested</b>	<b>Positive</b>	
Atafu	29	29	100
Fakaofu*	31	31	100
Fale	15	15	100
Fenuafala	15	15	100
Nukunonu	30	30	100
Tokelau, all chickens	90	90	100

\* includes one bird from Kalevalio

All birds tested on all three atolls had antibodies to IB, which is therefore well established and ubiquitous in Tokelau.

*Infectious bursal disease (Gumboro disease)*

(ELISA at CAHL)

<b>Population</b>	<b>No. of samples</b>		<b>Apparent Prevalence %</b>
	<b>Tested</b>	<b>Positive</b>	
Atafu	29	17	59
Fakaofu*	31	24	77
Fale	15	11	73
Fenuafala	15	12	80
Nukunonu	30	24	80
Tokelau, all chickens	90	65	72

\* includes one bird from Kalevalio

All populations examined showed high antibody prevalences. This virus is clearly well established in Tokelau. The apparent differences in prevalence among the three atolls are not significant. We were not able to distinguish between strains serologically, so the virulence of the strain(s) present in Tokelau is unknown.

*Infectious laryngotracheitis*

(ELISA at CAHL)

<b>Population</b>	<b>No. of samples</b>		<b>Apparent Prevalence %</b>
	<b>Tested</b>	<b>Positive</b>	
Atafu	29	26	90
Fakaofu*	31	28	90
Fale	15	13	87
Fenuafala	15	14	93
Nukunonu	30	29	97
Tokelau, all chickens	90	83	92

\* includes one bird from Kalevalio

Antibodies were found in 90% of birds consistently, across all islands. The disease is endemic in Tokelau.

*Avian encephalomyelitis*

(AGID at CAHL)

<b>Population</b>	<b>No. of samples</b>		<b>Apparent Prevalence %</b>
	<b>Tested</b>	<b>Positive</b>	
Atafu	30	2	7
Fakaofu*	31	0	0
Fale	15	0	0
Fenuafala	15	0	0
Nukunonu	30	0	0
Tokelau, all chickens	91	2	2

\* includes one bird from Kalevalio

No antibodies were found on Nukunonu or Fakaofu, and only 2 birds gave positive test results on Atafu. Unfortunately the sensitivity and specificity of the laboratory test are unknown, so it is not possible to conclude that the disease is absent or present in Tokelau, or on any of the islands. The two birds giving positive reactions to the AGID come from neighbouring households; one male and one female.

*Marek's disease*

(AGID at CAHL)

<b>Population</b>	<b>No. of samples</b>		<b>Apparent Prevalence %</b>
	<b>Tested</b>	<b>Positive</b>	
Atafu	29	1	3
Fakaofu*	30	1	3
Fale	15	0	0
Fenuafala	14	1	7
Nukunonu	30	8	27
Tokelau, all chickens	89	10	11

\* includes one bird from Kalevalio

The AGID is specific but not very sensitive, so it probably underestimates the true number of infected birds, and positive results are probably genuine. The infection is clearly present on Nukunonu (observed prevalence 26.7%) and probably present on the other atolls, on each of which only one bird reacted to the test. This viral infection is present throughout the Pacific.

*Other diseases*

Diseases of poultry not listed here have not been recorded or tested for in Tokelau.

**Japanese encephalitis**

The pig sera were tested for antibodies to the human viral infection Japanese B encephalitis. They all gave negative results to the HI test, and in the absence of clinical disease we can be confident that there is no JE virus in Tokelau. The mosquito-transmitted virus is present in SE Asia, but has not spread far into the Pacific.



## **CONCLUSIONS**

Tokelau appears to be free of OIE list A diseases of both pigs and poultry.

### **Pig diseases**

Aujeszky's disease virus is present throughout the islands, and affects all pigs. This is likely to be a significant factor in the high mortality rates experienced in piglets in Tokelau.

Tokelau has no transmissible gastroenteritis or porcine reproductive and respiratory syndrome, but parvovirus is endemic, and probably causing reproductive losses.

There is no evidence that *Brucella suis* or *Trichinella spiralis* is present, but it is possible that one or both of these infections is present at low prevalence on one or more islands. The prevalence of leptospirosis in Tokelau is very low.

### **Poultry diseases**

Infectious bronchitis, infectious bursal disease, infectious laryngotracheitis and Marek's disease are all present on all atolls. Avian encephalomyelitis is possibly present, at least on Atafu.

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## APPENDIX A: ABBREVIATIONS AND ACRONYMS

### Laboratories

CAHL	Central Animal Health Laboratory MAF Quality Management Ward Street Upper Hutt New Zealand
FVPL	Koronivia Veterinary Pathology Laboratory Ministry of Agriculture, Fisheries and Forests P.O. Box 77 Nausori Fiji
QHA	WHO Arbovirus Reference and Research Laboratory Queensland Health Scientific Services 39 Kessels Road Coopers Plains Queensland 4108 Australia
QHL	WHO/FAO Collaborating Centre For Reference And Research On Leptospirosis Centre For Public Health Sciences 39 Kessels Road Coopers Plains Queensland 4108 Australia

### General

OIE	Office International des Epizooties
SPC	Secretariat of the Pacific Community
PICT	Pacific Island Countries and Territories

## Laboratory tests

AGID	Agar Gel ImmunoDiffusion
ELISA	Enzyme-Linked Immunosorbent Assay
HI	Haemagglutination Inhibition
MAT	Microscopic Agglutination Test
RBPT	Rose Bengal Plate Test

## Diseases

AD	Aujeszky's disease
AE	Avian encephalomyelitis
AI	Avian influenza
Brucella	Brucellosis
CSF	Classical swine fever / hog cholera
FMD	Foot and mouth disease
IB	Infectious bronchitis
IBD	Infectious bursal disease
IBR	Infectious bovine rhinotracheitis
ILT	Infectious laryngotracheitis
Lepto	Leptospirosis
MD	Marek's disease
ND	Newcastle disease
PRRS	Porcine reproductive and respiratory syndrome
SVD	Swine vesicular disease
TB	Tuberculosis
TGE	Transmissible gastroenteritis
TS	Trichinosis

**APPENDIX B: DISEASES, LABORATORIES AND TESTS**

<b>Species</b>	<b>Laboratory*</b>	<b>Infectious agent*</b>	<b>Serological test*</b>
Pig	CAHL	TGE	ELISA
		PRRS	ELISA
		Classical swine fever	ELISA
	FVPL QHL QHA	Aujeszky's disease	ELISA
		<i>Trichinella spiralis</i>	ELISA
		<i>Brucella</i>	RBPT
Chicken	CAHL	<i>Leptospira</i> serovars	MAT
		Japanese encephalitis	HAI
		Infectious bronchitis	ELISA
		Infectious bursal disease	ELISA
		Infectious laryngotracheitis	ELISA
		Newcastle disease	HI
		Avian influenza	AGID
Marek's disease	AGID		
Avian encephalomyelitis	AGID		

\* For explanation of abbreviations and acronyms, see Appendix A

## APPENDIX C: RESULTS OF SEROLOGICAL TESTING

### Pigs

Numbers of sera tested and numbers giving positive results in tests for antibodies to 7 infections in p

Population	Transmissible gastroenteritis		Porcine repro. & resp. syndrome		Aujeszky's disease		Classical swine fever		<i>Trichinella spiralis</i>	
	Positive	Total	Positive	Total	Positive	Total	Positive	Total	Positive	Total
Tokelau, all pigs	0	88	0	88	76	88	0	88	0	8
Atafu	0	31	0	31	27	31	0	31	0	3
Fakaofu	0	30	0	30	30	30	0	30	0	3
Fale	0	15	0	15	15	15	0	15	0	1
Fenuafala	0	15	0	15	15	15	0	15	0	1
Nukunonu	0	27	0	27	19	27	0	27	0	2

## Poultry

Numbers of sera tested and numbers giving positive results in tests for antibodies to 7 infections in c

Population	Newcastle disease		Avian influenza		Infectious bronchitis		Infectious bursal disease		Infectious laryngotracheiti	
	Positive	Total	Positive	Total	Positive	Total	Positive	Total	Positive	Total
Tokelau	0	91	0	91	90	90	65	90	83	90
Atafu	0	30	0	30	29	29	17	29	26	29
Fakaofu – all	0	31	0	31	31	31	24	31	28	31
Fale	0	15	0	15	15	15	11	15	13	15
Fenuafala	0	15	0	15	15	15	12	15	14	15
Nukunonu	0	30	0	30	30	30	24	30	29	30