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Final report

Small research and development activity

SRA	**Assessment of zoonotic diseases in Indonesia**
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Contents

1 Acknowledgments

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2 Acronyms

AAHL	Australian Animal Health Laboratory
AARHD	Agency for Agricultural Human Resources and Development
AARD	Agency for Agricultural Research and Development
AGAH	Animal Health Service (FAO)
AI	Avian Influenza
AHP	Animal Health Post Pos *Kesehatan Hewan, poskeswan*
AusAID	Australian Agency for International Development
Balitvet	Research Institute for Animal Diseases
BIPP	Agricultural Extension Information Center (*Balai Informasi Penyuluh Pertanian; BIPP*)
CIDA	Canadian International Development Agency
CIVAS	Centre for Indonesian Veterinary Analytical Studies
CMU	Central Management Unit
CRIAS	Central Research Institute for Animal Sciences
DAH	Directorate of Animal Health
Deptan	Departemen Pertanian (Ministry of Agriculture)
DGLS	Directorate-General of Livestock Services
DIC	Disease Investigation Centre
Dinas Keswan	Government Animal Health Service
District	*Kabupaten*
ECTAD	Emergency Control Centre for Transboundary Animal Diseases
EMPRESS	Emergency Prevention System for Animal TADs (FAO)
FAO	Food and Agriculture Organization of the United Nations
FAO/RAP	FAO Regional Asia Pacific office
FAOR	FAO Regional Office
Government Livestock Services	*Dinas Peternakan*
GPS	Global Positioning System
GTZ	German Agency for Technical Cooperation
HPAI	Highly Pathogenic Avian Influenza
IPB	Institut Pertanian Bogor
JICA	Japan International Cooperation Agency
JTF	Japan Trust Fund
Komnas FBPI	National Steering Committee for the Control of Avian Influenza
LDCC	Local Disease Control Centre
M&E	Monitoring and Evaluation
MoA	Ministry of Agriculture
MoH	Ministry of Health
NAQS	National Animal Quarantine Service
NCAED	National Center for Agricultural Extension Development
NCEPH	National Centre for Epidemiology and Population Health
NGO	Non-governmental organization
NIHRD	National Institute for Health Research and Development
NSP	National Strategic Plan
OFFLU	FAO/OIE Network of Expertise on Avian Influenza
OIE	World Organization for Animal Health
PCR	Polymerase Chain Reaction
PDS	Participatory Disease Surveillance

PDR	Participatory Disease Response
Provincial Livestock Services	*Dinas Peternakan Propinsi*
PUSVETMA	Pusat Veterinaria Farma (Veterinary Biological Center)
R&D	Research and Development
RIVS	Regional Institute for Veterinary Science (Balitvet)
RMU	Regional Management Unit
TAD	Transboundary Animal Disease
TCEO	Emergency Operation Centre (FAO)
UGM	University of Gadjamada (Yogyakarta)
UNAIR	University of Airlangga (Surabaya)
UNICEF	United Nations International Children's Emergency Fund
UNUD	University of Udayana (Bali)
UNSYIAH	University of Syiah Kuala (Banda Aceh)
USAID	United States Agency for International Development
Veterinary Practitioner	*Doktor Hewan*
WHO	World Health Organization

3 Executive summary

This project was a small scoping project aimed at collecting data and information on zoonotic diseases in Indonesia with a focus on diseases that have measurable impact on livestock production and human health. The results of this project were intended to inform prioritisation and design of future efforts to assist Indonesia in control and prevention of zoonotic diseases.

Limited data were available for analysis to aid in identifying priorities and constraints and effort was also directed towards accessing expert opinion and discussion on issues wherever possible.

The highest priority diseases identified through the impact assessments described in this report were Brucellosis and Cysticercosis, followed by Toxoplasmosis and Avian Influenza and lastly Anthrax and Rabies. Specific issues amenable to research have been identified for each of these diseases with a recognition that projects are best developed in a consultative process involving relevant stakeholders (local and national, animal and public health). Many of the disease-specific projects involve recurring themes particularly in areas such as disease surveillance, effective control programs including adaptive research to understand factors driving reporting and compliance with control recommendations, and training of animal health staff at different levels in principles of epidemiology and surveillance.

There is also an opportunity to design projects to deliver outcomes against multiple goals for example determine the space-time distribution of taeniasis/cysticercosis in animals and people, identify risk factors, train field staff in principles of surveillance, perform adaptive research on factors influencing understanding of disease and effective control, develop linkages between animal and human health staff, and develop policy and legislative support for effective disease control.

There is considerable potential to leverage additional value from investment in disease-specific research and capacity development by incorporating disease-specific projects under a broader framework. Some of the benefits are associated with delivery of multiple outputs as described above. There may also be efficiency gains in some areas by developing research or training programs that can be applied in multiple locations, adapted to different diseases and delivered to more people at a time. This in turn provides indirect benefits in areas such as development of communication networks and cross-sector linkages between animal and human health personnel or between different segments of animal health.

Involvement of representatives from international agencies (WHO, FAO, AusAid and others) in discussions with senior representatives from Indonesian Ministries (MoA, MoH) offers the potential to harmonise and integrate activities. A strategic planning meeting of these major stakeholders would provide an avenue for reviewing existing activities as well as selecting a small number of priority projects, identifying potential funding sources and then developing project proposals for implementation. Successful completion of 1 or 2 projects that involve cross-sectoral collaboration, training and capacity enhancement and that address identified priority disease issues, will create momentum for further success. There are varying levels of integration and coordination that may be implemented ranging from involvement of relevant stakeholders in project planning to ensure that selected projects deliver benefits across a range of objectives, to the development of a national framework with in-country staff appointments to assist in coordination and a more structured approach to integration of project planning across different sectors (local to national, animal and human health, field training and certificate or degree training).

3.1 Indonesian translation of Executive Summary

Ringkasan

Proyek ini merupakan suatu kegiatan awal berskala kecil yang bertujuan untuk mengumpulkan data dan informasi mengenai penyakit-penyakit pada manusia yang disebabkan oleh hewan di Indonesia, dengan menitikberatkan pada penyakit-penyakit yang berdampak, baik dalam bidang produksi ternak maupun kesehatan manusia. Hasil dari kegiatan ini dimaksudkan untuk memberikan gambaran dalam rangka penyusunan prioritas dan rancangan kegiatan-kegiatan untuk membantu Indonesia dalam mencegah dan menangani penyakit-penyakit zoonosis tsb.

Data yang terbatas dapat dipergunakan untuk menganalisa guna membantu mengidentifikasi prioritas dan kendala-kendala yang ada. Sejauh memungkinkan, berbagai usaha akan diselaraskan dengan menampung pendapat para ahli serta melalui kegiatan diskusi.

Penyakit-penyakit dengan prioritas tertinggi yang berhasil diidentifikasi melalui kegiatan analisa dampak adalah Brucellosis dan Cysticercosis, diikuti oleh Toxoplasmosis dan Avian Influenza serta yang terakhir adalah Anthrax dan Rabies. Masalah-masalah tertentu yang dapat dikembangkan untuk diteliti sudah diidentifikasi untuk masing-masing penyakit dengan suatu pemahaman bahwa kegiatan ini akan dikembangkan melalui serangkaian proses konsultasi yang melibatkan pihak-pihak terkait (pada tingkat lokal dan nasional, baik dalam bidang kesehatan hewan maupun masyarakat). Banyak diantara proyek-proyek tentang penyakit akan mengacu pada tema yang berulang misalnya surveillance penyakit, program penanganan yang efektif termasuk riset adaptif untuk mengetahui faktor-faktor pendukung kelayakan sistem dan prosedur pelaporan beserta saran-saran penanganannya, dan pelatihan staf kesehatan hewan pada tingkat yang berbeda-beda berpatokan pada prinsip-prinsip epidemiologi dan surveillance.

Terdapat pula peluang untuk merancang proyek-proyek yang dapat memberikan hasil yang berbeda-beda, misalnya, menentukan batasan waktu atas penyebaran taeniasis/cysticersosis pada hewan dan manusia, mengidentifikasi faktor resiko, melatih tenaga-tenaga lapangan sesuai dengan prinsip-prinsip surveilanse, serta melaksanakan penelitian adaptif atas faktor-faktor yang berpengaruh pada pemahaman tentang penyakit dan pengendaliannya secara efektif, mengembangkan relasi di antara staf kesehatan hewan dan kesehatan manusia, dan mengembangkan kebijakan dan peraturan yang mendukung terlaksananya pengawasan penyakit secara efektif.

Terdapat potensi yang cukup besar yang berpengaruh pada nilai tambah atas investasi riset-riset khusus penyakit serta kemampuan pengembangannya dengan cara menggabungkan proyek-proyek penyakit dibawah satu kerangka yang lebih luas. Beberapa manfaat adanya penggabungan atas beragam hasil yang berbeda telah diterangkan sebelumnya pada bagian di atas. Terdapat pula kemungkinan efisiensi dalam beberapa hal melalui pengembangan penelitian atau pelatihan yang dapat dilakukan di berbagai lokasi, diadaptasikan pada penyakit-penyakit yang berbeda serta disampaikan kepada lebih banyak orang sekaligus. Pada akhirnya, hal tersebut akan memberikan keuntungan secara tidak langsung dalam hal pengembangan komunikasi jaringan kerja serta hubungan antar instansi diantara personil pada penyakit hewan dan penyakit manusia atau di antara bagian-bagian penyakit hewan yang berlainan.
Keterlibatan pihak-pihak dari organisasi internasional (WHO, FAO, AusAid dan lain-lain) dalam diskusi dengan wakil-wakil senior Departemen terkait di Indonesia (Departemen Pertanian, Departemen Kesehatan) akan berpotensi meningkatkan harmonisasi serta membentuk kegiatan-kegiatan yang terintegrasi. Suatu rencana pertemuan strategis dari pihak-pihak utama tersebut akan memberikan jalan untuk melihat kembali kegiatan-kegiatan yang ada seperti halnya menyeleksi sejumlah kecil prioritas proyek,

mengidentifikasi potensi sumber pendanaannya, dan kemudian mengembangkan usulan kegiatan untuk pelaksanaannya. Berhasilnya pelaksanaan 1-2 proyek yang melibatkan berbagai macam instansi, pelatihan dan penguatan kapasitas serta sejalan dengan masalah-masalah penyakit yang diidentifikasi akan menciptakan momentum untuk keberhasilan yang lebih luas.

Terdapat berbagai macam tingkatan integrasi dan koordinasi yang mungkin diterapkan, mulai dari keterlibatan para pemangku kepentingan dalam perencanaan proyek untuk memastikan bahwa proyek-proyek yang dipilih dalam memberikan manfaat-manfaat bagi perkembangan suatu kerangka nasional sampai dengan penunjukan staf-staf lokal yang membantu dalam hal koordinasi dan pendekatan yang terarah bagi terintegrasinya perencanaan proyek di seluruh sector-sektor yang berbeda (tingkat lokal sampai nasional, kesehatan hewan dan manusia, pelatihan lapangan dan beasiswa).

4 Introduction

A zoonosis is any disease or infection that is naturally transmissible from vertebrate animals to humans. Zoonoses may be caused by bacterial, viral, or parasitic agents. Zoonoses include diseases that have been well described over many years (rabies, anthrax) and new or emerging diseases that have appeared within the past one to two decades. Zoonoses affect millions of people every year either by preventing efficient production of food of animal origin, interrupting trade in animals or animal products or by directly affecting human health. In addition, some zoonotic diseases represent important threats to Australia.

An independent review of the Australian Centre for International Agricultural Research (ACIAR) Animal Health Program was undertaken in 2006. This review recommends some significant changes in direction from a predominantly production focus to a broader focus on adaptive research and institutional strengthening and support. ACIAR has highlighted 4 particular themes within focus countries, one of which is 'zoonotic and newly emerging diseases'. There was also recognition that 'the social, policy and regulatory environment are constraints in some countries, as demonstrated recently with avian influenza.'
This study was undertaken to identify the important constraints in managing these diseases, and to include consideration of social, policy and regulatory environments as well as technical constraints. This meant broadening the scope of the report beyond consideration of technical research requirements for particular diseases to include the enabling environment and the need to ensure activities are appropriate to the institutional and social environments within which they will operate.

Limited data were available for analysis to aid in identifying priorities and constraints and effort was also directed towards accessing expert opinion and discussion on issues wherever possible. These insights were valuable in understanding the impacts of various diseases, the broader ecological context (including social, political, cultural, economic and environmental issues) and in identifying opportunities and needs for future research and capacity building.

5 Research objectives

Zoonotic diseases are known to occur in Indonesia and this report represents an attempt to provide information on the following specific areas:

1. Identify what zoonotic diseases are present in Indonesia, their geographic distribution within the country and assess the quality of the information on which these judgments are made.
2. Estimate the relative importance of these diseases based on prevalence / incidence data available for animals and humans, the degree of trade disruption (mostly domestically but if relevant, internationally), economic impact and degree of threat to Australia. Additional impact measures may be used for assessing human health impacts of zoonotic diseases.
3. Identify knowledge gaps and opportunities for research to address these gaps for the most important of the diseases identified including consideration of the timeframe and impacts of research on measurable outcomes related to animal and human health effects of the diseases.
4. Brief assessment of institutional capacity to conduct research and identification of policy or regulatory constraints for effective management of the disease.

Avian Influenza (AI) is included, however; it is recognised that many resources are already being directed towards capacity building and assisting in responding to this disease. The Komnas FBPI is a national coordinating body that is assisting the Indonesian response to avian influenza including strategic input into prioritisation of research and other activities. This paper has not attempted to investigate in detail the issues and needs for avian influenza and has relied on information from FAO/WHO and government agencies in order to present a valid summary on the current status for avian influenza in Indonesia.

6 Identification of zoonotic diseases

An initial list of candidate diseases was compiled through a combination of literature review, web searching and through contacts with a variety of individuals who have been involved in animal health activities in Indonesia over a number of years. The criteria for inclusion of diseases in this initial listing included:

- zoonotic disease
- measurable impact on both livestock and humans
- either evidence or suspicion that the disease was present in Indonesia

This list was then modified in discussion with individuals within Indonesia during the information collection phase of this project.

Table 1: Priority classification of zoonotic diseases in Indonesia

Category	Disease
High priority	Avian influenza
	Taeniasis/Cysticercosis
	Brucellosis
	Toxoplasmosis
	Anthrax
Medium priority	Rabies
	Bovine tuberculosis
	Echinococcus
	Leptospirosis
Low priority	Trichinellosis
	Japanese encephalitis
	Salmonellosis
	Scabies

6.1 Disease Data: sources and quality

Data relating to prevalence and distribution of zoonotic diseases within animal populations in Indonesia were obtained from peer-reviewed, scientific papers, Ministry of Agriculture reports of counts of priority animal diseases, diagnostic test results from Disease Investigation Centres (DICs), and discussions with individuals interviewed during the course of an in-country visit by project team members.

6.1.1 Ministry of Agriculture reports

There are 12 priority animal diseases included in centralised reporting at the Ministry level in Jakarta. These include:

- Avian Influenza: added to the list in 2005 and not included prior to this. No data were included on AI in the reports provided.
- Anthrax
- Brucellosis
- Rabies
- Salmonella
- Bovine Viral Diarrhoea (BVD)
- Hog Cholera (also known as Classical Swine Fever)
- Infectious Bursal Disease (IBD)
- Infectious Bovine Rhinotracheitis (IBR)
- Jembrana Disease (JA)
- Newcastle Disease (ND)
- Septicaemia Epizooticae (SE)

Table 2: Counts of animal disease cases from Ministry of Agriculture records for four diseases. Data aggregated from 2000, 2001, 2002, 2003 and 2005.

Region	**Province**	**HPAI**	**Anthrax**	**Brucellosis**	**Rabies**	**Salmonella**
Java	BANTEN					
	DI YOGYAKARTA			71		
	DKI JAKARTA			1489		
	JAWA BARAT			216		
	JAWA TENGAH			51		8
	JAWA TIMUR			624		
Kalimantan	KALIMANTAN BARAT					
	KALIMANTAN SELATAN			2	10	
	KALIMANTAN TENGAH				43	
	KALIMANTAN TIMUR					
Maluku	MALUKU					
	MALUKU UTARA					
Nusa Tenggara	BALI					44
	NUSA TENGGARA BARAT		26			
	NUSA TENGGARA TIMUR			39	873	15
Sulawesi	GORONTALO					
	SULAWESI BARAT					
	SULAWESI SELATAN		14	354	386	5108
	SULAWESI TENGAH			1	27	
	SULAWESI TENGGARA			667	70	2
	SULAWESI UTARA				31	
Sumatra	BENGKULU			5	171	16773

	JAMBI				338	29
	KEPULAUAN BANGKA BELITUNG					
	KEPULAUAN RIAU					
	LAMPUNG			1	24	15
	NANGGROE ACEH DARUSSALAM			479	41	514
	RIAU				486	710
	SUMATERA BARAT				162	
	SUMATERA SELATAN				13	
	SUMATERA UTARA			6	218	
West Papua	IRIAN JAYA BARAT					
	PAPUA					
TOTAL		0	40	4005	2893	23218

Ministry of Agriculture records were obtained for five years (2000, 2001, 2002, 2003 and 2005) and included counts of animal disease cases for 11 of the 12 priority animal diseases (no counts were available for cases of Highly Pathogenic Avian Influenza (HPAI) cases). Data for diseases of interest to this report (See Table 1) were summarised and presented in Table 2. Data presented in Table 2 represent an aggregation of the five years of data and are counts of cases. No information was available in the aggregated national summaries on the case definition, diagnostic test procedures used to identify cases, or sampling strategies (how animals were selected for sampling). These data therefore represent a summary of disease testing activity.

6.1.2 Data from DICs

The Ministry of Agriculture manages regional laboratories through the Directorate of Animal Health (DAH) including seven regional (Type A) disease investigation laboratories (DICs), and larger numbers of Type B and C District or Subdistrict diagnostic laboratories. Data obtained for this report were drawn from the seven regional Disease Investigation Centers (DICs):

1. Sumatra
   a. Medan: DIC 1
   b. Bukitinggi, near Padang, Sumatra: DIC 2
   c. Bandar Lampung (formerly called Tanjungkarang-Telukbetung): DIC 3
2. Java
   a. Wates, near Yogyakarta: DIC 4
3. Kalimantan
   a. Banjarbaru: DIC 5
4. Bali
   a. Denpasar: DIC 6
5. Sulawesi
   a. Maros, near Makassar (formerly Ujungpandang): DIC 7.

The DICs are important providers of diagnostic services to farmed livestock with varying but generally more limited roles in providing services to aquatic livestock production and research. Universities with veterinary, medical and science faculties may also provide services on occasions. The Research Institute for Veterinary Science, Balitvet, at Bogor, is a national research and diagnostic centre. It reports along an entirely different route to a different Director General.

DIC data on diagnostic tests performed in all DICs in Indonesia covering a period from 2002 to 2006 were analysed to produce summary statistics for diseases of interest.

Table 3: Count and percentage of number of tests recorded in DIC database, arranged by animal group. Data drawn from 2002-2006.

Region	Province	Anthrax	Avian Tb	Brucella	Cysti-cercosis	HPAI	Lepto	Rabies	Salm.	Scabies	Toxo	Total
Java	BANTEN	7		50		2089		166	158			2470
	DI YOGYAKARTA	205		1601		7767		145	1017	39	294	11068
	DKI JAKARTA			198		2096		23	634			2951
	JAWA BARAT	106		2110		3194	71	1158	1104		85	7828
	JAWA TENGAH	273		4851		12963		113	1585		33	19818
	JAWA TIMUR	45		3893		7672	4	23	1148		59	12844
	Subtotal	636	0	12703	0	35781	75	1628	5646	39	471	56979
	Percent of regional total	1.12	0.00	22.29	0.00	62.80	0.13	2.86	9.91	0.07	0.83	100.00
Kalimantan	KALIMANTAN BARAT			495		788		30	17			1330
	KALIMANTAN SELATAN	2		7595		6489		147	203		5	14441
	KALIMANTAN TENGAH			291		2405		183				2879
	KALIMANTAN TIMUR	26		510		2781		51	261			3629
	Subtotal	28	0	8891	0	12463	0	411	481	0	5	22279
	Percent of regional total	0.13	0.00	39.91	0.00	55.94	0.00	1.84	2.16	0.00	0.02	100.00
Maluku	MALUKU			1046		472		74	24			1616
	MALUKU UTARA			1132		759		234				2125
	Subtotal	0	0	2178	0	1231	0	308	24	0	0	3741

	Percent of regional total	0.00	0.00	58.22	0.00	32.91	0.00	8.23	0.64	0.00	0.00	100.00
Nusa	BALI		9	6598	5	4181			15848	2		26643
Tenggara	NUSA TENGGARA BARAT	551		2066		1398			283			4298
	NUSA TENGGARA TIMUR	62		4310		2698		437	75			7582
	Subtotal	613	9	12974	5	8277	0	437	16206	2	0	38523
	Percent of regional total	1.59	0.02	33.68	0.01	21.49	0.00	1.13	42.07	0.01	0.00	100.00
Sulawesi	GORONTALO	13		172		505		1			1	692
	SULAWESI BARAT	21		1073		1044		3		22		2163
	SULAWESI SELATAN	690		3550		11675		584	156	27	23	16705
	SULAWESI TENGAH			90		1113		6	24			1233
	SULAWESI TENGGARA	15		1720		598		67	1			2401
	SULAWESI UTARA			122		1040		261	20			1443
	Subtotal	739	0	6727	0	15975	0	922	201	49	24	24637
	Percent of regional total	3.00	0.00	27.30	0.00	64.84	0.00	3.74	0.82	0.20	0.10	100.00
Sumatra	BENGKULU	95		800		4901		197	88	1		6082
	JAMBI	8		1252		1753		191	966			4170

	KEPULAUAN BANGKA BELITUNG			102		2142			175			2419
	KEPULAUAN RIAU			326		1684			252			2262
	LAMPUNG	76		7674		9445		49	102524	12		119780
	NANGGROE ACEH DARUSSALAM	7		864		3867		64	258			5060
	RIAU			1592		1841		50	227			3710
	SUMATERA BARAT	2		2437		5337		971	1567			10314
	SUMATERA SELATAN	11		702		3544		39	491			4787
	SUMATERA UTARA	2		2603		11145		903	442			15095
	Subtotal	201	0	18352	0	45659	0	2464	106990	13	0	173679
	Percent of regional total	0.12	0.00	10.57	0.00	26.29	0.00	1.42	61.60	0.01	0.00	100.00
West	IRIAN JAYA BARAT			67		1491						1558
Papua	PAPUA			395		981		19	9			1404
	Subtotal	0	0	462	0	2472	0	19	9	0	0	2962
	Percent of regional total	0.00	0.00	15.60	0.00	83.46	0.00	0.64	0.30	0.00	0.00	100.00
Total	Count	2217	9	60109	5	120627	75	5881	129533	103	500	319059
	Percent of national total	0.69	0.00	18.84	0.00	37.81	0.02	1.84	40.60	0.03	0.16	100.00

Table 4: Counts & percentages of tests performed by region and province.

Animal group	species	Anthrax	Avian Tb	Brucella	Cysti-cercosis	HPAI	Lepto	Rabies	Salm.	Scabies	Toxo	Total
Livestock	cattle	1308		48756			66	10	618	1	26	50785
	goat	168		8984		2	9	2	52	93	170	9480
	goat & sheep			520								520
	pig	3		1444	5	3935		16	421			5824
	sheep	62		831		2			1		263	1159
	water buffalo	337		1444				3	24		1	1809
Subtotal	Count	1878	0	61979	5	3939	75	31	1116	94	460	69577
	Percent of all livestock	2.70	0.00	89.08	0.01	5.66	0.11	0.04	1.60	0.14	0.66	100.00
Bird	unclassified bird		9			2763			16			2788
	chicken					106340		8	127593	1		233942
	chicken & duck					499						499
	duck					5747			713			6460
	duck & goose					12						12
	goose					225		23	3			251
	quail					297			2			299
	turkey					39			1			40
Subtotal	Count	0	9	0	0	115922	0	31	128328	1	0	244291

	Percent of all birds	0.00	0.00	0.00	0.00	47.45	0.00	0.01	52.53	0.00	0.00	100.00
Carnivore	cat					6		143		1	37	187
	dog							5888		7		5895
Subtotal	Count	0	0	0	0	6	0	6031	0	8	37	6082
	Percent of all carnivores	0.00	0.00	0.00	0.00	0.10	0.00	99.16	0.00	0.13	0.61	100.00
Other	civet							3				3
	deer	42		43		7		2	1			95
	horse	4		18								22
	human	3				2						5
	monkey							5				5
	mouse							4				4
	rabbit			2		55		3	4			64
	tiger							2				2
Subtotal	Count	49	0	63	0	64	0	19	5	0	0	200
	Percent of all Other	24.50	0.00	31.50	0.00	32.00	0.00	9.50	2.50	0.00	0.00	100.00
Unknown	unknown	290		245		1927		77	108		3	2650
	Percent of all unknown	10.94	0.00	9.25	0.00	72.72	0.00	2.91	4.08	0.00	0.11	100.00
TOTAL	Count	2217	9	62287	5	121858	75	6189	129557	103	500	322800
	Percent of Total	0.69	0.00	19.30	0.00	37.75	0.02	1.92	40.14	0.03	0.15	100.00

The most common tests being performed were for Avian Influenza, Salmonellosis and Brucellosis, accounting for 97.2% of all tests performed. Most of the Avian Influenza tests are understood to be tests performed for confirmation of development of serological antibodies following vaccination. Of the remaining diseases for which samples were tested, Rabies and Anthrax accounted for most of the testing.

The primary value of the above data is considered to be the relative numbers and proportions of tests performed in different areas for the different diseases. Disease testing activity was considered likely to be influenced by disease prevalence, animal and in some cases human population, and by prioritisation of disease testing activities within the DICs. Samples for animal disease testing may be derived from structured surveys involving some form of random sampling and from a range of activities that did not involve any structured approach to sampling such as investigation of suspected disease outbreaks. It was not possible to differentiate data derived from structured surveillance and data derived from other activities and as a result it was not possible to develop valid estimates of disease prevalence from the DIC data.

6.1.3 Yogyakarta DIC

The Yogyakarta DIC performs diagnostic tests on samples from animals sourced from all over Java. Copies of test results for selected diseases were obtained from the Yogyakarta DIC, concentrating on diseases listed in Table 1. Samples for disease testing were collected through a variety of activities including disease outbreak investigations (either involving DGLS or DIC staff collecting samples), active surveillance programs managed by DIC staff involving either testing for disease or for vaccination response, and occasional cross-sectional surveys.

DIC staff contributed valuable discussion on each of the diseases of interest for the project.

6.1.4 Denpasar DIC, Bali

A meeting was held with senior staff from the Denpasar DIC led by Dr Anuk Agung Gde Putra and there was very useful discussion covering each of the diseases of interest to the project team and other activities being undertaken by DIC staff.

6.1.5 Ministry of Health

Staff from the National Institute for Health Research and Development (NIHRD) and Dr Wilfied Purba, Head of the Sub-Directorate of Zoonoses within the Ministry of Health provided discussion of disease testing activities, research and disease prioritisation for the Ministry of Health.

6.1.6 International agencies

Additional information was sourced from discussion with staff from WHO, Jakarta and FAO, Jakarta and from reports compiled by WHO and FAO based on activities completed in Indonesia. These included WHO evaluation of public health surveillance in Indonesia, conducted in August 2004, and FAO activities concentrating on avian influenza.

Information was also obtained from the OIE website on official animal disease status for Indonesia.

7 Zoonotic disease in Indonesia

7.1 Anthrax

Anthrax is endemic in several provinces in Indonesia, including West Java, Central Java, Yogyakarta, South Sulawesi, Central Sulawesi, Southeast Sulawesi, and East Nusa Tenggara. It appears that animal deaths may not be well reported at all and that human cases of anthrax are more likely to be reported to health providers. Human cases are known to act as sentinels for animal health providers for example information from researchers at Balitvet indicated that investigations into animal cases of anthrax may be initiated following awareness of human cases in a particular area. Anecdotal information indicates that while human cases may occur following exposure to environmental spores they are more likely to occur following one or more animal cases. Human cases may therefore be considered as indirect indicators of recent animal cases and may offer an alternative measure of prevalence at the outbreak level that is less affected by under-reporting though still offering little information on numbers of animals affected in any outbreak.

Human cases may be more likely to occur in association with Islamic festivals (Eid ul-Fitr and Eid ul-Adha) when animals (commonly small ruminants) may be killed and eaten in community celebrations.

There are limited data available on numbers of cases. Ministry of Agriculture data presented in Table 2 indicate that over a 5-year period there were 26 confirmed cases in West Nusa Tenggara and 14 in South Sulawesi. DIC data reported in Tables 3 and 4 provide evidence of testing in various regions but it is not clear whether these results represent positive diagnoses of disease outbreaks.

Data reported from Ministry of Health on human cases of anthrax in West Java within the last 10 years indicated outbreaks occurred in the districts of Purwakarta, Subang, Bekasi and Karawang (1996), Purwakarta, Subang and Karawang (1997), Purwakarta, Subang and Bekasi (1999), Purwakarta (2000), and in Bogor district (2001).

The outbreaks in Bogor district in 2001 occurred in association with Islamic festivals Eid ul-Fitr and Eid ul-Adha. Anthrax cases in Bogor district have fluctuated between 2001 and 2006 with a peak of 30 human cases occurring in 2004 with 9 fatalities in a family following consumption of animal meat.

Testing performed at the Yogyakarta DIC for Anthrax appeared to be almost all devoted to serological testing to confirm presence of an immunological response to vaccination in healthy animals. In addition some tests were performed on soil samples to examine for presence of spores though results were not observed for such tests. Results were presented for samples taken from sheep, cattle and goats but appeared to indicate 100% response, presumably meaning that all tested animals had been effectively vaccinated. Information from Denpasar DIC indicated that Bali was historically free of anthrax. Effective control (based on vaccination) has been established in Lombok island (last case in 1989) in West Nusa Tenggara (NTB) while nearby Sumbawa island is associated with diagnosed cases of anthrax on an annual basis. In East Nusa Tenggara (Nusa Tenggara Timur or NTT), control has been established on Timor island (last case in 2003) and Sumba island (last case in 1980) while Flores island remains an endemic problem with cases reported every year.

Information on human cases has also been obtained from a web-based search of PROMED reports[1] and is presented below in summary form:

- March 1999: At least one person died and 267 others have been hospitalised in a suspected anthrax outbreak in Indonesia's eastern island of Flores after a meal of water buffalo. The buffalo had died suddenly and was then consumed. No confirmatory testing on the animal was performed.
- Feb 2001: Anthrax has infected 20 residents of Tajur Tapos hamlet in Hambalang subdistrict, Citeureup over the past month, 2 of whom have died. The local residents have been suffering from bleeding ulcers, which is identified as a specific symptom of anthrax, after reportedly eating either goat meat or beef.
- March 2002: A suspected anthrax outbreak was reported in several regencies in Central Java after one villager died in the town of Boyolali. Head of the provincial health office Krishnajaya reported that there had been at least 126 human cases of anthrax in the province, with 20 fatalities in the 1990-2001 period. At least 18 of the deaths were recorded in 1990 alone from 90 cases in Teras.
- August 2002: At a cattle-breeding farm in Bogor, West Java, 5 workers were infected with anthrax after being exposed to cow's blood. The breeder said he slaughtered the cow after noticing it was sick and sold the meat at a local market.
- Jan 2003: 8 residents of Bima, West Nusa Tenggara (NTB) on the island of Sumbawa died last month after consuming goat meat allegedly infected with anthrax. A spokesperson from the Bogor health agency in West Java also confirmed that there were 7 residents in the Bogor area who were suffering anthrax after eating goat meat at a party held by their neighbour.
- Jan 2003: Promed mail reported summary statistics on human and animal cases of anthrax in Indonesia over several years with the comment that years where no data were reported did not mean that no cases had occurred but may equally have represented variability in reporting.

Table 5: Number of anthrax cases reported for Indonesia between 1988 and 2000. Sourced from Promed.

Year	Sheep/Goat	Pig	Cattle	Human
1988		252		
1989				89
1990				
1991	501	74	309	
1992	19		41	88
1993	11		15	136
1994	8		10	127
1995	11		5	79 (6 deaths)
1996	11	38	72	17
1997			9	13
1998	17		17	
1999				
2000	19			

[1] www.promedmail.org

- Jan 2004: 3 residents of Pisang village, Karadenan subdistrict, in the Bogor district were confirmed to have been infected with anthrax. The 3 had been infected in Dec 2003, after consuming meat from a sick goat that was slaughtered for consumption. The infected man had refused to have the goat vaccinated against anthrax despite recommendations that livestock in the area be vaccinated every 6 months. The affected man was quoted as admitting that he slaughtered the sick goat and distributed the meat to 3 families, totalling 15 people. It was not clear whether the 12 others had fallen ill.
- October 2004: An anthrax outbreak caused by consuming goat meat or entrails, left 6 people dead (and other people affected) in the Bogor district.
- November 2004: Information from an anthrax outbreak on the island of Sumbawa, Indonesia indicated that about 22 cattle had died and that 6 human cases of cutaneous anthrax were being treated through the local health office.
- Nov 2005: An anthrax outbreak near Bogor, West Java claimed 6 lives and may have affected as many as 65 people. Ministry of Health officials reported that infected goat meat was the cause.
- Nov 2005: An anthrax outbreak was reported in Makassar (Ujungpadang) in which 29 cattle and water buffaloes died. There were 6 human cutaneous cases associated with the outbreak.
- Oct 2006: An anthrax epidemic was declared in Gowa, South Sulawesi, with cows in 3 villages reported by villagers to have been sick or dying and confirmation of anthrax following necropsy & sampling of some animals. Two possibly infected cows had been slaughtered before the disease was detected and their meat sold to the public.
- April 2007: An anthrax outbreak was reported in West Sumba resulting in 8 people dead from two villages. The deaths occurred after consuming beef. Health officials were treating 6 additional people and monitoring approximately 90 families in the 2 villages in the West Sumba regency, East Nusa Tenggara. The families had eaten the meat of cows and water buffaloes believed to have been infected.

Vaccination is highly effective at controlling anthrax. There are two sources of vaccine: Pusat Veterinaria Farma or Pusvetma, a DGLS facility located in Surabaya; and a private pharmaceutical company in Bogor. The current recommendation is that all animals in endemic areas should be vaccinated every 6-months. Information from the AUSVETPLAN for anthrax[2] indicates that a single vaccination with the Sterne 34F2 vaccine used in Australia confers effective immunity for 6 to 12 months and that animals vaccinated twice, at least 6-months apart, are probably immune for life. Factors such as concurrent antibiotic therapy, inadequate dose or improper administration or an overwhelming challenge may all result in inadequate protection or disease occurring in a vaccinated animal.

There also appears to be some uncertainty over duration of immunity in livestock following vaccination with one recent paper indicating that there is a lack of systematic experimental data on the duration of actual protection induced by the livestock vaccine (Turnbull et al 2004).

The Sterne vaccine contains live, avirulent *B. anthracis* and may cause adverse reactions in some vaccinated animals. Reactions are relatively uncommon and mild in cattle and sheep but may be severe in goats, alpacas and horses.

[2] http://www.animalhealthaustralia.com.au/programs/eadp/ausvetplan_home.cfm

There are a number of issues that appear to be interfering with vaccination of at-risk animals:

- use of a modified live vaccine with a consequent witholding period before product (meat etc) from vaccinated animals can be sold
- requirement for repeated vaccination
- limited vaccine production capacity resulting in shortages of available vaccine
- post-vaccination reactions observed primarily in small ruminants (goats more than sheep) where vaccinated animals appear to show signs consistent with anaphylactic shock (shivering, ataxia, recumbency) and where a number of animals may die.
- other less serious post-vaccinal reactions including lumps and abscessation at vaccination sites

Reports of post-vaccinal reactions and deaths in goats (and to a lesser extent in sheep), were repeated by several people in discussion. Reviews of published literature did not identify any detailed scientific information on the topic of anaphylactic reaction in sheep and goats to the use of the anthrax vaccine though there was mention in the AUSVETPLAN manual on anthrax of the possibility of severe reactions to vaccination in goats, alpacas and horses and that enforcement of vaccination in these species therefore needed careful consideration. Anecdotal reports appear to be inferring that the adjuvant may be responsible for the reactions but there is no information to substantiate this report. There are apparently attempts to modify the vaccination protocol for small ruminants including the use of half-dose vaccine to try and eliminate the risk of post-vaccine reaction. However, it is not known whether this might result in reduced vaccine efficacy. Culture stocks used for vaccine production are apparently based on seed cultures maintained over decades and there may have been changes in the properties of the seed cultures over this time. There appears to be a need for research into the current vaccine including immunogenicity and factors associated with risk of post-vaccinal reaction. There is also an opportunity to explore the development of a new vaccine that may be based on sub-unit technology and produce long-lasting immunity from a single injection with elimination of side effects.

There may also be variable and even cyclical levels of awareness about anthrax, risks to health and methods of prevention. In response to an outbreak among animals and people the level of awareness and compliance with vaccination and other recommendations is reported to be high initially and then over time as cases are not reported awareness of anthrax declines, and high risk behaviours occur once again including refusal to vaccinate and killing and eating animals that may be sick due to anthrax or that have died suddenly. A report from the Human Health Agency for Research and Development (2002) indicated that the coverage of anthrax vaccination for goat and sheep populations in the Bogor district increased from 12.6% to 66.3% in 2002, presumably in response to an outbreak and subsequent activity associated with awareness and vaccination campaigns. However, the level of protection in 2002 reached only 16%. The study also said that the community objected to the vaccination program conducted by the local livestock services office, because they thought the program was not economical and caused unexpected side effects such as sudden death, post vaccination shock and pustules at the injection site. These comments were supported by staff at DGLS (Jakarta), Balitvet and at DICs in Yogyakarta and Denpasar.

People are commonly exposed to anthrax through dressing and eating animals that have died from anthrax and through handling skins and other animal products. In most cases DIC staff indicated that human cases are generally cutaneous and that people in anthrax affected regions are likely to recognise cutaneous anthrax and notify health authorities in order to obtain treatment. In a small number of cases there was anecdotal mention of development of severe disease and fatality associated with anthrax, presumably due to high levels of exposure and development of pulmonary or systemic disease in people. Issues relevant to anthrax that were identified in the course of discussion and review of literature and other sources of information include:

- Contextual or adaptive research aiming to better understand why communities in endemic districts continue to suffer from human and animal cases of what is in many countries a very preventable disease. There are existing education and awareness programs with planned activities timed to coincide with high risk events such as Islamic festivals, an existing vaccination program for endemic areas, and variable levels of ante- and post-mortem inspection of animals killed for consumption. Improving prevention and control of this disease will require an ability to adapt these and other awareness measures to ensure they are effectively implemented within the context of the local communities in endemic districts.
- Investigation of the immunogenicity and side effects associated with the current vaccine.
- Development of a new anthrax vaccine based on sub-unit technology and producing a long-lasting immunity following a single vaccination with no side effects.
- Potential value of a rapid test that could be applied in the field to blood samples from a sick or dead animal in an attempt to diagnose or rule out the presence of anthrax. This form of testing would be valuable as a means of providing very useful information about risk to those people who may be considering whether to kill/eat an animal that could be infected with anthrax. In addition, there was interest in development of rapid testing methodology that could be used on animal products to demonstrate presence or absence of anthrax spores as a means of rapidly identifying animal products as being free from anthrax and raising public confidence in endemic areas. Discussions have been held between Dr Agung (Denpasar) and Dr Stan Fenwick (Murdoch University) on this issue.

7.2 Avian Influenza

The first reported outbreak of highly pathogenic avian influenza (HPAI) type H5N1 in Indonesian poultry occurred in August 2003 and was confirmed in a report to the World Animal Health Organisation (OIE) in 2004. Since that time HPAI has spread across much of the country and has now been reported in 30 of 33 provinces. HPAI is now considered endemic in bird populations in much of the country. Human cases of H5N1 have been reported since mid-2005 and Indonesia now has the highest number of human fatalities worldwide (83 fatalities from 104 known cases of HPAI in humans as of 16 August 2007). Most human cases (~80% of all cases) have been reported from Western Java, consistent with the hypothesis of higher human-poultry densities being associated with higher risk of exposure of people to virus.

According to government livestock statistics 2005, there are more than 286 million native chickens, 98 million broiler chickens and 34 million ducks in Indonesia in sectors 3 and 4. Poultry are distributed unevenly across Indonesia, with 60% in Java, 40% in Sumatra, 6% in Kalimantan and 4% in Sulawesi. The distribution of birds closely follows the distribution of human population. Sixty percent of Indonesian households keep poultry for household consumption or for ready cash sale of birds and eggs. Eighty percent of poultry are sold in 13,000 live-bird markets across the country with little or no health inspection or biosecurity, representing an important risk for virus transmission between poultry and other birds including water birds. Hundreds of village hatcheries, most without biosecurity or health-inspection, distribute day-old chicks and ducklings to Sector 3 producers. Sector 1 and 2 commercial poultry farms and hatcheries generally practice a higher level of biosecurity than village chickens though their biosecurity practices are understood to be variable and health status remains largely unknown.

Approximately 10.5 million birds were culled in 2004 in an attempt to eradicate the disease from Indonesia. Indonesia started to vaccinate against HPAI early in 2004 and continues to use vaccine in outbreak or infected areas throughout the country. There are indications that there are insufficient vaccine stocks to ensure vaccination of all birds in all affected regions. DIC staff are involved in structured surveillance of birds to monitor for serological response to vaccination. Results appear to indicate that between 50-90% of sampled birds had no circulating antibody, indicating that vaccination is not currently achieving acceptable levels of protection. In some cases vaccine shortages mean that vaccination is limited to ring-vaccination around known outbreak locations. The estimated cost of the vaccine was Rp 300 per bird-dose. Larger commercial layer operations buy their own vaccine. Broiler operations generally do not vaccinate, mainly because their grow-out period is short enough to be associated with lower risk of exposure and disease and they may use an all-in all-out management. Indonesian government support provides compensation in the event of disease for village chickens.

Over time reports of disease outbreaks have declined. Reporting appears to indicate that more outbreaks may be occurring in village chickens compared with commercial operations though it is understood that there are . There were 454 confirmed HPAI outbreaks in Indonesia in 2006 with 247 (54%) of these occurring in Sumatra, 108 (24%) in Java, 53 (12%) in Sulawesi and 29 (6%) in Nusa Tenggara. The pattern of outbreaks closely follows the population density for birds and people. Positive test results were mostly reported from chickens (80%), ducks (6%), quail (5%), and also from a range of other birds. Of the positive results reported for chickens, 46% were kampung chickens, 5% broilers, 3% layers and the remainder were either unclassified or other types. Under-reporting is acknowledged as a major problem and reported outbreak statistics may not accurately represent actual disease occurrence.

Government decentralization has had significant consequences for HPAI control. Since the central government shifted autonomy from the provinces to the districts, the latter are now in full charge of activities and budget allocation with central treasury funds being passed directly to districts and not to provincial level government. This shift in civil service administration has had varying and predominantly adverse consequences for the management and resourcing of district animal health services and for movement of data and reporting from local animal health agencies to central government.

There are also acknowledged deficiencies in the national legal and regulatory framework that interfere with the ability of government and private veterinary services to carry out and enforce emergency disease control measures. For example DGLS staff may not have sufficient regulatory power to complete a number of functions that may be considered critical to effective disease control including: entering poultry farms, destruction of poultry (unless by special decree), setting up roadblocks to control poultry movement, closing poultry markets etc.

In an outbreak it is understood that official policy is to cull birds in affected villages within a defined in-contact area ranging from 100 metres to 1 km. There are compensation programs involving payment to owners for slaughter of in-contact birds though the level of compensation appears to be lower than the commercial value of a bird and the programs may not be implemented in all parts of Indonesia. As a result it appears to be common for farmers to conceal mortalities that may be due to HPAI and immediately sell or move surviving chickens from affected villages in order to salvage some income. This also means that birds dying from HPAI are disposed of in an ad hoc and indiscriminate way (tossed in the field) and may further contribute to spread of virus.

Table 6: Number of serological tests done by province for HPAI antibody. Data from Yogyakarta DIC.

Province	Tests done	Negative	Low	High	% Neg	% Positive
Banten	1511	960	346	205	63.5	36.5
Jakarta	451	403	15	33	89.4	10.6
Jawa Barat	1367	967	243	157	70.7	29.3
Jawa Tengah	4280	2045	914	1321	47.8	52.2
Jawa Timur	3437	2116	632	689	61.6	38.4
Yogyakarta	1863	990	245	628	53.1	46.9
Total	12909	7481	2395	3033	58.0	42.0

Information from DIC personnel indicate that sampling for the results presented in Table 6 was completed using a pseudo-random process ie 2 districts were selected from each province and farms then convenience sampled within selected districts. An important conclusion is that relatively small percentages of birds have circulating antibody (%positive is calculated based on the combination of low plus high serological response results). Between 50 and 90% of birds sampled had no detectable antibody levels meaning that they would be susceptible to circulating HPAI virus. These results indicate that it is very difficult to assess vaccine efficacy because of the low levels of serological response. Results may also be used to modify estimated impacts of circulating virus on levels of morbidity and mortality.

There is considerable activity by Indonesian government agencies and international aid agencies focused on capacity for animal disease control and specifically for HPAI in bird populations. There is a National Committee for Avian Influenza Control and Pandemic Influenza Preparedness[3], known as Komnas FBPI, that provides a coordination and facilitation role to the Indonesian government response to the H5N1 avian influenza virus. Komnas FBPI is advised by a panel of experts and is in consultation with the key animal- and human-health professional associations in Indonesia. Komnas FPBI has six associated task forces that provide direction on: research and development, animal health, human health, vaccine and anti-viral medicines, and mass communication and public information.

A number of projects directed at avian influenza response and control have already been completed or are in progress. Laboratory capacity projects are in progress including equipping all DIC laboratories to BSL2 standard, with RIVS (Balitvet) serving as a national BSL3 HPAI reference laboratory. All DICs have been equipped with Real Time PCR, and selected Provincial Laboratories with diagnostic equipment. Bilateral cooperation with the Australian Government includes: technician training at Geelong; training in basic and molecular virology of 16 veterinarians; laboratory information networking; introduction of a laboratory QA programme and collaborative testing on virus isolates. A large-scale Integrated National Avian Influenza Control Project is understood to be in development currently under the management of the Ministry of Agriculture and FAO with a budget approaching $USD 150 million and involving support from multiple international aid agencies and an expansive set of objectives covering a full range of issues associated with HPAI control and eradication, including participatory surveillance, blanket vaccination of Sector 3 and sector 4 backyard poultry, surveillance and epidemiology, laboratory services, animal movement control and quarantine, attention to legislative and regulatory requirements for disease control, communications and public awareness, applied research into outstanding HPAI-related matters, and development of guidelines for poultry industry restructuring.

[3] http://www.komnasfbpi.go.id/aboutus.html

7.3 Brucellosis

Brucellosis in cattle and pigs has historically been reported from Jakarta, West Java , Central Java , East Java , NTB, NTT, Sulawesi and Sumatra. Ministry of Agriculture data on priority animal diseases (Table 2) indicates that most testing for Brucellosis occurs in Java (61% of all Brucellosis testing), Sulawesi (26%), and Sumatra (12%).

There is a control program in place in Indonesia for bovine brucellosis that is based on vaccination as well as test and slaughter. The approach followed is dependent in part on the estimated prevalence at the district or province level – there is some uncertainty over the denominator used for prevalence estimation. If the seroprevalence is greater than 2% then positive animals are removed and remaining animals vaccinated with either strain 19 or RB51 vaccines. RB51 is a more recently developed vaccine strain with the added potential benefit that vaccinated animals can be distinguished from naturally infected animals using serological testing. Over time as disease positive animals are removed, vaccination can then be phased out and the area moved towards disease freedom by adopting the approach used when prevalence is <2% which is no vaccination and test and slaughter of animals until all animals test negative. There is a compensation program being operated in some provinces designed to return value to owners of animals slaughtered under the eradication program but the amount of money provided under these programs varies between local governments and is typically less than the market value of animals. There is therefore expected to be some reluctance from smallholders to participate in the control and eradication program. Movement of vaccinated animals may also occur which potentially interferes with test and slaughter programs since current testing protocols may not allow clear distinction between vaccinated and infected animals. DIC staff at Yogyakarta indicated that Brucellosis is believed to be a problem of dairy cattle only and that Beef cattle and Buffalo are believed to be free of the disease. It is not clear why this might be the case.

Samples for testing at the Yogyakarta DIC appear to be derived from a mixture of surveillance performed by DIC staff and investigations of reported abortions (by either DGLS or DIC staff depending on who the farmer reports to). DGLS laboratories perform Rose-Bengal tests (RBT) which involves mixing serum from test animals with antigen and examining the solution with the naked eye for presence of agglutination. The RBT is very rapid, cheap and easy to perform in the field and is regarded as a very good herd-level screening test. Positive results should then be followed up with a confirmatory test and in Indonesia, positive RBTs performed by DGLS are then followed by submission of samples to the DIC for Complement Fixation Testing (CFT).

There appears to be uncertainty over whether different serotypes of Brucella may be present in Indonesia eg B. melitensis, B. suis, B. ovis, B. abortus.

Table 7: Results of Brucellosis testing at Yogyakarta DIC for the 12-months of 2006

Province	**Pig**		**Sheep**		**Goat**		**Cattle**	
	positive	test	positive	test	positive	test	positive	test
Banten		0	0	20	0	420	0	96
Jakarta		0		0		0	70	83
Jawa Barat	0	47	0	578	0	109	53	1110
Jawa Tengah	11	137	0	213	0	1077	8	2103
Jawa Timur	4	25	0	30	0	267	100	1069
Total	15	209	0	841	0	1873	231	4461

These results indicate that *B. abortus* (cattle) and *B .suis* (pigs) may be considered to be present in Java. The lack of any seropositive results in sheep and goats provides some evidence to suggest that *B. ovis* and *B. melitensis* may not be present in Java but these results should be interpreted with caution since it is not clear whether samples were collected in a systematic manner sufficient to provide defined levels of confidence in disease freedom or meet conditions for declaration of freedom as outlined by the OIE. Information obtained from Denpasar DIC indicates that Bali is historically free of Bovine Brucellosis. In West Nusa Tenggara (NTB), Lombok island was declared free in 2002 and Sumbawa island declared free in 2005. Since then the price of cattle has gone up and farmers may be selling too many cattle to take advantage of the increased price with some risk of animal numbers falling to very low levels in these islands. In East Nusa Tenggara (NTT), Timor island has had cases since 1986, reactors have been found over a 10-year period on Sumba island and a control program is now in place. Reactors have also been identified on Flores island between 1997-2006.

Serosurveillance performed in cattle from Sumatra between 1999-2002 indicated 0 positive from 2756 samples in West Sumatra, 4 from 2422 (0.16%) in Riau and 3 from 8063 (0.04%) from Jambi provinces. Similar serosurveillance performed in Java (West and East Java) reported seropositive results from 5 to 12% of cattle tested. Animal-level serological prevalence estimates have been produced from serological data derived from the Yogyakarta DIC. These data showed 231 seropositive from 4461 cattle samples (5.2%) and 15 seropositive from 209 pig samples (7.2%). These estimates are consistent with published estimates from other countries where Brucellosis is endemic. Discussions with Dr Darminto (Balitvet) indicated that seroprevalence in pig samples (assumed to be *B. suis*), tested at Balitvet was typically much higher (up to 40%) than seroprevalence results from cattle samples.

Estimates of seroprevalence in endemic countries are summarised below:

- >5% in Africa (range from 4.8 to 41%) in cattle
- 7% in cattle in China
- 8% in sheep and 2% in goats while results from separate states ranged from 5 to 50% in either species
- 3 to 11% in pigs in India
- herd level seroprevalence in cattle from Brazil ranged from 33 to 11% and the animal seroprevalence from <1 to 7.5%.
- 4 to 8% animal level seroprevalence in Central America and a rate of herd infection (mainly dairy herds) from 10 to 25%

A number of studies have also examined human seroprevalence in countries where animal Brucellosis is endemic:

- annual incidence of >1% in people in Africa
- highest prevalence of human infections in China was in abattoir workers of 22-34%
- most human infections in China are in adults due to contact with animals and rates of 2% were reported for rural people generally vs 22% for people in rural areas where livestock are grazed
- Between 6 to 28% of hospital patients in Nigeria tested positive to Brucellosis with the highest seroprevalence of 43.8% observed in abattoir workers/butchers.

- Incidence rates for human brucellosis from endemically infected countries in the Eastern Mediterranean region range from Iran (29.8/100,000), Saudi Arabia (32.8/100,000), Syria (21.0/100,000), Jordan (20.4/100,000), Palestine (21.5/100,000) and Oman (16.6/100,000). Bahrain and Cyprus have reported zero incidence. In the rest of the countries, the incidence varies from 0.8/100,000 in Egypt to 9.0/100,000 in Tunisia.

7.4 Cysticercosis

Taeniasis/cysticercosis is believed to be a major problem in some parts of Indonesia but there appears to be relatively little data to describe the problem. There are a number of publications in the scientific literature from intermittent surveys and other research projects that have been completed. There does not appear to be any data derived from regular surveillance performed by DIC or DGLS staff. The bulk of the information used in this report was therefore derived from scientific literature.

There are three known endemic provinces for taeniasis/cysticercosis in Indonesia: Papua, Bali, and North Sumatra. Cases of taeniasis and/or cysticercosis have also been reported sporadically from East Nusa Tenggara, South East Sulawesi, Lampung, North Sulawesi, East Java and Jakarta. Papua appears to have one of the highest rates of endemic human cysticercosis in the world. In 1996 there was an outbreak of epilepsy investigated in Papua involving some 3,600 affected people that was attributed to *T. solium* cysts. The problem appeared to be related to methods of preparing and eating pig meat that allowed viable cysts to be consumed and also poor general hygiene in communities that increased the risk of faecal-oral transmission of material.

There is some evidence that *T. solium* taeniasis and cysticercosis is now relatively rare in Bali compared to 10–20 years ago and this has been attributed to improvements in sanitation and pig husbandry. In contrast *T. saginata* taeniasis may have increased in prevalence related to consumption of local raw beef dishes, under inadequate meat and food inspections. In addition *Taenia asiatica* may also account for cases in association with consumption of pig meat.

The seroprevalence of cysticercosis has been reported to range from 2% in northern Sumatra to 48% in Papua (Simanjuntak et al., 1997) and 1.65% (6/363) in three villages in Bali (Sutisna et al., 1999). In a survey of 160 human sera samples from 18 villages in Jaywijaya District of Irian Jaya, 81 (50.6%) were found to be positive by the immunoblot (Subahar et al., 2001). These results clearly indicate considerable variability in the seroprevalence of cysticercosis in different parts of Indonesia.

A very high prevalence of *T. solium* taeniasis and cysticercosis in the Wissel lakes area in Papua was associated with an "epidemic" of epilepsy and burns (Simanjuntak & Widarso, 2004). Serosurveys in Papua using immmunoblots revealed 8-10% prevalence in people; approximately 2% of 548 examined persons had demonstrable taeniasis, half of which were diagnosed as *T. solium*. In addition, studies in Papua indicate that the majority of people with epilepsy had *T. solium* cysticercosis.

Suweta (1991) reported a prevalence rate of 0.15% for cysticercosis in pigs in Bali while a more recent survey using the immunoblot on pig sera, reported 50 of 71 pigs (70.4%) from Irian Jaya positive and hence considered to have been exposed to the metacestodes of *T. solium* (Subahar et al., 2001).

Data on porcine cysticercosis may be obtained from examination of pork in official slaughterhouses but this probably underestimates the degree of the problem since many pigs in developing countries in Asia, as in other regions of the world, are not slaughtered in officially sanctioned slaughterhouses. Infected pigs may be more likely to be slaughtered unofficially for fear of economic loss from condemnation following inspection in official slaughterhouses. Meat inspection is carried out by provincial and district Animal Health Services in both public and private abattoirs, but the efficacy of this program is likely to be variable based on anecdotal information that not all slaughtered animals are inspected, carcass rejection rates are low, and meat inspectors may be employed by the slaughterhouses where they are performing inspections. It is also not clear what level of training is provided to animal health staff who may be performing carcass inspection at these facilities.

7.5 Rabies

Rabies is present in most parts of Indonesia though selected areas such as Bali and West Nusa Tenggara (NTB) are considered free. Ministry of Agriculture data on priority animal diseases (Table 2) indicate that most rabies testing is performed in Sumatra (36% of all cases reported at the national level), Nusa Tenggara (22%) and Sulawesi (13%).
The principles of control of rabies in Indonesia are based on a combination of measures including:

- Vaccination programs in rabies endemic areas for pet animals and particularly dogs.
- Elimination of non-owned animals, particularly wild dog and cat.
- Imposition of quarantine measures and movement control in rabies free areas to prevent introduction of animals that may inadvertently introduce rabies (particularly dogs).
  - Dogs, cats and other susceptible animals must be vaccinated a month before entering the area.
  - Unvaccinated animals are quarantined for 45 days

However, there have been problems with the control program through issues such as:

- Insufficient supplies of vaccine to ensure pets are vaccinated twice each year.
- Poor vaccination coverage. There appears to be variable levels of compliance with vaccination programs and in some regions people may actively avoid vaccinating their dogs for fear of adverse reaction to the vaccine or loss of athletic ability or courage in animals post-vaccination.
- Lack of compliance with movement controls and quarantine so dogs may be moved between provinces in violation of movement controls. This poses a real risk of introduction of rabies to different areas of Indonesia.
- Lack of efficacy of wild dog destruction programs including anecdotal evidence suggesting that strychnine bait programs are not effective at killing dogs.

Flores island in Nusa Tenggara Timur (NTT) is an example of a developing outbreak. Flores island was free of rabies until September 1997 when three dogs were brought onto the island from rabies endemic Sulawesi. In the period between 1997 and December 2006 (9 years) the following estimates have been made concerning the rabies outbreak on Flores island:

- 258 cases in animals (253 dogs, 3 goats, 1 pig and 1 cat)
- 10820 human exposures, mostly from dog bites. About 50% of these exposures were in children under 15 years of age. Almost all of these people are believed to have received post-exposure treatment (PET).
- 158 deaths in people attributed to rabies (all from dog bites). The human population of Flores island is estimated at 3.5 million.

- Attempts have been made to slaughter stray dogs on Flores Island and vaccinate owned dogs but poor compliance from the public has interfered with these measures and the outbreak continues.

The rabies problem in Flores Island appears to be an urban dog issue and not a wild animal issue. There are estimated to be ~250,000 dogs on Flores Island (Dr Agung, Pers comm 2007) and while most of these animals may be considered to have owners it also appears likely that many dogs are not confined in secure housing (more likely to roam like stray animals) and may be considered to behave more like semi-owned or stray animals. There also are cultural reasons why dogs are considered to be important to their owners and there is considerable resistance to attempts to control dog populations on the island. Previous attempts by authorities to kill stray dogs have met with varying levels of resistance by people on the island and vaccination coverage is not high enough to allow effective control of the condition. NTT is the closest part of Indonesia to Australia and the unapproved movement of fishing vessels between Indonesia and Australia offers a genuine risk of rabies being inadvertently introduced into Australia.

DICs do perform fluorescent antibody testing on brain tissue from suspected cases. Data from Yogyakarta DIC indicated that 13 suspect cases were investigated during the 2006 year and five were diagnosed as positive for Rabies. All cases were dogs and all were submitted for investigation following potential exposure of people through dog bites. Staff indicated that historically most rabies cases are seen in dogs with occasional cases involving other species such as cats or monkeys. DIC staff reported that it is very rare to see a case of Rabies in livestock (cattle or buffalo) though they did acknowledge that individual cases have been seen historically (estimated to have occurred within the past 10-15 years). There was also acknowledgement that cases in livestock would be more likely to be not investigated (under-reported).

Most Rabies cases in Java come from one particular area (three districts in Jawa Barat) where there is relatively inaccessible terrain. There is a rabies vaccination program with Government supplying vaccination for dogs in West Java where Rabies continues to be a problem. Vaccination generally involves owned dogs and stray or wild dogs are usually not vaccinated. Anecdotal reports indicate that owners of dogs may not wish their animals to be vaccinated because of a perception that vaccination makes the dog weaker – this is particularly common for dogs that are used as hunting animals. There is also a Government program to kill wild dogs using strychnine baits as part of a Rabies control program. There appear to be anecdotal reports that strychnine baits are not effective or are losing effectiveness as a method of killing wild dogs.

Data from Sulawesi (DIC VII, Maros, near Makassar) from the 2006 year indicated that there were 199 cases of suspected rabies investigated and 137 (69%) positive diagnoses were made (Mudigdo et al, 2006). The suspect cases all involved interaction (commonly animal biting a person) between one or more people and an animal such that the animal was identified as being possibly infected with rabies. Of the 137 confirmed cases in animals, 134 (98%) involved dogs and 3 (2%) involved cats. Of the human exposures, 75 (55%) involved children between the ages of 1 and 15 years with the remainder involving older people or people of unknown age. The most common anatomical locations for bites were the body (n=62, 45%) and legs (n=48, 35%).

There is also evidence that West Sumatra has the highest annual incidence of confirmed rabies cases in animals of any Indonesian province with the total number of confirmed cases in animals per year over a four year period being 343, 401, 411 and 239 in 1997, 1998, 1999 and 2000, respectively (Harsono et al 2001).

Topics that may be suitable for research identified during discussions in Indonesia included the following:

- Sequencing of isolates from clinical cases to allow molecular epidemiological investigation of patterns of disease spread.
- Investigation of seropositive dogs that are detected in rabies-free areas. It seems that this occurrence would be most likely due to movement of a vaccinated dog from a rabies infected district but it is possible that there may be circulating strains of rabies virus that are less pathogenic.
- Contextual research aimed at understanding why there is variable success in different areas of Indonesia in relation to public awareness, animal vaccination, movement control and reporting of suspected cases.
- Investigation of methods for effective killing of wild dogs and why strychnine baits are not appearing to be effective
- Investigation into factors influencing success of rabies control programs between different locations in Indonesia
- Investigation into feasibility and application of oral bait vaccination as a means of improving vaccination coverage rates in wild dog populations.

7.6 Toxoplasmosis

Toxoplasmosis has been identified as a potential problem in parts of Indonesia though there appears to be relatively little surveillance to document the condition and no structured control program. Dr Purba (Sub-Directorate of Zoonoses, MoH) identified Toxoplasmosis as a problem in North Sulawesi and indicated that there were approximately 5 cases per 1000 pregnant women per year of congenital toxoplasmosis. The Yogyakarta DIC has been involved in cross-sectional serological surveys in animal populations for Toxoplasmosis in 2004 and 2005. Results of these tests are presented below.

Table 8: Results of testing for Toxoplasmosis in Java in 2004-2005

Year	Province	Species	negative	positive	test
2005	Yogyakarta	Sheep	0	2	2
		Cat	4	7	11
		Buffalo	0	1	1
		Cattle	19	22	41
		Goat	14	28	42
2004	Yogyakarta	Goat	27	43	70
		Sheep	0	1	1
		Human	0	1	1

These results confirm that Toxoplasmosis is circulating in Java though serological response indicates only previous exposure and does not necessarily confirm presence of abortion or other disease in affected animals.

Review of the scientific literature indicates that congenital toxoplasmosis in people has been confirmed in Indonesia and congenital anomalies in newborn children have been attributed to *Toxoplasma gondii*. The parasite is widespread, with seroprevalence rates of 2-70% in humans, 35-73% in cats, 75% in dogs, 11-36% in pigs, 11-61% in goats, and less than 10% in cows. The prevalence of Toxoplasma antibodies in pregnant women in

Jakarta was 14.3%, and in 50 women who had aborted the seroprevalence was 67.8%. Positive serology is indicative of prior exposure but does not necessarily provide clear evidence of a causal role for the organism in any disease or adverse outcome. It is therefore difficult to interpret the serological findings with respect to impact on public health and particularly congenital disease in pregnant women. There is some evidence to suggest that no significant difference exists in serostatus between women with or without histories of habitual abortions or stillbirths.

Evidence from Poland indicated that specific IgG antibody was found in 41.3% (95% CI 39.9–42.7) of pregnant women with an annual seroconversion rate of 0.7% (95% CI 0.004–0.010). The risk of primary infection was estimated to be 0.5% for 9 months, i.e., an incidence of 5⁄1000 pregnancies. Assuming a 30% maternofetal transmission rate, 1.5⁄1000 neonates were infected in utero, this being an estimate of the risk of disease in people. Dr Purba (Sub-Directorate of Zoonoses, MoH) estimated the incidence of congenital toxoplasmosis in pregnant women to be 5 cases per 1000 pregnant women. This is consistent with the above figure estimated for Poland.

The following section is reproduced from the ARC/NHMRC Research Network for Parasitology[4]:

> “Seroprevalence of toxoplasmosis in Australia is 30-40% and the rate of congenital Toxoplasma infection in Australia is 0.2%-0.5%. This means that 6-8 million Australians are currently infected and 500 - 1, 250 pregnancies a year are affected (Federation of Australian Scientific and Technological Societies report, 2002). Congenital infection often results in foetal losses or severe disabilities in the newborn child. Of congenitally infected babies without symptoms at birth, three-quarters will later develop severe mental retardation and/or hearing defects and as many as 90% will suffer eye problems as they grow older, which results in a huge drain on the public health system. Furthermore, immunocompromised patients (e.g. AIDS patients or those undergoing immunosuppressive drug therapy for cancer or for organ transplantation) infected with Toxoplasma are at a high risk of developing fatal encephalitis. The estimated cost in Australia, of human toxoplasmosis alone, is $1 billion/year.”

Dr Wyan Artama (Gadja Mada University) leads an active research program into aspects of Toxoplasmosis and Dr Darminto (Balitvet) indicated that Balitvet is involved in collaborative research with Dr Wyan. Balitvet researchers have been involved in the development of an ELISA for detection of anti-Toxoplasma antibodies. There is interest in continuing this work to allow development of a test that can distinguish between acute and chronic infections. Identification of recent exposure in pregnant women would allow clarification of risk as opposed to historical exposure that may have occurred well before the pregnancy which would not be associated with any risk. IgM response to exposure typically appears sooner and disappears faster than the IgG response but some individuals can have persistent IgM responses to infection. More recently researchers have assessed the value of IgG assays that measure avidity or net antigen binding force of the antibody. IgG avidity is initially low after primary antigen challenge and then rises over time. Anti-Toxoplasma IgG avidity assays appear to offer potential to differentiate recent infection from chronic exposure and there is interest amongst Balitvet researchers in working towards the development of this capability.

There have also been discussions held between Balitvet researchers and Dr JP Dubey (USDA, Beltsville Agricultural Research Center, USA) concerning the development and application of PCR testing for Toxoplasmosis with particular interest in molecular typing of Toxoplasmosis isolates. These techniques have application in determining for example

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[4] http://www.parasite.org.au/arcnet/2006/communication.shtml

whether there are associations between sheep or goat or chicken isolates and human disease and identification of risk pathways for human exposure and disease.

7.7 Other diseases that were considered

7.7.1 Bovine tuberculosis

Human tuberculosis due to Mycobacterium tuberculosis is a major problem worldwide and in Indonesia.

Bovine tuberculosis is a disease of cattle caused by *Mycobacterium bovis*. Cattle and buffalo are considered to be the maintenance hosts for *M. bovis*. Infections have also been described in numerous other domestic and wild animals. Most of these species are considered to be spill–over hosts; however, some can act as wildlife reservoirs including possums in New Zealand, badgers in the UK and Ireland, deer in the USA, bison in Canada and antelope species in Africa.

Human infection with bovine tuberculosis is a problem where the prevalence of the disease in cattle is high. *M. bovis* can infect humans, primarily by ingestion of raw (unpasteurized) milk or dairy products but also through aerosols and breaks in the skin. Infections in humans may result in asymptomatic infections, pulmonary tuberculosis, or disseminated infections. The symptoms of pulmonary infection in people can include fever, cough, chest pain, cavitation, hemoptysis, and fibrosis. Untreated infections may be fatal.

In developed countries, eradication efforts have significantly reduced the prevalence of this disease, but reservoirs in wildlife make complete eradication difficult. Bovine tuberculosis is still common in less developed countries, and economic losses can occur in cattle and African buffalo from deaths, chronic disease, and trade restrictions. Infections may also be a serious threat to endangered species.

Bovine tuberculosis is usually a chronic debilitating disease, but can occasionally be acute and rapidly progressive. Early infections are often asymptomatic in cattle. In the late stages, common symptoms include progressive emaciation, a low–grade fluctuating fever, weakness, and inappetence.

Bovine tuberculosis is often a sporadic disease, with many infections confined to one or two animals in a herd. In two studies of transmission from naturally infected reactor cattle, 0–40% of susceptible contacts became infected and 0–10% developed gross lesions. The severity of disease varies with the dose of infectious organisms and individual immunity. Infected animals may remain asymptomatic, become ill only after stress or in old age, or develop a fatal, chronically debilitating disease.

Tuberculosis can be difficult to diagnose based only on the clinical signs. In developed countries, few infections become symptomatic; most are diagnosed by routine testing or found at the slaughterhouse.

There appears to be very little data on bovine tuberculosis in livestock in Indonesia. DIC staff from Yogyakarta and Denpasar indicated that they do not perform any testing of samples from livestock for Mycobacterium and there is no control program in place that involves performing disease testing on live animals using procedures such as the skin-fold or tuberculin test.

Human tuberculosis due to *Mycobacterium tuberculosis* is a major problem in Indonesia and there is a very large amount of effort being directed at control of this disease in people. While bovine tuberculosis is capable of causing disease in people, there are no data generated within the MoH on human cases of tuberculosis that can provide any information as to whether any cases of human tuberculosis may be due to *Mycobacterium bovis* and not *Mycobacterium tuberculosis*.

It is understood that tuberculosis cultures are not widely available in Indonesia, and that laboratories who are offering cultures may not have validated quality assurance systems in place. The WHO Supranational TB Reference Laboratory in Australia (The Institute of Medical and Veterinary Services in Adelaide), is currently assisting WHO to strengthen the laboratory-based diagnostic services in Indonesia. A recent Australian-led TB project in Timika, Papua Province cultured 107 sputum samples from people who were positive on TB screening tests. A total of 101 samples were positive for *Mycobacterium tuberculosis* and none were positive for *Mycobacterium bovis*. This finding is consistent with studies in other settings with a high burden of human TB where evidence suggests that *M. bovis* is typically a very minor component of TB in humans.

Further work in the form of baseline surveys is necessary to establish the presence/absence, extent and severity of bovine tuberculosis infection in Indonesia.

7.7.2 Echinococcus

There is very little available information concerning echinococcus in Indonesia and it is not possible to draw any conclusion about the presence or absence of the disease and its impact on livestock or human health.

Anecdotal evidence suggests that the disease in humans is rarely reported in Indonesia and this may be interpreted as supporting a hypothesis that the disease is rare or not present. Dr Wilfried Purba (Sub-Directorate of Zoonoses, MoH) indicated that cystic echinococcus (CE) was known to occur in Sulawesi but that there was no data on prevalence.

Further work is required in the form of an initial survey to determine whether CE is present and causing disease in livestock and people.

7.7.3 Japanese encephalitis

Japanese encephalitis is caused by a flavivirus called Japanese encephalitis virus (JE), commonly transmitted by rice field breeding mosquitoes (primarily the *Culex tritaeniorhynchus* group). Mosquitoes become infected by feeding on domestic pigs and wild birds infected with the JE virus. Infected mosquitoes then transmit the Japanese encephalitis virus to humans and animals during the feeding process.

Japanese encephalitis virus is NOT transmitted from person-to-person. Only domestic pigs and wild birds act as reservoirs of the virus. Birds are the natural hosts for Japanese encephalitis. Epidemics occur when the virus is brought into the peri-domestic environment where there are pigs, which serve as amplification hosts, infecting more mosquitoes which then may infect humans. JE epidemics usually do not last more than a couple of months, dying out after the majority of the pig amplifying hosts have recovered from infection.

Japanese encephalitis is the leading cause of viral encephalitis in Asia with 30-50,000 cases reported annually and a case fatality rate ranging from 1 to 60%.

JE virus is capable of causing disease in infected pigs, resulting in a range of symptoms including stillbirth, mummification, embryonic death, and infertility, and encephalitis in horses. However, it is believed that JE virus does not commonly cause clinical disease in pigs and that most commonly pigs act as amplifying hosts only to raise the risk of mosquitoes then acquiring infection and transmitting it to humans.

There is ample evidence indicating that JE is an important cause of disease in humans in Indonesia.

Animal health agencies and DICs do not appear to be testing livestock for JE virus and there is little or no data confirming that the virus is circulating within livestock populations (particularly pigs) and similarly no data to indicate whether the virus may be causing clinical disease if it is present. Currently JE virus remains a focus area for MoH staff and not for animal health agencies.

Further work in the form of baseline surveys is required in order to establish whether JE virus is circulating within livestock populations and whether it is causing any clinical disease or impact on health and productivity. This work is necessary before any decision can be made on directing animal health resource towards this condition in livestock.

7.7.4 Leptospirosis

Leptospirosis is a worldwide zoonotic disease of domestic animals and wildlife. It is caused by a spirochete bacteria classified under the genus Leptospira, of which there are ~17 species. The same disease processes are seen in all animals, although some species are more resistant to acute infections. Infections may be asymptomatic or cause various signs, including fever, icterus, haemoglobinuria, renal failure, infertility, abortion, and death.
Infection is commonly acquired by contact of skin or mucous membranes with urine and, to a lesser extent, by intake of urine-contaminated feed or water. Humans are susceptible to all pathogenic serovars found in domestic animals, and transmission from wildlife generally occurs after contact with tissues of infected animals or surface waters contaminated by urine from infected animals.

Leptospirosis infection of people is reported in Indonesia and there was a surge in cases in the Jakarta area in early 2007 following severe flooding in the city and surrounding area. There is no routine testing being performed on livestock for Leptospirosis at the Yogyakarta DIC. The Denpasar DIC does not routinely perform Leptospirosis testing either though they have been involved in a cross-sectional survey of cattle in Bali in 1988 when all samples were negative. Since that time there have been sporadic cases diagnosed in dogs in Bali.

There is therefore little data on which to make conclusions about the presence or absence of Leptospirosis in livestock in Indonesia. Human cases appear likely to be the result of exposure to organisms being carried by rodents and other carnivores and not necessarily by livestock. Available information suggests that leptospirosis in Indonesia is more a problem of rodents and people as opposed to a livestock disease issue with a zoonotic impact. However, it is acknowledged that this assessment is based on anecdotal information and further work would be required in the form of an initial survey to determine whether Leptospirosis is present and causing disease in livestock and acting as a zoonosis from livestock to people.

7.7.5 Salmonellosis

Salmonella is a ubiquitous gram-negative bacteria of which more than 2400 serotypes have been identified.

All domestic and wild animals are at risk of contracting salmonellosis. The disease also spreads easily from animals to humans. While some serotypes of salmonella may only infect a single species of animal or bird, most serotypes are capable of infecting a wide variety of animals and birds. Salmonellosis usually affects the intestinal tract and causes severe diarrhoea, often ending in the death of animals. Some types of salmonella bacteria will cause infection of other organs. For example, salmonellosis, caused by *Salmonella* *dublin* in calves, is often confused with pneumonia. Some species of Salmonella may cause abortion. A notable feature of salmonella bacteria is that they will often invade a bird or animal, which then becomes a carrier of the disease. Carrier animals appear normal or to have recovered from disease but shed the bacteria into their surroundings through manure, saliva and discharges.

Fortunately, salmonella bacteria are usually opportunistic and do not often cause disease in healthy, vigorous animals. Animals develop salmonella infections when their immune defences are lowered or when they are subjected to various stressors such as malnutrition, transportation, extremes of weather, poor ventilation, filthy surroundings, co-existing disease, a lack of clean water, surgery, treatment with drugs, starvation, mixing with other animals, or the stress of giving birth.

The majority of cases in people are sporadic with occasional outbreaks. Transmission mainly occurs by ingestion of contaminated food, mainly of animal origin, or faecal contamination from an infected person or animal. Illness is characterised by watery and sometimes bloody diarrhoea, abdominal pain, headache, nausea, vomiting, and fever. Complications include septicaemia or focal infection e.g. septic arthritis.

In the last two decades *Salmonella enterica* serotype Enteritidis has emerged as an important cause of human illness worldwide. In some cases the source of this particular organism has been identified as shell eggs and chicken meat while there is also evidence emerging more recently to implicate a variety of rodents and other household vermin as potential reservoirs of infection. In the last several years there has apparently been a dramatic increase in the number of human *S. enteritidis* cases in people returning to Australia from Bali, raising concerns over the level of exposure in Indonesia. It is not clear whether there is any disease issue in the poultry and this may be primarily a food-safety issue.

DIC staff are involved in surveillance programs aimed at sampling various levels in the food chain particularly in the poultry industry to assess the presence of salmonellosis. Samples include cloacal swabs for microbial culture from live birds as well as blood samples for serological testing and culture swabs taken from meat and egg products. Most or all of the sampling done by DIC staff in this surveillance process is from apparently healthy animals. There appears to be little information to determine whether salmonella organisms may be causing clinical disease in birds or other livestock though there was recognition that farmers may be likely to conceal such disease expression to try and avoid any official constraint or response. When DIC testing reveals a positive result, the test results are communicated to DGLS staff for follow-up at the farm level.

These results indicate that Group D Salmonella organisms can be identified in poultry as well as in livestock in Indonesia. It seems highly likely that there will be other serotypes of salmonellae present within Indonesian livestock systems and that there may be some expression of clinical disease in poultry and livestock associated with salmonella infection.

There is also strong anecdotal evidence that poultry farmers (and potentially other livestock farmers) source and use antibiotics to medicate animals in an attempt to keep diseases such as salmonellosis under control. DIC staff estimated that up to 75% of commercial poultry farms use antibiotic in broilers for control of salmonellosis. There is also anecdotal evidence indicating that most of the isolates of *E.coli* from human diarrhoea cases are resistant to many commonly used antibiotics, raising concerns about indiscriminate use of antibiotic leading to an antibiotic resistance problem.

There does not appear to be any valid information to document salmonellosis as a cause of morbidity or mortality in livestock including broiler and layer segments of the industry though it seems reasonable to assume from general knowledge of the organism and its impact on livestock elsewhere that some disease may be present.

There is insufficient data to prioritise salmonellosis as a zoonotic disease that requires specific investment in Indonesia. Further research is necessary in the form of initial surveys to determine the presence of salmonellosis and whether it is associated with adverse impacts on livestock health and production as well as human health.

7.7.6 Scabies

There appears to be very little data on Scabies in Indonesia though a number of people from MoH and MoA indicated that it was a problem in some areas of the country. No data could be obtained to allow any estimate of prevalence in animal or human populations. There was anecdotal information indicating that scabies was commonly observed in dogs and goats and occasionally in people. There was also evidence that there was growing awareness of the efficacy of ivermectin as a treatment for scabies in animals and as a result the condition was perhaps becoming less common.

Balitvet researchers indicated that Scabies infestation could quite rapidly result in death of goats if left untreated (within 1-2 months) and that ivermectin treatment while effective may not be either available or affordable for sections of the country. Control programs involving mass treatment of goats with ivermectin have been initiated in some areas such as Lombok Island but such activities do not appear to be widespread. There was discussion of a need to investigate alternative methods of treatment that might be effective and cheaper or more readily available than ivermectin. There also appears to be variability in commitment to treatment since animal health providers are accustomed in some areas to making income either from selling treatments or by buying infected animals cheaply then treating them and selling them at a profit.

It is understood that scabies mites from humans, dogs and other animals (e.g. wombats, wallabies and foxes) are all genetically distinct. Furthermore scabies mites from animals do not cause persistent infestation or reproduce on humans. At most scabies mites from animals appear to cause short lasting irritation on people. As a result the available evidence tends to suggest that scabies is not as important a zoonotic disease in Indonesia as other disease covered in this report.

7.7.7 Trichinellosis

Trichinellosis is a disease caused by parasitic nematodes from the genus Trichinella. Within the genus are eight recognised species, and three genotypes that are yet to be given a taxonomic grouping. Humans have been infected by *T. spiralis, T. nativa, T. britovi, T. nelsoni, Trichinella T6* and *T. murrelli. T. spiralis* is the major cause of trichinellosis in humans largely due to the high numbers of larvae that are produced by this species which can then circulate within the host.

Human infections are established by consumption of insufficiently cooked infected meat, usually pork or bear, although other species have been implicated. Natural infections occur in wild carnivores; trichinellosis has also been found in horses, rats, beavers, opossums, walruses, whales, and meat-eating birds. Most mammals are susceptible.
In humans, initial symptoms of the disease include general discomfort, fever, chills, excessive sweating and occasionally diarrhoea. The disease may then progress to include facial oedema, muscle pains, and localised haemorrhages in small blood vessels below the skin, in the conjunctiva of the eye and in the nail beds. Symptoms can last for several weeks and further cardiovascular and neurological complications can occur. In severe cases these complications have led to deaths, but this is rare. Clinical disease is treated medically with anthelmintics and may be treated simultaneously with glucocorticoids.

Most infections in domestic and wild animals go undiagnosed. Trichinellosis is therefore primarily an issue affecting market access and food safety and not an important cause of adverse impacts on livestock health and productivity.

There appears to be little or no data present on Trichinellosis in Indonesia. Dr Wilfried Purba (Sub-Directorate of Zoonoses, MoH) indicated that he considered trichinellosis to be present in Indonesia but there was no data to establish prevalence or geographic distribution.

Further work is required in the form of an initial survey to establish the presence, extent and impact of trichinellosis in Indonesia. This is considered to be a lower priority under the terms of reference for this project given that the condition appears less likely to result in adverse impacts on livestock health and productivity.

8 Measures of impact of zoonotic diseases

Six diseases were identified as high priority based on findings from a combination of literature review, review of available data from Indonesia on disease prevalence and from discussions with various individuals within Indonesia and elsewhere. The selected diseases were:

- avian influenza
- anthrax
- bovine brucellosis
- taeniasis/cysticercosis
- toxoplasmosis
- rabies.

An attempt was then made to complete impact assessments for these six priority diseases using a combination of different approaches to develop measures of impact of zoonotic diseases on livestock and public health.

Other diseases that were included in an initial list of diseases were not subjected to a detailed impact assessment. In some cases this was because there was insufficient data or information available to estimate whether the diseases were present or to attempt to assess their impact. In other cases diseases were assessed as being unlikely to have any adverse impact on livestock health or production.

8.1 Prioritisation of animal diseases using the ILRI approach

This section describes the use of a modified form of the scoring system developed by The International Livestock Research Institute (ILRI) and published by Perry et al (2002) to compare the impact of livestock diseases. The ILRI methodology uses objective data with regard to incidence with subjective data that identifies the potential importance of the disease to farming systems, farm profitability, external effects (such as trade) and human effects. It is regarded as a useful way of including a range of relevant social, economic and technical factors in the disease prioritization process. The scoring method outlined by Perry et al (2002) was developed as a means of assessing impact of different diseases on poor producers in the developing world. It was designed to allow comparative assessment of different diseases and contribute to prioritisation of research investment aimed at poverty alleviation.

The ranking is based on scored impacts on socio-economic and zoonotic outcomes. The methodology is well described in the report by Perry et al (2002) and has been reproduced in an Excel spreadsheet during the course of this project. The following brief description of the methodology is taken directly from the description in Chapter 2 of Perry et al (2002).

The ILRI method assesses each disease on three types of impact:

- Socio-economic
- Zoonotic
- National

Specific criteria were developed for measuring impacts and each criterion was scored on a scale of 0-5 with five representing the most severe type of impact. Scores were then combined to produce a single composite index to allow comparative assessment of different diseases.

Economic impact was assessed as expected production losses, which are assessed through estimates of annual disease occurrence, disease impact on affected herds/flocks and control costs incurred by smallholders measured as the proportion of livestock health expenditure allocated to that disease. In many cases smallholders invest relatively little in controlling diseases and control costs are therefore assigned a weight of 15% vs 70% for production losses in terms of impact.

National impacts were defined as impacts beyond the individual smallholder level that also affect the smallholder. These are comprised of the effects of disease on livestock marketing opportunities and on the amount of public expenditure directed at the poor.

The criterion-specific scores are then combined using weightings (0.7 for production impacts, 0.15 for control costs, 0.1 for market impacts and 0.05 for impacts on public expenditure), to produce an overall socio-economic impact score.

The ILRI method also incorporated an adjustment of the socio-economic score to adjust scores associated with different diseases that affect different animal species. This was intended to be based on a ranking of the relative importance of different livestock species to smallholders in different regions. After some discussion we chose to remove this adjustment and to report an unadjusted socio-economic score. This means that calculations assume that all animal species are of equal importance to livestock holders. It is accepted that in particular situations individual smallholders may be more dependent on one livestock species than another but at the national level the assumption of equal importance was deemed to be appropriate.

Estimates of the percentage of herds or flocks affected each year were derived from a combination of published material on prevalence or incidence and on data and other information collected during the course of the project. Denominator data on animal and human population estimates were derived from the 2006 Statistik Peternakan[5] publication and from the Statistics Indonesia web site[6]. The approach taken and the assumptions made for disease occurrence are outlined here.

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[5] *Statistik Peternakan 2006. Direktorat Jenderal Peternakan, Jakarta, 2006*
[6] http://www.datastatistik-indonesia.com/component/option,com_staticxt/staticfile,depan.php/Itemid,17/

8.1.1 Anthrax

All herbivores were assumed to be susceptible. The expected number of outbreaks in livestock in any given year was derived from data reported for NTT over a 12 year period and presented in a recent ACIAR report (Christie, 2007). This was used as a base estimate of outbreak occurrence that was then applied on a population weighted basis to other areas of the country. Each outbreak was assumed to involve 1.2 herds and each herd was assumed to contain 4 animals.

8.1.2 Assumptions for diseases of interest

Avian influenza

The total number of outbreaks in each region of Indonesia was derived from data obtained from FAO for 2006.

- Village chicken:
  - unit of interest = village
  - number of chickens per unit= 30
  - number of units affected in any one outbreak = 5
  - multiplier to reflect underreporting= 1.5
  - village chickens (sector 4) were assumed to account for 75% of all outbreaks with the remaining 25% occurring in sector 3 of the poultry industry
- Sector 3 poultry
  - unit of interest = farm
  - number of chickens per unit = 3000
  - number of units affected in any one outbreak=2
  - multiplier to reflect underreporting = 1.15
  - sector 3 chickens were assumed to account for 25% of all outbreaks.

Toxoplasmosis

Cattle, pigs, goats and sheep were assumed to be susceptible and a single estimate of 10% used as the measure of % herds affected in any one year. This measure is a crude estimate of the likely % of animals that may be expected to experience an initial exposure to toxoplasmosis in any one year.

Brucellosis

Brucellosis assessment includes *Brucella abortus* and *Brucella suis* since data collected in Indonesia indicate that there are seropositive test results in cattle and pigs. The prevalence was assumed to be 10% in Java and 1% in most other regions and free (0%) in Kalimantan and Maluku. An overall % of herds likely to be affected (3.4%) in any one year was then derived for the entire country based on region-specific animal population data and disease prevalence.

Cysticercosis/taeniasis

Estimates of the % animals affected in any one year were based on pig data from published literature. An estimate of 50% of animals affected in any one year was used for Papua to reflect the very high risk of exposure in that region. Estimates in other areas included 1% in NTT, 10% in Sumatra and 0% in all other regions of the country. An overall national estimate of the % of pigs affected in any one year was then derived from the above region specific estimates and region specific pig population data.

Rabies

There were no confirmed reports of livestock deaths due to rabies though several people indicated that they were aware of historical cases of occasional deaths in livestock due to rabies. In Indonesia, rabies is predominantly a disease of dogs and people with some cases also occurring in monkeys and cats. While all warm-blooded animals are known to be susceptible to rabies, domestic livestock species (horses, cattle, sheep, goats, pigs) tend to be accidental dead-end hosts and do not play major roles in the epidemiology of the disease. An exception may be wild pigs which under conditions of high density may be a factor in the transmission of the disease[7]. For the purposes of the ILRI assessment it was assumed that 0.01% of animals were exposed to rabies in any one year.

8.1.3 Public health impacts

Public health (zoonotic) impacts were assessed based on the incidence of disease in livestock, extent of human populations at risk and its severity in affected individuals. Zoonotic impacts were adjusted in some cases to reflect particular risk modifying factors for some diseases. Examples of these were toxoplasmosis where almost all clinical disease is experienced by pregnant women. In this case the zoonotic score was adjusted by a weighting to reflect the proportion of the population that were expected to be pregnant in any year (derived from Indonesian statistics on average annual fertility rates for all age groups of women and population estimates for males and females). Zoonosis score adjustments were also performed for Sector 3 poultry operations (commercial operations involving layers or broilers up to about 5000 birds) to reflect the fact that only a small proportion of the human population are associated with these operations, and for taeniasis and brucellosis to reflect the fact that parts of the country are free (or at much lower risk) and therefore only a proportion of the population are at risk.

8.1.4 Scoring

The two main criteria for assessing results were the socio-economic score and the adjusted zoonotic score. The socio-economic score is a comparative measure of the impact of each disease on the livestock sector and the adjusted zoonotic score on the public health sector. The adjusted zoonotic score incorporated the following disease-specific assumptions:

- Anthrax: no change as the entire population was considered to be at risk;
- Avian influenza:
  - For Village chickens there was no adjustment as the entire population was considered to be at risk.
  - In sector 3 poultry the raw zoonotic score was adjusted by weighting for the proportion of the human population that was deemed to be in close contact with Sector 3 poultry farms (estimated as 0.2).
- Toxoplasmosis: adjustment reflected the fact that only pregnant women were considered to be at risk of disease associated with exposure to Toxoplasmosis. National data on human fertility were used to estimate the proportion of the total human population that were likely to be pregnant and therefore at risk on an annual basis.
- Brucellosis: adjustment reflected the fact that some regions of Indonesia were free of Brucellosis and therefore the human population in these regions were not at risk.

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[7] *AUSVETPLAN Disease Strategy Manual for Rabies, 1996.*
http://www.animalhealthaustralia.com.au/programs/eadp/ausvetplan_home.cfm

- Taeniasis: adjustment reflected the fact that only a proportion of the human population was considered at risk of the disease.

The order of ranking of the six diseases based on socio-economic scores (highest to lowest) was brucellosis, toxoplasmosis, cysticercosis, avian influenza, anthrax and rabies. The main factors affecting where diseases ranked appeared to be annual cumulative incidence (% of herds/flocks affected), followed by scores on the various impact criteria.

Toxoplasmosis ranked highly despite scoring either 0.5 or 0 on all impact criteria for socio-economic factors, reflecting the importance of cumulative incidence in driving the summary score. If the cumulative incidence in animals was halved to 5%, then the socio-economic impact score also was reduced by 50% to 1.75. The low adjusted zoonotic score reflects the fact that only a small proportion of the human population may be considered to be at risk of disease due to Toxoplasmosis.

Similarly the low scoring for anthrax reflected the combined effects of lower number of outbreaks and fewer number of animals affected per outbreak compared to avian influenza.

The ranking of the six diseases based on adjusted zoonotic scores was brucellosis, cysticercosis, avian influenza, toxoplasmosis, rabies and anthrax. Cysticercosis ranked relatively highly even though it was assessed as a disease primarily occurring in only two regions of the country (Papua and Sumatra) with a very low number of cases in NTT.

Table 9: Results of impact assessment scoring of selected animal health diseases using methods developed by ILRI (Perry et al 2002)

		Scores	**Anthrax**	**Avian Influenza Village chicken**	**Avian Influenza Sector 3**	**Toxo-plasmosis**	**Bruc-ellosis**	**Cysticercosis/ Taeniasis**	**Rabies**
		Socio-economic impacts	0.51	1.05	1.91	3.50	5.31	2.48	0.30
		Zoonotic impacts	0.0067	0.09	0.83	9.00	5.27	12.05	0.03
		Adjusted zoonotic impacts	0.0067	0.09	0.17	0.13	4.93	0.79	0.03
Criteria	Category								
Socio-economic	A1	% of herds or flocks affected each year (endemic)	na	na	na	10	3.40	7.09	0.01
	A2a	No of years between outbreaks (epidemic)	0.0062	0.0019	0.0042	na	na	na	na
	A2b	% of herds/flocks affected when an outbreak occurs?	0.00001	0.00004	0.0020	na	na	na	na
	B	Impact in affected herds/flocks	5	5	5	0.5	2	0.5	0
	C	Cost of prevention/control to poor producers	0	2	2	0	2	0	0
National	D	Market effects on poor people	4	4	4	0	2	0	2
	E	Current levels of public expenditure?	2	5	5	0	2	0	2
Zoonosis	F	Incidence indicator in people	4	2	2	1	1.5	1	3
	G	Severity of impact in affected people	4	5	5	2	2	3	4
Scoring system									
B	0=negligible, 1=mod reduced prodm, 2=chronic reduced prodn, 3=chronic prodn effects & some deaths, 4=serious prodn effects & deaths, 5=high mortality & severe prodn impact								
C	0=<5%, 1=5 to 20%, 2=21 to 40%, 3=41 to 60%, 4=61 to 80%, 5=81 to 100%								

D	0=none, 1=local restriction & 1 species, 2=movement restriction & export bans, 3=imp risk to other countries & multiple species, 4=stop trade in live animals, 5=stopping of all trade	
E	0=<5%, 1=5 to 20%, 2=21 to 40%, 3=41 to 60%, 4=61 to 80%, 5=81 to 100%	
F	0=not a zoonosis, 1=minor risk to livestock keepers, 2=signif risk to livestock keepers & minor to others, 3=major risk to all in contact with animals or living close,	
	4=major risk to consumers and people in contact with animals, 5=risk fo general public	
G	0=not a zoonosis, 1=minor & easily treated, 2=unpleasant illness & often undiagnosed, 3=serious illness needing extensive treatment & often undiagnosed	
	4=hospitalisation & risk of death & expensive to treat & often undiagnosed, 5=high death rate & expensive to treat & often undiagnosed	
Socio-economic impacts		Endemic: (A1*B*0.7)+C*0.15+D*0.1+E*0.05
		Epidemic: (A2b/A2a*B*0.7)+C*0.15+D*0.1+E*0.05
Zoonotic impacts		Endemic: A1*(F*0.5+G*0.5)
		Epidemic: A2b/A2a*(F*0.5+G*0.5)
Adjusted zoonotic impacts		HPAI Sector 3: multiplied by 0.2 to reflect % pop associated with sector 3 poultry industry
		Toxoplasmosis: multiplied by 0.029 because clinical impact limited mainly to pregnant women
		Brucellosis: multiplied by 0.93 to reflect % population at risk (allow for disease free areas)
		Taeniasis: multiplied by 0.065 to reflect % population at risk

8.2 Prioritisation of public health impacts using DALYs

The Disability-Adjusted Life year (DALY) is a measure of the burden of disease and reflects the total amount of healthy life lost to all causes associated with a particular disease, whether from premature mortality or from varying levels of disability for a period of time.

Five key social preferences or values are incorporated into the DALY:

a. Duration of time lost due to premature mortality, estimated as the difference between the age of death for someone dying of a particular disease and the life expectancy for a healthy individual of the same age
b. Disability weights or degrees of incapacity associated with non-fatal conditions
c. Age-weights which indicate the relative importance of healthy life at different ages
d. Time preference, which indicates the relative value of healthy gains today compared to the value of healthy gains at some time in the future (akin to discounting earnings to account for inflation)
e. Population estimates are based on sums of individual estimates. Two people who lose 10 years each of healthy life are treated the same as one person who loses 20 years.

The years of life lost for a given health state (i) are estimated as:

$$DALY_i = YLL_i + YLD_i$$

YLLi = years of life lost due to premature mortality attributable to health condition i and YLDi is the healthy years of life lost in a population due to disability attributable to health condition i. YLL are estimated with respect to a standard expectation of life at each age. By definition DALYs are a measure of detrimental impact so a smaller value is "better". The burden of disease is simply the sum of DALYs attributable to premature mortality or morbidity.

Individual health conditions are associated with a severity weight indicating the disabling impact of the condition (0=healthy to 1 for dead). The adverse impacts of a health state were determined in part in reference to the definition of disability in the ICIDH. Weights were derived from the judgements of a panel of experts using a person trade-off methodology. In coming to this assessment experts were asked to consider the health condition in an "average social milieu" thus evading any need to account for variations in environment, gender, socio-economic status and culture within which a health condition is actually experienced and allowing the creation of a single, globally applicable severity weight for each health state. This approach has stimulated considerable debate and criticism over aspects of the DALY and yet it has been adopted widely at the international level as a measure of the global burden of specific diseases.

Table 10: Disability weights used in DALY calculations as proposed by Murray (1994)

Degree of morbidity	Disability
Healthy	0
Limited ability to perform at least one activity in one of recreation, education, procreation, occupation	0.096
Limited ability to perform most activities in one area	0.22
Limited ability to perform most activities in 2+ areas	0.4
Limited ability to perform most activities in all areas	0.6
Requires assistance with instrumental activities of daily living (meal preparation, shopping, housework)	0.81
Requires assistance with instrumental activities of daily living (Eating, personal hygiene, toilet use)	0.92
Dead	1

The methodology for estimation of DALYs is well described in publications from WHO, World Bank and in the mainstream scientific literature. The WHO web site includes papers describing the methodology and Excel worksheets containing templates that have formulae already entered and ready for modification to fit additional diseases[8]. Sample spreadsheets were downloaded from this site and modified to suit the purposes of this project. A new template was created for estimation of DALYs and worksheets were then created for each of the six diseases of interest and populated with input values for Indonesia.

The approach used population estimates, age and sex distributions and life expectancy taken from statistics presented for the Indonesian population and sourced from the statistics-Indonesia web site[9].

Assumptions were then made for disease prevalence, severity and disease outcomes based on data and information described elsewhere in this report. For each disease data were sourced from provinces where the disease was more common and where the best quality information appeared to be available. For some diseases annual cumulative incidence estimates were based on WHO data.

Table 11 shows the major assumptions used in the DALY estimates for each disease. The entire Indonesian population was assumed to be equally at risk of exposure to Anthrax, Rabies and Avian Influenza. It is acknowledged that this is a gross over-simplification and that there are areas of the country free of these diseases. However, the proportion of the human population likely to be free from any risk for these diseases was considered to be relatively small and the assumption of equal risk was therefore considered reasonable for the purposes of this model. Toxoplasmosis was assumed to only affect pregnant women and the number of cases was based on an annual estimate of 6.3 million pregnancies across the country and 5 cases per 1000 pregnant women. Disease due to Cysticercosis was assumed to be limited to three regions of Indonesia with estimated proportions of the human population affected in these regions based on extrapolation from a variety of sources as described earlier in this report. Brucellosis was assumed to be more likely to affect people in Java than elsewhere in the country based on estimated animal prevalence figures. Estimates of Avian Influenza cases in humans were based on WHO figures for 2006.

[8] http://www.who.int/healthinfo/bodresources/en/index.html
[9] http://www.datastatistik-indonesia.com/

Each disability weighting was accompanied by an estimated duration in years for determining impact on DALYs. For non-fatal conditions associated with Anthrax, Avian Influenza and Rabies (post-exposure treatments), individuals were assumed to make a full recovery within weeks. Individuals affected with Brucellosis were assumed to have a risk of chronic illness that may last for some years while individuals affected with Toxoplasmosis or Cysticercosis were at risk of having disabilities that may last up to 30 years (most of the lifetime for some affected individuals).

Table 12 presents summary information on DALYs estimated for each of the six priority diseases. The Excel spreadsheets are available on request to allow modification of inputs in a scenario testing or sensitivity analysis approach to explore the impact of changing assumptions.

Table 11: Assumptions used in DALY estimation

Disease	**Anthrax**	**Av Influenza**	**Brucellosis**	**Cysticercosis**	**Rabies**	**Toxo**
Estimated cases	99	100	47,408	343,469	100	31,500
Uniform distribution	yes	yes	no	no	yes	no
% Popn affected		50 deaths per yr	Java: 30 cases per 100,000	Papua: 7.5%	100 fatalities	5 per 1000 preg women
		Remainder: morbidities	Elsewhere: 10 cases per 100,000	Sumatra: 0.5%	1000 post exposure treatment	
				Bali: 0.05%		
				Elsewhere: 0%		
Disability weight	% cases	% cases	% cases	% cases	% cases	% cases
1 (deaths)	10.1	50	2.5	2.5	9.1 (all cases fatal)	10
0.8	9.1	25	30	10	0	10
0.5	80.8	25	0	25	0	20
0.4	0	0	30	22.5	0	20
0.2	0	0	37.5	20	0	20
0.1	0	0	0	0	90.9 (PET)	0
0	0	0	0	20	0	20
Total	100	100	100	100	100	100

Table 12: Summary of DALY estimates for each of six diseases in a simulated province with a total population of 1 million people

Total DALYS									
	Population estimates			DALYs per 1000 population					
Age	Males	Females	Total	Anthrax	Av Influenza	Brucellosis	Cysticercosis	Rabies	Toxo
0-4	9,983,140	9,608,600	19,591,740	0.00215	0.0107	0.3470	0.455	0.0299	4.719
5-14	22,608,836	21,353,115	43,961,951	0.00093	0.0046	0.2026	0.419	0.0322	0.000
15-29	29,396,979	29,931,007	59,327,986	0.00065	0.0032	0.1691	0.410	0.0062	0.000
30-44	24,455,328	24,831,433	49,286,761	0.00069	0.0034	0.1737	0.412	0.0057	0.000
45-59	15,498,584	14,604,755	30,103,339	0.00091	0.0045	0.2002	0.418	0.0025	0.000
60-69	4,791,736	5,110,884	9,902,620	0.00189	0.0094	0.3159	0.448	0.0000	0.000
70+	2,878,916	3,032,975	5,911,891	0.00210	0.0104	0.3408	0.454	0.0000	0.000
Total	109,613,519	108,472,769	218,086,288	0.00098	0.0049	0.2085	0.420	0.0125	0.424

The highest DALYs were observed for cysticercosis, followed by toxoplasmosis, brucellosis, rabies, avian influenza and anthrax.

Sensitivity analyses were then performed to test the impacts of various changes in assumptions on DALY estimates. Cysticercosis remained the most important disease until quite major changes were made for example if Bali and Sumatra were assumed to be free of disease (annual human cumulative incidence = 0 cases), and the proportion of people affected in Papua was reduced to 0.025 (2.5%), and the proportion of cases that die was reduced to 0.01 (1%) and the proportion of cases that had disability weightings of 0.8, 0.5, 0.4, 0.2 reduced to 0.1, 0.2, 0.2, 0.2, respectively, the overall DALY estimate was reduced considerably to 0.525 but this was still the highest estimate for any of the diseases being studied.

If the proportion of the Papua population that was affected was reduced further to 1% and other assumptions remained as described in the above paragraph, then the DALY for Cysticercosis was reduced to 0.42, just below that for Toxoplasmosis.

Toxoplasmosis was classified as the second most important disease from a public health perspective even though disease was limited to pregnant women in the estimation of DALYs.

8.3 Economic analysis of disease impacts

Economic evaluations may take various approaches with choice of an appropriate technique depending on:

- The perspective: Is the level of analysis the smallholder, community region or national level? Usually estimating the costs and benefits of interventions at the commodity or farm level is simpler than undertaking economy-wide analyses. Sophisticated analyses not based on adequate data may prove useless and lead to poor decision-making and policy.
- The purpose: Interventions may be evaluated for different purposes, i.e. verify technical or cost-effectiveness, adoption rates and social effects.
- The extent: If an evaluation does not consider both the costs and the benefits it is a partial, not a full, economic analysis and is usually used to determine the economic loss caused by a particular problem. Also, if it considers both costs and benefits but does not attempt to undertake a comparison with the status quo it is also regarded as a partial analysis.
- Data availability: The level, type and quality of available data are an important determinant of the methodological approach.

In this report the perspective is the smallholder and the purpose is to prioritise the defined zoonotic diseases by incidence and both human and livestock impacts. The extent will vary with the perceived importance of the disease and the data availability.

8.3.1 Data availability

Sourcing appropriate and accurate data in Indonesia is a severe limitation in evaluating economic loss and making meaningful conclusions concerning the benefits of research into zoonotic disease. While it is possible to produce some generic gross margins which can be used to estimate economic loss in livestock, matching this with credible data on human loss has proved difficult. For example brucellosis is regarded as primarily a disease of cattle and Indonesia is undertaking various control and eradication programs through the Ministry of Agriculture. Presence of the disease in livestock should lead to some incidence in humans, but there are no data available to confirm this. While there are data available for Australia, the differences in management systems and human contact with livestock mean that attempts to use these data as a surrogate would be misleading. Brucellosis is not regarded as a priority human disease in Indonesia and hence no accurate data are collected.

Even with significant work being undertaken to accurately ascertain the effects of AI in Indonesia, the whole process is still limited by lack of data. Even data as basic as bird population varies dramatically between sources with FAO estimates ranging from 900 million to 1,218 million birds and the Indonesian Ministry of Agriculture estimating the national poultry flock as 275 million (Rushton et al 2006). The GM constructed for this study are a guide only and must be used only to consider relative profitability and provide a simple means of differentiating and prioritising zoonotic diseases in Indonesia. Apart from the need for more accurate basic data (e.g. population, price, input costs, productivity and mortality ratios) to establish baseline GMs there is also the need to elicit better data with regard to the disease, both for local short term effects (e.g. mortality and birth rates) and more long-term, national effects (e.g. trade and market issues).

There is also variation in level of impact for different diseases. Some disease issues are more focused on local productivity costs and benefits (e.g. anthrax, toxoplasmosis) while other diseases have implications including broader national affects (e.g. brucellosis and AI).

Data for this economic analysis were derived from Indonesian Central Statistics Office (BPS), past economic analysis and local knowledge. Livestock population data used in this analysis (Table 13) were obtained from the BPS (2006).

Table 13: Indonesian livestock population; 2002-2006 (‘000 head)

Livestock type	2002	2003	2004	2005	2006
Beef cattle	11,298	10,504	10,533	10,569	10,836
Dairy cattle	358	374	364	361	382
Buffalo	2,403	2,459	2,403	2,128	2,201
Goat	12,549	12,722	12,781	13,409	14,051
Sheep	7,641	7,811	8,075	8,327	8,543
Pig	5,927	6,151	5,980	6,801	7,087
Horse	419	413	397	387	399
Native/village chicken	275,292	277,357	276,989	278,954	298,432
Layer chicken	78,039	79,206	93,416	84,790	95,478
Broiler chicken	845,075	847,744	778,970	811,189	972,221
Duck	46,001	33,863	32,573	32,405	34,612

Source: BPS (2006)

8.3.2 Gross margins

Gross margins (GM) were constructed for the major livestock enterprises within Indonesia. They are a guide only and should be interpreted with the understanding that situations, prices etc may differ markedly from region to region. It is also important to understand that livestock have other benefits apart from productivity and profit to farmers in Indonesia. For example:

- Village (kampung) chickens play an important role in self-sufficiency and food security. They are not always managed as a profit-making commodity but rather are an available food supply that receive little additional feed (low cost of production) and are often not marketed.

- In the eastern islands, in particular, pigs are an important asset and status symbol. While they are some sometimes sold at a market, the value is largely determined by their use in traditional ceremonies. If a pig is required for a particular ceremony it may be worth as much as a cow – 3 to 4 times its market value.
- Cattle are also an important source of value as an asset and for use in ploughing. Productivity, while important, is often not the most important reason for maintaining cattle.

When there are other non-monetary benefits in raising livestock a gross margin analysis can underestimate the value of these commodities.

Table 14: Basic data – gross margins ($AUD1 = Rp.7,000)

Type	Bali cattle	Goat (breeding)	Layer chicken	Broiler chicken	Pig (breeding)	Goat (fattening)
Herd/flock size	10 cows	5	500	5,000	10	15
Income						
Stock sale ($)	1,590	340	35,000	9,143	570	1,020
Other ($)	570					
A. Total income ($)	2,160	340	35,000	9,143	570	1,020
Costs						
Stock purchase ($)	35	134	150	2,643	71	650
Feed Purchase ($)	0		31,500	5,613	20	108
Veterinary/supplement ($)	30	2	107	174	10	10
Transport ($)	23	9			30	20
Commission ($)	80				30	
Other ($)	30		520	174		70
B. Total Costs ($)	198	145	32,280	8,604	161	858
A-B Gross Margin/year ($)	1,962	195	2,620	3,234*	409	648#
Gross Margin/head ($)	196	39	5.24	0.11	41	10.80

* assumes this enterprise is repeated 6 times per year.
# this enterprise is repeated 4 times per year

This GM analysis cannot be considered in isolation from other analytical techniques in determining priorities for research. What this part of the analysis can provide is some indicative estimates of economic loss caused by the various zoonotic diseases. Logically the diseases that have the largest economic loss would be those with the widest distribution throughout Indonesia (e.g. AI and brucellosis), however when considered on a regional, village or even household level, they may not be as important to the smallholder as more localised diseases. In terms of effects on smallholder income and health, rabies may be important to producers in Flores, anthrax more important to producers in NTB and AI to producers in West Java. In terms of national priorities, which along with poverty alleviation also include international trade and meeting regional biosecurity requirements, brucellosis and AI may be regarded as the most important diseases.

Final rankings of disease priority by the Government of Indonesia must be made with regard to these national, provincial and household priorities and also the estimated costs of eradication and control.

8.3.3 Diseases evaluated

Scabies

Scabies is a small localised issue in some provinces. In NTB some farmers do suffer economic loss as they are unaware of or unable to take advantage of cheap medication. Control requires use of Ivomectin ®, at a cost of Rp.6,000 per dose. This will provide a benefit of approximately Rp.185,000 ($26) per goat; the difference between the market value of a goat affected by scabies (Rp.15,000) and a healthy goat (Rp.200,000). While a significant economic loss to poor smallholders, this is regarded as an issue to be resolved and managed by existing Indonesian animal health programs.

Avian Influenza

There are many economic analyses being undertaken by multilateral and bilateral agencies working on the AI issue in Indonesia. For this reason, this study does not replicate this work but uses the estimates presented by Finzi et al (2006). They stated that:

> "*The disease has seriously affected the poultry industry, with over 16 million birds killed or culled and the consumption of poultry and poultry products has declined rapidly since confirmation of the initial human deaths… Direct losses are estimated at over US$170 million, with the greatest loss registered among an estimated 30 million backyard village farming households raising between 170 and 200 million chickens. An estimated 23% of industrial and commercial farm workers have lost their jobs and 40% of these have been unable to find alternative employment.*"

This report assumes that AI is the major significant zoonotic disease affecting Indonesian livestock at present. It estimates the potential economic loss in kampung chicken industry (the most susceptible) as $120million/year. This is under the assumptions that there are 300,000,000 kampung chickens valued at Rp.30,000/bird with an annual mortality rate caused by AI of 10%. If this mortality was to increase to 20%, and with the government managed culling and compensation program it could increase to an even higher percentage, the economic loss would increase to $240million per year.

Rabies

Coleman (2004) appears to be the first attempt to estimate DALYs for rabies. Due to underreporting of rabies cases, they used a decision tree based on human dog-bite injuries which were routinely reported. Globally there are 35,000 deaths per year of which approximately 30,000 occur in India (WHO 1998). The authors produced an estimate of 1.16 million DALYs, placing rabies as a disease of major importance globally and the authors considered this estimate to be an under-representation of the true burden of rabies due to the level of under reporting (true prevalence in humans in Tanzania may be up to 100 times higher than reported).

Rabies is a regarded as a disease of humans caused through exposures mainly as a result of dog bites though other animal reservoirs may be more important than dogs in different parts of the world. There is a small amount of evidence that rabies affects cattle and other livestock in Indonesia as occasional cases but data are largely non-existent. The most recent data of an outbreak was in Flores Island (NTT). In the 10 years until 2006 there have been 258 cases in animals (all dogs apart from 3 goats, 1 pig and 1 cat). If estimates of underreporting are expected to be similar to Tanzania, this would imply approximately 400 cases in goats and pigs. This study assumes these cases are all goats and that affected goats die. The economic loss is the value of an adult female.

Anthrax

Outbreaks of anthrax are unlikely to have serious livestock productivity effects. The main economic effect may be the decrease in general livestock trade from the area during an outbreak. Their may be a residual period of 2 months after an outbreak where stock movements may decline due to loss of public confidence in animals and animal products from the affected region. The following discussion measures the economic loss as a small breeding cow mortality rate increase and for each case a 20 day loss of labour. The economic loss is defined as the value of a breeding cow in Lombok (NTB); $714. It is believed that people living in endemic areas may self-medicate for cutaneous anthrax and hence the actual number of cases in people may be underreported by as much as 500%. In this analysis where there have been 26 confirmed cases in 5 years, that is 5 confirmed cases per year. If it can be assumed that this is underreported a truer annual incidence estimate may be as high as 25 human cases per year. At Rp.5,000/day this equates to a labour loss of Rp.2,500,000 ($357) per year. In terms of livestock costs, the analysis assumed that each confirmed case causes 3 breeding cow deaths (i.e. 15 cattle per year). This analysis does not include the cost of government managed vaccination programs undertaken after outbreaks. This would add significantly to the cost.

Bovine Brucellosis

In Mongolia (Roth et al 2003) found that in a population where 16% of the population were infected with brucellosis, there were significant benefits to both human health and livestock productivity from an eradication campaign. If there could be a reduction of 52% of brucellosis transmission from cattle to humans there would be a benefit of 49,027 DALYs. With overall costs of US$26.6 million and intervention costs of US$8.3 million there was a benefit cost ratio of 3.2:1 and a net present value (NPV) of US$18.3 million. An analysis was undertaken of a brucellosis eradication program. Indonesia has been successful in eradicating brucellosis in many provinces including Bali and NTB. This analysis used estimated prevalence data from previous analyses undertaken in NTT (Patrick 1998) and Timor island in 1998 (AusVet 1998) and adjusted these analyses using updated gross margin data. It makes assumptions based on the Australian experience of the related human effects as no data on human impacts from bovine brucellosis are available in Indonesia.

The actual productivity effect on Bali cattle (*Bos sondaicus*) of brucellosis is still relatively unknown. In European cattle (*Bos indicus*) it may cause the loss of up to 12 months calf production in affected cattle. Chronically affected cattle are more likely to suffer reproductive problems, further abortions, stillbirths or retained foetal membranes at further matings or pregnancies. These problems may add up to a further 20 per cent calf wastage and loss of production from infected cows for each year after the year of initial infection. In this study it was assumed that an infected cow will have an average calving rate of 60 per cent. This implies that over its productive life (9 years) it will have 6 live calves with a calf mortality rate of 20 per cent. Unaffected cows will have a calving rate of 77 per cent and calf mortality rate of 16 per cent. Table 14 presents the potential economic loss for the scenario presented above. The result indicated that the GM per breeding cow will be reduced by an average of Rp.400,000 (A$57) per year.

There are no data on human incidence. A study undertaken by Geong (unpublished results, 1997) has indicated significant prevalence of Undulant Fever in abattoir workers in NTT (Kab. Belu and TTU). Vaccinators involved in the brucellosis vaccination program in this province were also found to have the disease. A course of antibiotics to control the disease is estimated to cost Rp.140,000 ($20).

Based on the Mongolian data it is assumed that there is a 10% per cent chance of a cattle owner becoming infected. An infected person if untreated will lose 36 days per year in labour costs due to sickness. With labour valued at Rp5,000 per day this is a direct economic loss of Rp.36,000/breeding cow unit per year, approximately 20% of costs. This is an extremely rough estimate and included in order to give some indication of the potential human costs of the disease.

Table 15: Economic impacts of bovine brucellosis in Indonesia

	Without control	**With control**
Calving rate (%)	65	77
Calf mortality rate (%)	29	20
Gross Margin ($/cow)	196	229
Labour cost ($/cow)	5.25	0

The other potential area of benefit and the main reason that brucellosis was controlled in Australia, was the potential for increased trade options. Eradication of brucellosis from the cattle population may allow development of trade options that are not currently available. As most Indonesian provinces presently have brucellosis, the potential benefits to trade are a long way off. It is expected that supplying the local demand (assuming demand will increase again after the monetary crisis) and competing with imports will be the main roles of beef producers in the foreseeable future and that opening up additional trade options may not be as important for Indonesian beef producers. An improvement in domestic market share does not require brucellosis eradication. No national benefits are included in this analysis.

Indonesia is well on the way to eradication of brucellosis from the cattle population. Bovine brucellosis is regarded as a disease primarily of cattle and therefore there tends to be no linkage with the Ministry of Health. This is likely to continue in the future. An analysis undertaken in 1998 for a planned brucellosis eradication program in Timor Island (AusVet 1998) concluded that:

> "*Control can be justified on economic grounds purely through smallholder benefits. Eradication, however; must be justified with regard to broader provincial and national benefits.*" (p.58)

Toxoplasmosis

In this analysis the effects of the disease were evaluated with regard to goats. Evidence suggests that goats (and to a lesser extent sheep and pigs) are the major livestock types affected by the disease. A gross margin for goats (Table 15) is approximately $38 per breeding goat per year. This used a kidding rate of 150% and kid mortality rate of 6%. In a susceptible flock between 3 and 30% of breeding females may abort. There may also be reduced life spans and productivity decreases on the congenitally infected kids. This analysis summarises the effects of Toxoplasmosis as a reduction in kidding rate and an increase in kid mortality (Table 16).

Table 16: Effect of Toxoplasmosis on GM of breeding goat enterprise ($)

		Kidding rate (%)			
		150	145	135	100
Kid mortality rate (%)	6	38.45	36.66	33.07	20.52
	8	37.71	35.55	32.04	19.76
	10	36.16	34.45	31.01	19.00

A worse case scenario on goat production would be a 50% reduction in breeding goat profitability. If this is applied across the Indonesian goat population this could mean a minimum economic loss of $202,000 and a maximum of $1.97 million. The average economic loss in infected goats per head is $10. This uses an Indonesian goat population data of 14 million goats (BPS, 2006). Of these it is assumed that 40% are fattening enterprises and hence not included and of the remainder only 40% are breeding goats, the rest are bucks and kids. This implies a susceptible population of 3.36 million goats within Indonesia.

The human affects are not included in this analysis as they are regarded as predominantly quality of life rather than productivity issues. These are better estimated by using a DALY.

Cysticercosis / Taeniasis

Cysticercosis is a particular problem in areas with high populations of pigs and close proximity to humans. There is evidence of disease problem in Bali and in particular Papua. This analysis considers the impact of Cysticercosis on the pig productivity and makes estimates as to the potential effect on labour productivity. Cysticercosis may be more important as a human health and welfare issue rather than animal productivity or health and therefore, may be better analysed using the DALY.

There is evidence of prevalence in pigs ranging from 20 to 50% with a moderate impact on productivity and saleability. This analysis assumes a 10% reduction in birth rate, 15% increase in piglet deaths and a 10% reduction in piglet value as an estimation of moderate effects. It must be remembered that in some areas such as Papua, market price is rarely a useful estimator of pig value. Using the above assumptions pig GM is reduced from $41/sow to $27/sow, a 30% reduction.

The prevalence in humans is estimated at 10% with only 5% of these suffering debilitating illnesses. With a population of approximately 2.6 million this equates to about 13,000 human suffering the effects of Cysticercosis. As with other diseases this analysis assumes that this will lead to a decrease in productivity of 30 days per year per adult affected at a cost of Rp.5,000/day. Of the 13,000 cases it is assumed 1 in 3 are adult. Not including welfare effects or medication, the effect on human productivity, therefore, is $92,850. This is added to the livestock loss for a total economic loss of $330,850.

Table 17: Economic loss estimations for the major zoonotic diseases in Indonesia

	Livestock type at risk[10]	**Livestock population at risk**	**Livestock Incidence/ prevalence (%)**	**Human health costs included**	**Economic loss per head (A$/yr)**	**Economic loss population (A$/yr)**	**Economic importance[11]**	**Human importance**	**Livestock importance**
Avian Influenza (H5N1)[12]	Chickens (kampung)	300,000,000	10	no	4	120,000,000	NPL	✓✓✓✓	✓✓✓
Rabies	Goats (adult females)	24,000[13]	0.02	no	100	4,800	PL	✓✓✓✓	✓
Anthrax	Cattle (breeding cows)	184,000[14]	0.000115	yes	738	10,900	L	✓✓✓	✓
Brucellosis	Cattle (breeding cows)	3,920,000[16]	10	yes	57	22,334,000	NPL	✓✓	✓✓✓
Toxoplasmosis	Goats (adult females)	3,370,000	0.03	no	10	1,011,000	NPL	✓✓	✓✓
Cysticercosis, Taeniasis	Pigs (sow)	56,600[17]	30	yes	14	330,850	L	✓✓	✓✓

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[10] *This is not the only species at risk but, for simplicity, are the only species included in this analysis*
[11] *N=National, P=Provincial, L=Local*
[12] *Economic loss information is taken from Finzi et al (2006), US$1 = A$0.70*
[13] *At present the best data on rabies incidence is in Flores, therefore, this island is used as a case study. NTT goat population is 498,348, we are assuming 30% on Flores, 40% are goats for fattening and 40% of the remainder are adult females.*
[14] *This analysis is undertaken for an anthrax endemic area; NTB. There are 460,000 head in NTB, 40% of which are breeding females.*
[15] *There have been 5 cases reported per year in the last 5 years, if only 1 in 4 cases is reported, this means 20 human cases per year. 20 human cases assumes 3 cattle die per case. A total of 60 cattle/year in endemic area.*
[16] *Total beef population is 10.8 million, however Bali and NTB are free, and 40% are breeding cows*
[17] *The population of pigs in Papua is 566,000 of which 1 in 10 is a sow.*

8.4 Degree of threat to Australia

The Northern Australia Quarantine Strategy (NAQS) has completed a semi-qualitative risk analysis of disease threats to animal species from northern neighbours. The methodology involved assessment of disease characteristics, likelihood of entry into Australia, likelihood of establishment and consequences. Of the 29 diseases under consideration by NAQS, the only ones that were also included in the list of six priority zoonotic diseases for Indonesia developed during this project were avian influenza, rabies and taeniasis/cysticercosis. Most of the remaining diseases from the NAQS list were either not zoonotic (diseases such as foot-and-mouth disease) or were not considered important in Indonesia (West Nile Virus) or had insufficient data in Indonesia to allow accurate determination of impact (trichinellosis).

Other diseases from the list in Table 1 are also recognised as being important in Australia.

Anthrax is a notifiable disease in Australia and the AUSVETPLAN strategy for Anthrax was the first such strategy developed for an animal disease already present in Australia[18] [19]. Anthrax is uncommon in Australia and is classified as a Category 3 emergency animal disease in the Government and Livestock Industry Cost Sharing Deed In Respect of Emergency Animal Disease Responses (EAD Response Agreement).

Brucella abortus (bovine Brucellosis), *B. suis* (swine Brucellosis) and *B. melitensis* (Malta fever) are all nationally notifiable diseases in Australia. Australia is free from *Brucella abortus*, and *Brucella melitensis* and continues to experience cases of disease due to *Brucella suis*.

Toxoplasmosis is the only disease from the list of six priority zoonotic diseases for Indonesia (see Table 1) that is not currently a notifiable disease in Australia. Toxoplasmosis is known to occur in Australian animal and human populations.

A recent report has also been completed on risk assessment of infectious disease entry in northern Australia from a public health perspective (Merianos et al 2006). The following conclusions were made in this report:

- economic burden of emerging zoonoses often falls disproportionately on the rural sector and the poor because of their greater risk of exposure to diseases of livestock and wildlife and pre-existing urban-rural socioeconomic inequalities.
- lack of surveillance data on emerging zoonoses from many developing countries means that the burden of human, livestock and wildlife disease is underestimated and opportunities for control interventions thereby limited.
- Australia is potentially vulnerable to emerging diseases from our northern neighbours – in particular the eastern archipelago of Indonesia, PNG and Timor-Leste – as well as local emergence through the interactions between humans, livestock animals, wildlife and vectors. Northern Australia is considered at higher risk of the introduction of such exotic diseases because of its proximity to Asia where a significant proportion of newly identified diseases have emerged in the last 30 years.
- Dengue fever, Japanese encephalitis and chikungunya viruses, malaria and multi-drug resistant tuberculosis (MDR-TB) are endemic in the Asia Pacific Region and all have been confirmed in one or more of PNG, the Indonesian archipelago and Timor-Leste.

[18] http://www.animalhealthaustralia.com.au/programs/eadp/ausvetplan_home.cfm
[19] http://www.animalhealthaustralia.com.au/programs/adsp/nahis/diseases/diseases_home.cfm

- Indonesia is currently experiencing outbreaks of highly pathogenic avian influenza A/H5N1 in humans and a resurgence of poliomyelitis.
- The most immediate risks to northern Australia were identified as Japanese encephalitis, dengue fever, chikungunya and MDR-TB. The introduction of Nipah virus was also identified as a concern with the likely route of introduction through migration and mixing of Pteropus species bat populations.

While the report identified general risk factors, the main disease risks identified from an Australian public health perspective were in association with diseases that were not included in the list of six priority zoonoses from Indonesia.

8.5 Conclusions of disease impact assessment

The three impact assessment methods (ILRI score, DALY, Economic loss) have produced different results for the six selected zoonotic diseases under consideration. Two different results were derived from the ILRI score approach: one called socio-economic impacts was aimed at assessing the impact on livestock and the other called the adjusted zoonotic score was aimed at assessing the impact of diseases on human health. The differences are not surprising given that the three methods have incorporated different underlying assumptions and parameters. All three methods have suffered from a lack of objective data and therefore results need to be interpreted with some caution.

Table 18: Summary of ranks derived from three different methods for zoonotic diseases of importance to Indonesia

	ILRI score ranking		**DALY**	**Economic**	**Overall rank**
Disease	Socio - economic	Adjusted zoonotic			
Anthrax	5	6	6	5	6
Av Influenza	4	3	5	1	4
Brucellosis	1	1	3	2	1
Cysticercosis	3	2	1	4	2
Rabies	6	5	4	6	5
Toxoplasmosis	2	4	2	3	3

The overall rank presented in the last column of Table 18 was derived from the arithmetic average of the ranks of the four component assessments and assumes equal weighting to the four methods.

The methods can be used with some confidence to assign diseases to upper, middle and lower levels of importance. The most important diseases identified through this assessment were Brucellosis and Cysticercosis. Toxoplasmosis and Avian Influenza have been identified as being of middle importance while Anthrax and Rabies may be viewed as being of lower importance. These assessments apply at the national level and it is recognised that at sub-national levels the relative importance of the six identified diseases will vary.

Avian Influenza is an extra-ordinary disease. The assessments performed in this report were based on the actual impact of Avian Influenza at the time this report was compiled. It is recognised that an important part of the impact of the disease was due to the policy of slaughtering of contact animals within a defined margin in relation to an index village in the case of an outbreak. It is also recognised that compliance with stated policy is variable. Finally, additional importance is being placed on Avian Influenza because of the plausible threat of a human pandemic of influenza with associated potential impacts on the world's human and livestock populations.

9 Knowledge gaps and opportunities

There were a number of constraints identified as limiting the ability of animal and human health agencies to address concerns over zoonotic diseases.

There is a paucity of good quality surveillance data in both human health and animal health arenas, due to a combination of lack of resources and variable levels of technical skill and knowledge within the provincial and district level health service providers. Resourcing difficulties are a real constraint on the ability of health staff to conduct structured, active surveillance into specific diseases and in particular limit the number of samples that can be collected and tested in health laboratories.

Decentralisation has led to widely variable levels of resourcing and effective decision making in the animal and human health areas. Some districts appear to have purposefully directed resources away from animal and human health for a variety of reasons. The level of autonomy at the district level under decentralisation means that there is varying and sometimes little incentive for districts to comply with centralised reporting or directives concerning policy relating to disease detection and response. The quality of governance, coordination across sectors or disciplines, and decision making leadership appears to be widely variable.

There are numerous agencies, ministries, directorates, sub-directorates and other structures within the human and animal health spheres such that there is redundancy of equipment and responsibilities, competition for resources and authority, and lack of coordination and integration in making effective decisions.

There appears to be variable and often poor commitment and understanding within the community of the value of effective disease control and biosecurity and even of the risks associated with various diseases and actions. Some high risk behaviours appear to be associated with general poverty such as reports of villagers dressing and eating animals that have died of anthrax, and lack of commitment to disease eradication programs particularly when this might involve purchase of vaccines or other forms of treatment and slaughter of healthy, in-contact animals during a response to a disease outbreak. There is also evidence of lack of community commitment to disease control and eradication efforts for socio-cultural reasons such as reluctance to vaccinate animals and refusal to eradicate dogs in rabies endemic areas because of the perceived value of these animals or fear of side-effects due to vaccination. In other areas effective disease control has also led to unanticipated consequences such as declining cattle numbers in NTB following eradication of bovine brucellosis as farmers realise increased livestock values by selling all their cattle. In addition there are anecdotal reports of the control of Newcastle disease leading to an oversupply of chickens and subsequent decline in smallholder income as a result of lowered death rates. Ready availability of medications has resulted in self-diagnosis and treatment with under-reporting of diseases and increased risk of antibiotic resistance in response to uncontrolled use of antibiotics in poultry and livestock either to improve growth or prevent disease.

There is a huge amount of donor investment being directed into countries like Indonesia with a major increase in this activity in response to avian influenza outbreaks. This has created a number of issues associated with donor fatigue amongst Indonesian health personnel who struggle to get their regular work completed as well as meet with increasing numbers of well meaning donor representatives. In some cases there appears to be the potential for conflict of interest when donors may arrive with specific priorities that are not necessarily well aligned with the particular needs of the country or agency. Donor driven priorities and activities such as selective research or training targets, vertical programs, short-term investments, fly-in-fly-out experts are now being recognised as having an adverse effect on the ability of in-country personnel and agencies to identify problems and develop, implement and monitor effective control or eradication programs. If effort is not directed at developing trust and particularly towards addressing issues of importance to Indonesian stakeholders then there is a risk of loss of interest on the part of the Indonesian collaborating agencies with associated loss of effective participation and failure of the program to achieve any effective outcomes. Development of trust is considered to be dependent on involving local personnel in planning and decision making, responding in a genuine way to expressed needs, and utilising social capital in local areas where possible.

There was very strong interest expressed from almost all people interviewed in Indonesia in investment in applied areas associated with training and extension activities. There was less interest expressed in the term “research” though this seemed to be motivated in part by varied interpretation of the word “research”. Many people seemed to view research as implying fundamental scientific research conducted in a laboratory and not necessarily with any direct relationship to field activities aimed at controlling or eradicating diseases. A typical response to discussions on research needs was negative ie further research is not needed, the technical issues are known. This response may also have been motivated in part by recent experiences with a variety of aid-funded teams travelling within Indonesia, collecting data in research programs and then departing with relatively little attention to Indonesian needs or follow-up communication and collaboration with Indonesian agencies.

There are a number of related issues associated with training of in-country personnel in various skills related to their positions and needs. Training programs that involve short-term or one-off courses without follow-up and with overseas technical experts tend to serve little longer term benefit.

Particular research needs for the six zoonotic diseases identified in this report as being of higher priority for Indonesia are variable. In some cases there is less need for specific technical research since the disease epidemiology and principles of control and eradication may be well known. There may be particular issues associated with understanding the contextual epidemiology of a specific disease within the Indonesian socio-economic, geographical, cultural, climatic and political landscapes. A related issue is understanding how to adapt knowledge of disease control and eradication derived from other countries (including Australia for example) to the Indonesian context to ensure that what is implemented is tailored to the local situation as opposed to attempting to impose methods directly from a completely different context. In other cases there may be particular technical challenges to be overcome such as research to assess the development of and application for oral bait vaccines for rabies that can be effectively delivered in Indonesia. Common themes identified in discussions with Indonesian personnel in animal and human health agencies included:

- the need for a systems approach to implementing methods for surveillance and disease control that are likely to be effective in Indonesia (contextual needs);
- building on strengths and social capital already in existence;
- tailoring activities to specific needs ie technical research where required to address specific questions, adaptive or contextual research and capacity building and training;
- recognition of an almost universal need for improvements in basic surveillance in order to better appreciate the distribution, incidence and impacts of various diseases so that more effective decisions can be made concerning control and eradication.

9.1 Research opportunities and other needs

A number of opportunities have been identified for implementation of research and capacity enhancement activities aimed at directly addressing issues relating to zoonotic diseases in Indonesia. These recommendations are made in a favourable environment following the 2006 Presidential decree outlining the need to increase international collaborations on research and strengthening health and animal health systems and the increasing integration of international aid efforts aimed at improving avian influenza response in Indonesia.

At the same time there is also a need to ensure that resources and activities are planned in a collaborative manner with relevant Indonesian stakeholders to ensure in-country support, drive development and utilisation of social capital and improve the likelihood of successful outcomes. For example it is necessary for projects to be developed in discussion with (registered) the Ministry of Agriculture, particularly the Directorate General of Livestock Service (DGLS) and the Bureau of International Co-operation, and also with the Ministry of National Development Planning (Bappenas).

Visits and discussions held during the course of this project confirmed the high level of interest in Indonesia for effective collaboration focused on local needs while also confirming an increasing frustration and lack of patience with foreign aid programs and technical experts that do not make the effort to focus on outcomes developed through consultation with Indonesian agencies at both national and local levels.

It is apparent that there is considerable geographic heterogeneity in disease distribution and in success of disease control. Examples include:

- cysticercosis where there is limited evidence suggestive of a serious level of disease in Papua and relatively low levels or little data from elsewhere in Indonesia.
- rabies in West Java and Flores island where there are ongoing outbreaks and where attempts to control or eradicate the disease have been unsuccessful to date.
- varied success in controlling anthrax with some islands and areas appearing to have very successfully controlled the disease while others are reported to have cases occurring almost annually.
- success in Nusa Tenggara in eliminating bovine brucellosis from a number of islands. Investigation of factors associated with successful disease control methods in NTT may allow identification of approaches that can be applied in other areas.

There are a variety of factors associated with geographic variability in disease occurrence and control including socio-cultural, economic, climatic, topographical, social capital and others. Research opportunities exist to investigate the reasons for variability and to understand the factors that drive this variability that are amenable to manipulation or to adoption into control programs that can be implemented in different regions in Indonesia.

Issues related to training and skill development for animal and public health personnel were identified as important needs by several people during the in-country information collection stage of this project. Animal health staff at one facility indicated a need for training in how to recognise problems (animal disease issues) and respond to them, indicating a need for development of skills and expertise in surveillance and epidemiology. Training programs need to be developed in close collaboration with Indonesian representatives to ensure that programs deliver desired outcomes and they need to be associated with longer-term mentoring of in-country personnel to ensure opportunities for trainees to apply acquired knowledge in addressing Indonesian problems with expert guidance. Examples of successful programs include SAHMBA, field epidemiology training programs (FETP) in public health, and Phase 2 of ASEAN+3 Emerging Infectious Diseases program.

There is a need for further development of community education and extension activities within Indonesia associated with disease control programs.

A number of research questions were also identified that range from general surveillance issues such as the need for baseline delimiting surveys to establish the incidence/prevalence, distribution and severity of diseases to more specific questions targeted to particular disease issues such as the development of oral bait vaccines for rabies.

9.2 Institutional capacity

9.2.1 Ministry of Agriculture (MoA)

District and Provincial offices of the Directorate General of Livestock Services (DGLS) provide a valuable source of collaborating personnel and also represent a primary target for training programs aimed at developing skills and expertise in veterinary officers, para-veterinary personnel and extension personnel. All activities identified in this report require involvement of MoA personnel at central as well as local government levels to be involved in planning, approval and implementation.

The diagnostic laboratory system is hierarchical with the most advanced technical expertise and equipment level existing at Balitvet.

- Research Institute for Veterinary Science, Bogor, Indonesia (Balitvet). Balitvet is a major source of advanced animal health research expertise in Indonesia particularly in relation to investigation of priority animal diseases. Balitvet serves as a Biosecurity Level 3 reference laboratory for avian influenza and as a national reference laboratory for several other diseases of priority for Indonesia. Balitvet is an important source of technical research expertise for animal diseases.
- Disease Investigation Centres (DICs). There are currently seven DICs with a possible additional two DICs being considered as part of avian influenza response enhancement. DICs are equipped to BSL2 standard and act as a primary source of laboratory and general epidemiological expertise at the sub-national level.
- There are a range of additional diagnostic capabilities existing at the provincial and district and occasionally sub-district level.

The project team met with staff from Balitvet and two DICs (Yogyakarta and Denpasar) and were impressed with the breadth and depth of skills amongst the staff and the level of commitment. The presence of effective networks within the animal health sector and between animal and human health provides a sound foundation of social capital that is considered to be an important contributor to the likelihood of successful outcomes in planning and implementing research and capacity enhancement activities aimed at zoonotic diseases. DICs such as Denpasar have been involved in successful disease control programs and are well placed to act as focal points and potentially as role models in developing approaches that can then be adapted to other areas within Indonesia.

9.2.2 Ministry of Health (MoH)

The National Institute for Health Research and Development (NIHRD) is a major repository of technical research expertise within the MoH and includes specific expertise in medical and biomedical research, epidemiology, anthropology, social science and a range of other disciplines. NIHRD staff tend to focus on research for human diseases that are identified as high priority by central government. Staff also participate in collaborative projects funded by external agencies as well as with local governments.

Comments concerning MoA are also directly applicable to MoH personnel for zoonotic diseases. The Sub-Directorate for Zoonoses within the Directorate of Vector Born Disease Control and the Directorate-General for Communicable Disease Control and Environmental Health, is particularly relevant for the terms of reference for this report. The current head of the Sub-Directorate of Zoonoses (Dr Wilfried Purba) is a veterinarian.

9.2.3 The Eijkman Institute for Molecular Biology

The Eijkman Institute originally served as a research laboratory for pathology and bacteriology and was re-developed in the 1990s as the Eijkman Institute for Molecular Biology. The Institute has established international stature in such arenas as mitochondrial diseases and the study of hemoglobinopathies, and serves as Indonesia's national resource center for genetic testing.

9.2.4 Universities

There are five veterinary faculties in Indonesia:

- Syiah Kuala University, Banda Aceh: smaller school and not strong with respect to research capacity
- Bogor Agricultural University, Bogor, West Java: approximately 100 students per year and a source of research expertise in animal health and production
- Airlangga University, Surabaya, East Java: approximately 150 students per year and a potential source of research expertise in animal health and production
- Gadjah Mada University, Yogoyakarta: 200 students per year. The largest veterinary faculty in Indonesia and co-located with a strong animal science faculty. A major source of research and training expertise in animal health and production. Staff at Gadjah Mada are involved in externally funded research as well as Indonesian funded projects investigating aspects of animal health and diseases.
- Udayana University, Denpasar, Bali: about 80 students per year.

These faculties and Balitvet offer expertise in animal health research and may serve as network facilitators in developing links as required to additional expertise within allied areas such as animal science.

Human health capacity is also located at multiple sites across Indonesia and in particular at:

- Hasanuddin University, Makassar. One of the most prominent medical schools in Indonesia.
- University of Indonesia, Jakarta. The oldest university in Indonesia with strengths across all disciplines and particularly medicine and public health.
- University of Airlangga, Surabaya, East Java.
- The Gadjah Mada University, Yogyakarta. the largest university in Indonesia in terms of student population.
- University of North Sumatra, Medan, Sumatra.
- Udayana University, Denpasar, Bali.

9.2.5 Other providers

The Centre for Indonesian Veterinary Analytical Studies (CIVAS) is a non-government organisation with skills in epidemiology and animal health. CIVAS offers expertise in research and capacity enhancement activities and is currently involved in several research projects as well as delivery of training programs aimed at enhancing skills of animal health personnel in Indonesia.

10 Policy or regulatory constraints for prevention and control

A major constraint to effective prevention and control of zoonotic diseases of livestock can be attributed to the effects of the decentralisation policy commonly known as Otonomi on all levels of government. Movement of responsibilities including budgets from central government to provincial and Kabupaten levels have increased the variability and complexities in decision making and in provision of services. Local governments at the Kabupaten (District) level may now determine the type and scope of Livestock Production and/or Animal Health Services at the District, Sub-District and village levels. Some Districts may elect not to support livestock production or animal health services; others increase and upgrade such services, based on local need or demand. Such changes have the potential to adversely impact animal disease surveillance if for example local government chooses (as some apparently have) to abolish or reorganize Type C laboratories, poskeswan and other service resources as they see fit.

Mounting an effective disease control or response program has as a result of these changes, become more complex particularly where the response may require cooperation across different districts, different levels of government and between different agencies. Under this system it is particularly important that to ensure all levels of government, particularly at provincial and district levels, are supportive of any project or program. Projects that do not obtain such support are highly likely to be unsuccessful.
There are acknowledged deficiencies in the national legal and regulatory framework that interfere with the ability of government and private veterinary services to carry out and enforce emergency disease control measures. For example DGLS staff may not have sufficient regulatory power to complete a number of functions that may be considered critical to effective disease control including: entering affected farms, destruction of livestock (unless authorised by special decree), setting up roadblocks to control livestock movement, closing markets etc. The legislative system appears to be more suited to a centralised government decision making process while the budget and operational responsibilities for livestock health have been moved to local government levels.

It is understandable given the scope and nature of changes resulting from Otonomi that there might be variability in understanding the roles and requirements for an effective animal health system that is managed at the District and Provincial levels. These issues appear to be compounded by a lack of highly trained individuals at appropriate levels in the decision making process, a lack of general training amongst staff and various difficulties in accepting and discharging responsibilities at the local level. Those individuals that have built strong networks between agencies and levels of government, and that have developed a consultative approach to building support for activities and programs, appear to be functioning more effectively.

The experience of the authors in discussing Indonesian animal health issues with individuals in Australia and in Indonesia is that Otonomi has resulted in a “fragmented animal health system that is failing to control important production-limiting and zoonotic diseases”[20] in many areas. This lack of effective implementation of an animal health system is compounded by a lack of suitable training and skills as well as effective leadership.

It is recognised also that Australia has experience and expertise to offer to Indonesia in the development and implementation of legislation and operational guidelines to allow effective management of animal health at local, state and national levels. While it is not necessarily appropriate to suggest that systems developed and adopted in Australia may also be successful in Indonesia, there are lessons from the Australian situation that can be applied to Indonesia. The broader need is for review of the current Animal Health Systems within Indonesia and for adaptation and further development to ensure the system is operating effectively and can manage livestock disease control and prevention.

11 Conclusions and recommendations

11.1 Disease-specific problems

Six priority zoonotic diseases were identified as (listed in alphabetical order): **anthrax, avian influenza, brucellosis, cysticercosis, rabies and toxoplasmosis**.

Three different methods were then used to assess impact for each of the six priority diseases:

1. International Livestock Research Institute (ILRI) scoring system based on scored impacts on socio-economic and zoonotic outcomes. The socio-economic score was a comparative measure of the impact of each disease on the livestock sector and the adjusted zoonotic score on the public health sector.
2. The Disability-Adjusted Life year (DALY) is a measure of the burden of disease borne by humans and reflects the total amount of healthy life lost, to all causes associated with a particular disease, whether from premature mortality or from varying levels of disability for a period of time.
3. Economic analysis of the impacts (in Australian dollars) of the six priority diseases using a gross margin approach.

The findings of the three methods differed perhaps reflecting the fact that they were not directly assessing the same parameters and that each model involved assumptions about different input parameters.

The methods were used to assign diseases to upper, middle and lower levels of importance. The most important diseases identified through this assessment were Brucellosis and Cysticercosis. Toxoplasmosis and Avian Influenza have been identified as being of middle importance while Anthrax and Rabies may be viewed as being of lower importance. These assessments apply at the national level and it is recognised that at sub-national levels the relative importance of the six identified diseases will vary.

It is important to incorporate different information into a decision making process on project prioritisation, including existing capacity, Indonesian priorities (at local and national levels) and likelihood of success, as well as impact ranking based on assessments described in this report.

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[20] Christie, B.M. 2007. A review of animal health research opportunities in Nusa Tenggara Timur and Nusa Tenggara Barat provinces, eastern Indonesia. Canberra, ACIAR Technical Reports No. 65: 33.

The following section outlines disease-specific problems for each of the six priority diseases.

11.1.1 Anthrax

Anthrax cases continue to occur in Indonesia in animals and people, despite an ongoing government program that has continued for over 20 years.

Major issues identified in this consultative process that were considered to be amenable to research and improvement were associated with understanding the current control program and at identifying methods for improvement in raising community awareness of the disease, risks to human and animal health and biosecurity and control measures. These issues are considered to be well suited to one or more projects with an adaptive research focus to investigate why some communities apparently do not heed extension and education programs. There may be direct benefits from implementing a risk-based system of applying control programs (including vaccination) only in areas where cases are known to have occurred.

Anthrax cases are likely to be under-reported across the country and more so for animal cases than human cases. In many areas animal health personnel will use notifications of human cases as an alert which is then followed by investigation of livestock deaths to determine if animals may have died recently from anthrax. There is a need for improved reporting and coordination between animal and public health systems.

Anaphylactic reactions to vaccination amongst goats in particular and possibly sheep, have led to a reduction in smallholder interest in control programs and reluctance to vaccinate livestock. There is a need for research to elucidate the cause and extent of the reaction and for development of an effective anthrax vaccine that can be applied to all livestock without risk of side effects. There are two separate (though related) researchable issues here: the first is the development of a new anthrax vaccine based on sub-unit technology that is capable of producing long-lasting immunity following a single administration; and the second issue is the need to understand the causal factors leading to anaphylactic-like reactions in small ruminants and develop measures to eliminate these.

Coupled with development of an effective vaccine is the need for an effective serological test to determine immunity levels in vaccinated animals.

Anthrax is currently diagnosed using conventional smears of blood or body fluids. There is strong interest in the development of test capability for anthrax that may be applied in the field to assist in rapid diagnosis of anthrax and that could also be applied to animal products including meat for example. The main application identified for such a test is in demonstrating disease freedom in animals and animal products from an area soon after an anthrax outbreak has occurred as a means of increasing public confidence.

There is also interest in development and validation of a test to identify soil contaminated with anthrax spores as a way of monitoring and identifying environmental hot spots. Dr Stan Fenwick, Murdoch University has particular expertise in this area and has discussed these issues with Dr Agung (Denpasar).

11.1.2 Avian influenza

Avian influenza is driving recognition of the need for innovative ways of thinking, cross-sectoral collaborations and commitment and acknowledgement of the non-technical and contextual issues as well as technical requirements.

The Komnas FBPI[21] provides a coordination and facilitation role in the Indonesian national response to H5N1 avian influenza virus and includes six task forces that provide direction on research and development; animal health; human health; vaccination; anti-viral medicines; mass communication and public information. Major international aid agencies contributing to Komnas FBPI include WHO, FAO, UNICEF, World Bank, AusAID, USAID and CIDA. Information on current strategies and issues can be accessed through the Komnas FBPI.

Caution is urged in consideration of further investment in avian influenza mainly because there is already an enormous amount of resource and effort being directed into this disease including a very large-scale, ambitious program currently under development with FAO coordination as well as current projects involving AusAid and ACIAR funding.

11.1.3 Brucellosis

There have been numerous projects in Nusa Tenggara and other eastern regions of Indonesia over the last two to three decades that have involved surveillance for bovine brucellosis and capacity enhancement for control and eradication of the disease. Bovine brucellosis has now been successfully eradicated from some islands in this area while in other areas the program appears to be faltering or failing to achieve successful reduction in prevalence. In many areas it is difficult to determine effectiveness of the eradication program because of a lack of structured surveillance.

The bovine brucellosis control program should be reviewed to allow constraints to achieving eradication to be identified and addressed or removed. This recommendation is supported by the findings of a recent ACIAR report[22].

There is a need to establish whether *B. suis, B. melitensis* and *B. ovis* are present in different regions in Indonesia as well as determination of the distribution and prevalence/incidence of *B. abortus*. This need is best met through structured survey research involving representative sampling followed by assessment of the effectiveness of the control program. This sort of research is a wonderful tool for training purposes and can be used to develop skills and experience for animal and public health personnel at multiple levels while addressing particular needs for disease control.

Individuals and organisations with particular expertise in brucellosis include Dr Maria Geong, the head of the Animal Health Sub-Dinas in NTT. Dr Geong completed her PhD at Murdoch University involving aspects of control of bovine brucellosis. Staff at Balitvet and DICs also have considerable experience in bovine brucellosis research and control.

11.1.4 Cysticerosis

Cysticercosis appears to be a major problem in Papua and there is a paucity of data in other regions of Indonesia. There is a need for structured survey research involving representative sampling followed by development of a disease control program. An important part of any control program will include development of methods for detection of the disease (diagnostic tests) and training of animal and public health providers in disease diagnosis, prevention and control. There are also opportunities for adaptive research into effective methods of community awareness and education as part of a control strategy.

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[21] http://www.komnasfbpi.go.id/aboutus.html
[22] Christie, B.M. 2007. A review of animal health research opportunities in Nusa Tenggara Timur and Nusa Tenggara Barat provinces, eastern Indonesia. Canberra, ACIAR Technical Reports No. 65.

11.1.5 Rabies

Rabies is not generally considered as a disease of livestock. It has the potential to cause disease and death in livestock though the incidence of rabies in cattle and other livestock appears to be very low. Rabies is an important disease of dogs in Indonesia and in some parts of Indonesia dogs may be considered as a food animal. Perhaps a more important consideration is that rabies control or prevention involves the same principles and requirements as for control of other livestock diseases. Therefore investment in rabies control is a way of building general capacity in animal health systems that can be applied to a range of other diseases.

There are overlaps between rabies and anthrax with respect to the need for adaptive research to understand why control programs are effective in some areas and not effective in others and to develop effective methods of communicating with smallholders and other stakeholders about the risks and prevention options as well as public health issues.

There are also a number of more technical research issues that require attention including:

- Sequencing of isolates from clinical cases to allow molecular epidemiology and better understanding of the patterns and factors contributing to spread and persistence of the disease;
- Investigation of sero-positive dogs that are detected in rabies-free areas. While this seems most likely to be the result of movement of animals from areas where rabies vaccination is being carried out, it is also possible that there may be circulating strains of rabies virus that are less pathogenic;
- Investigation into methods for effective killing of wild dogs and understanding why strychnine baiting appears to be less effective than expected at eliminating wild dogs;
- Investigation into feasibility and application of oral bait vaccination as a means of improving vaccination coverage rates in wild or stray dog populations.

11.1.6 Toxoplasmosis

Requirements for toxoplasmosis are identical to those for cysticercosis.

11.2 Management of research at a national level

Disease-specific projects addressing the issues identified above are best developed in a consultative process involving relevant stakeholders (local and national, animal and public health). External expertise could be harnessed to suit particular project requirements and Indonesian personnel in key stakeholder groups could also be selected to play key roles in these projects.

Many of the disease-specific projects involve recurring themes particularly in areas such as disease surveillance, effective control programs including adaptive research to understand factors driving reporting and compliance with control recommendations, and training of animal health staff at different levels in principles of epidemiology and surveillance.

There is also an opportunity to design projects to deliver outcomes against multiple goals for example determine the space-time distribution of taeniasis/cysticercosis in animals and people, identify risk factors, train field staff in principles of surveillance, perform adaptive research on factors influencing understanding of disease and effective control, develop linkages between animal and human health staff and develop policy and legislative support for effective disease control.

The term ***adaptive research*** is used to refer to research that looks at local contextual issues influencing implementation and success of disease control programs. This may include a clear understanding of what the target group(s) prioritised needs are; careful matching of program goals to resources; and incorporating attention to the complex array of socio-cultural, economic, geographic and political constraints that may limit implementation and success of any given project. For example given a particular disease and specific challenges relating to disease control (diagnosis, prevention, control, eradication etc) the choice of a particular test or control strategy may be influenced strongly by local conditions. Adaptive research can be used to determine why some disease control programs succeed and others fail, what the characteristics or attributes are of programs that are more likely to be successful, and what the requirements are for successful programs in a particular local context. The aim is to design a disease control program that is likely to be effective and successful given the particular local constraints that may be active in a given area.

Some projects will be suited for cross-sectoral activities involving Indonesian staff from animal and human health sectors working together. Other projects may have a clear animal health focus such as development of improved vaccination for anthrax. Training in principles of epidemiology, surveillance and disease control could be developed for general application while specific projects may incorporate more specific or detailed training in particular focus areas.

There is considerable potential to leverage additional value from investment in disease-specific research and capacity development by incorporating disease-specific projects under a broader framework. Some of the benefits are associated with delivery of multiple outputs as described above. There may also be efficiency gains in some areas by developing research or training programs that can be applied in multiple locations, adapted to different diseases and delivered to more people at a time. This in turn provides indirect benefits in areas such as development of communication networks and cross-sector linkages between animal and human health personnel or between different segments of animal health.

Involvement of representatives from international agencies (WHO, FAO, AusAid and others) in discussions with senior representatives from Indonesian Ministries (MoA, MoH) offers the potential to harmonise and integrate activities. A strategic planning meeting of these major stakeholders would provide an avenue for reviewing existing activities as well as selecting a small number of priority projects, identifying potential funding sources and then developing project proposals for implementation.

Successful completion of 1 or 2 projects that involve cross-sectoral collaboration, training and capacity enhancement and that address identified priority disease issues, will create momentum for further success.

Strong support was generated through the course of this project for a national framework involving an Indonesian coordinator and an external technical consultant. The national framework approach was identified as a means of involving Indonesian stakeholders from different organisations in an integrated, strategic process that used disease-specific projects to deliver multiple outputs as mentioned above. It is recognised that this sort of framework is likely to be very difficult to develop and sustain and issues surrounding decentralisation in Indonesia may make it even more difficult.

There are varying levels of integration and coordination that may be implemented ranging from involvement of relevant stakeholders in project planning to ensure that selected projects deliver benefits across a range of objectives, to the development of a national framework with in-country staff appointments to assist in coordination and a more structured approach to integration of project planning across different sectors (local to national, animal and human health, field training and certificate or degree training). Benefits of coordination include:

- efficient strategic planning and allocation of resources to address real-world disease issues while also delivering on training, capacity enhancement and policy outcomes.
- integration with academic institutions to allow training programs to be certified (certificate, diploma and degree) in a way that ensures participants receive measurable benefits that can enhance career options as well as develop specific skills.
- development of modular training materials in core areas that can be delivered more efficiently to various levels of animal and human health staff.
- integration of animal and public health training and development plans so that they learn, train and work in integrated teams to address problems and achieve efficiencies associated with programs involving multiple participants.
- able to be applied to other ASEAN+3 countries to further leverage additional benefits from international collaboration and involvement through exchanges, projects on different diseases and different problems and through pooling of resources and experiences.

A number of existing programs were identified as having various characteristics that could be incorporated into a coordinated approach to animal health projects. It is not intended that any of these programs be replicated. Instead there may be components or functionalities from some of these programs that may serve as useful models in any attempt to develop a coordinated approach to research and training in Indonesia that is aiming to improve zoonotic control. These include:

- Field epidemiology training programs (FETP): The Field Epidemiology Training Program (FETP) is a 2-year post-graduate program designed to develop epidemiological expertise among health professionals. FETP programs have been established in a range of countries including Thailand, Indonesia, Mexico, Taiwan, Peru, Egypt, Spain, Australia, Colombia, Saudi Arabia, Japan, Italy and Zimbabwe. There are many aspects of the FETP program that would be useful in planning a coordinated approach to research and training.
- Support for Market-driven Adaptive Research (SMAR) program being administered by ACIAR. SMAR aims to strengthen adaptive agricultural R&D services for smallholders and agribusiness/SMEs in four provinces of Eastern Indonesia, and to ensure that R&D outcomes are effectively packaged and delivered for application. While the SMAR program may not be directly related to zoonotic disease control it does offer insights into the development of a model for strengthening province-based agricultural R&D capacity that is market and client-driven and effectively transferring knowledge to end-users. The SMAR program has three delivery components: Adaptive Research and Development; improvement in linkages and knowledge transfer processes between R&D providers and extension providers; and, institutional development, assisting with the development of optimal R&D planning, budget allocation, and investment in human resources and infrastructure.
- ASEAN +3 EID program: The ASEAN+3 Emerging Infectious Disease (EID) program aimed to develop capacity for detecting and responding to emerging infectious diseases in both animal and human health sectors. It is now completed and is being followed by a Phase 2 program aimed at implementing findings and recommendations from the initial project.

- ACIAR review report: Future directions for ACIAR's animal health research (2006), provides useful information and recommendations for ACIAR activities in the future.
- SAHMBA (Strengthening Animal Health Management and Biosecurity in ASEAN). This AADCP project aims to help upgrade ASEAN animal health surveillance capabilities, to improve regional food security, increase livestock exports and farmer incomes, and safeguard human health. The project has three components. The first component deals with risk analysis, a complex skill required under the rules of the World Trade Organisation to support trade in animals and animal products. The second component aims to improve the capacity of member country animal health authorities to undertake effective, timely and affordable animal disease surveillance. The third component seeks to improve access to the information required for an effective regional approach to disease management and eradication. Each component has workshop and training activities and mentored projects being undertaken by country participants to consolidate their skills and address genuine surveillance problems in each country.
- CIVAS/USDA epidemiology training. Experts in animal health surveillance and veterinary epidemiology are running a series of training workshops throughout Indonesia in early 2007 as part of a USDA sponsored program aiming to enhance capacity.

12 References

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13 Appendixes

13.1 Appendix 1: Itinerary

Thursday 25 Jan 2007	***Perkins***
Afternoon	Flight: Brisbane to Jakarta
Evening	Drive: Jakarta to Bogor
Overnight	Accommodation: Salak Hotel, Bogor
Friday 26 Jan 2007	***Perkins***
Meeting 8am to 4pm	CIVAS, Bogor
	drh Tri Satya Naipospos
	drh Albert Muljono
	drh Denny Lukman
Evening	Drive: Bogor to Jakarta
Overnight	Flight: Jakarta to Brisbane
Friday 23 Feb 2007	***Perkins, Patel***
Afternoon	Flight: Brisbane/Sydney to Jakarta
Evening	Drive: Jakarta to Bogor
Overnight	Accommodation: Pangrango 2 Hotel, Bogor
Saturday 24 Feb 2007	***Perkins, Patel***
Meeting 8am to 5pm	CIVAS, Bogor
	drh Tri Satya Naipospos, Chairman, CIVAS
	drh Albertus Muljono, Executive Director, CIVAS
	Dr drh Denny Lukman, Bogor Agricultural University
Overnight	Accommodation: Pangrango 2 Hotel, Bogor
Sunday 25 Feb 2007	***Perkins, Patel, Patrick***
am	Drive: Bogor to Jakarta
Meeting 12pm to 3 pm	Drs Perkins, Patel, Patrick
Meeting 7pm to 9pm	Dr John Weaver, FAO Indonesia
	Accommodation: Acacia Hotel, Jakarta
Monday 26 Feb 2007	***Perkins, Patel, Patrick, Muljono***
Meeting 9am to 1 pm	WHO, jl HR Rasuna Said Kav. 100-11, Kuningan, Jakarta
	Dr Gina Samaan, WHO, Field Epidemiologist
	Benjamin Johns, WHO, Technical Officer
Meeting 2pm to 4pm	***Perkins, Patel, Patrick***
	Accommodation: Acacia Hotel, Jakarta

Tuesday 27 Feb 2007	***Perkins, Patel, Patrick, Muljono***
Meeting 9am to 12pm	National Institute for Health Research and Development, Ministry of Health, Jakarta
	dr. Endang R. Sedyaningsih, Head of Biomedic & Pharmacy
	Drg Sekar Tuti, Researcher
	Sahat Ompusunggu, Researcher
	Rita Marleta Dewi, Researcher
	Melati Wati, Researcher
	dr Dina Bishara, Researcher
	Ima Nurisa, Researcher
Meeting 2pm to 3pm	Directorate General of Disease Control and Enviromental Health, Ministry of Health, Jakarta
	drh Wilfred Purba, Director, Animal-borne diseases
	Dr Gina Samaan, Field Epidemiologist
Evening	Flight: Jakarta to Yogyakarta
Overnight	Accommodation: Novatel Hotel, Yogyakarta
Wednesday 28 Feb 2007	***Perkins, Patel, Patrick, Muljono***
Meeting 8:30am to 1pm	Disease Investigation Centre, Wates, DGLS, Ministry of Agriculture
	Sutrisno, Acting Head of DIC
	Slamet Witono, Head of Programme & Evaluation Dept
	Samkhan, Head of Veterinary Inform Dept
	Waluyo Budi Priyono, Researcher
	Verawati, Researcher
	Nasirudin, Researcher
	M. Avina Rachmawati, Researcher
	Tugiyat, Researcher
	Sri Handayani Irianingsih, Researcher
	C. Setyo Rini, Researcher
Meeting 2pm to 4pm	Ministry of Health Office, Yogyakarta (***Patel, Muljono***)
	Drs. Elvi Effendi, Head of Surveillance Section
	Emi Rusdiati, Staff
Meeting 2pm to 4pm	Faculty of Veterinary Medicine, Gajah Mada University, Yogyakarta (***Perkins, Patrick***)
	Dr. Wayan T. Artama, Vice Dean of Faculty
	Heru Susetya, Faculty member
Evening	Flight: Yogyakarta to Denpasar
	Drive to Udayana Eco Lodge, Jimbaran Heights, Bali
Overnight	Accommodation: Udayana Eco Lodge
Thursday 1 March 2007	***Perkins, Patel, Patrick, Muljono***
Meeting 9 am to 2pm	Disease Investigation Centre, Denpasar, DGLS, Ministry of Agriculture
	Anak Agung Gde Putra, Head of DIC
	Dr. D.M.N Dharma, Researcher
	Dr. Ni Luh Dartini, Coordinator of Bacteriology Lab
	Ketut Mastra, Coorindator of Parasitology Lab
	Ni Made Arsani, Coordinator of Epidemiology Lab
	Rince Morita Butar Butar, Researcher
Meeting 5pm to 6:30 pm	Udayana Eco Lodge, Bali (***Perkins, Patel, Patrick, Muljono***)
Overnight	Accommodation: Udayana Eco Lodge

Friday 2 March 2007	***Perkins, Patel, Patrick, Muljono***
Meeting 9am to 5pm	Udayana Eco Lodge, Bali
Overnight	Accommodation: Udayana Eco Lodge
Saturday 3 March 2007	***Perkins, Patel, Patrick, Muljono***
am	Flight Denpasar to Jakarta
	Drive Jakarta to Bogor
Meeting 3:30 to 7pm	CIVAS, Bogor
	drh Albertus Muljono
	Dr drh Denny Lukman
Overnight	Accommodation: Hotel Salak, Bogor
Sunday 4 March 2007	***Perkins, Patel, Patrick***
am	Drive Bogor to Jakarta
	Patel and Patrick return flight: Jakarta to Sydney
Overnight (Perkins)	Accommodation: Sari Pan Pacific, Jakarta
Monday 5 March 2007	***Perkins***
Meeting 1pm to 2pm	FAO, jl MH Thamrin Kav. 3, Jakarta
	drh Tri Satya Naipospos, CIVAS
Meeting 2pm to 3:30pm	Dr John Weaver, FAO, Senior Technical Adviser
	Dr Leo Loth, FAO, Technical Adviser
Overnight	Flight Jakarta to Sydney
	Flight Sydney to Brisbane
Monday 30 April 2007	***Perkins***
Afternoon	Flight Brisbane to Jakarta
Overnight	Accommodation Parklane Hotel, Jakarta
Tuesday 1 May 2007	***Perkins***
am	Drive Jakarta to Bogor
Meeting 10am to 1pm	Research Institute for Animal Diseases (Balitvet), Bogor
	drh Darminto, Director of Balitvet
	Balitvet staff representing each division
pm	Drive Bogor to Jakarta
Overnight	Accommodation Parklane Hotel, Jakarta
Wednesday 2 May 2007	***Perkins***
Meeting 10am to 12pm	Directorate General of Livestock Services, Jl. Harsono RM no 3, Pasar Minggu, Jakarta
	Ir. Mathur Riady, Director General, DGLS
	Dr. Musny Suatmodjo, Director Animal Health
	drh Akhmad Junaidi, Subdirectorate of Zoonoses
Meeting 3pm to 4:30pm	drh Tri Satya Naipospos, CIVAS
5pm	Drive to airport
Overnight	Flight Jakarta to Brisbane

13.2 Appendix 2 Research team

Dr Nigel Perkins, BVSc, MS, PhD, Dip ACT, FACVSc
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Nigel is recognized nationally and internationally for his achievements in veterinary epidemiology. He has broad experience in investigations of animal health and disease in a number of species including sheep, cattle, horses, poultry, aquatic species, and wildlife. Nigel has worked in Australia, USA and New Zealand and has been involved in a number of projects in Asian countries associated with capacity building, avian influenza preparedness and response, risk analysis and disease outbreak investigations. Nigel has particular interests in analytical epidemiology, disease investigation and surveillance. He is the author or co-author of numerous scientific articles and book chapters. Nigel is a multi-award winning teacher and has extensive experience in post graduate training programs in epidemiology.

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Ian has over 20 years experience as a Project Designer, Environmental and Resource Economist and Team Leader in Australia and developing countries (Indonesia, East Timor, Laos, Thailand, Ethiopia, Ghana, Tanzania, Kenya and the Philippines). Ian has extensive experience in project design to AusAID and the World Bank standards and has successfully led AusAID Feasibility and Design teams. Responsibilities have included community/agricultural survey design, management (including enumerator and data management training) and analysis in developing countries and development of policy to improve market and agribusiness institutions and linkages. Ian has also played a role in the development of the education sectors in Africa and East Timor. Ian has made a major contribution in the area of livestock health economics and evaluated the efficiency of disease control and smallholder development programmes. He has also developed appropriate project monitoring and evaluation techniques. Ian is presently employed at the UNE as a Senior Researcher/Project Director at the Institute for Rural Futures (IRF) where he is working at developing UNE's profile in the areas of agro-industry sustainability and agricultural sector postgraduate education in developing countries.

drh. Albertus Muljono
Executive Director

drh. Tri Satya Naipospos
Chairman Directive Board

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Drh. Muljono acted as the major focal point in Indonesia for both animal and human health sectors. Dr Tri Satya Naipospos also provided valuable input into the report and project activities. Dr Naipospos is one of South East Asia's most experienced veterinary epidemiologists and has extensive experience and contacts in Animal Health and Public Health within Indonesia.

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Stan spent several years coordinating disease control programmes and capacity building in the Yemen Arab Republic, principally for rinderpest, but including FMD, sheep and goat pox, brucellosis and other exotic transboundary diseases. He has over 20 years experience in diagnostic veterinary microbiology and public health and has broad interests in the epidemiology of food-borne and zoonotic diseases, including animal reservoirs of infection and environmental dissemination of pathogens; development of rapid methods for detection and differentiation of zoonotic and food-borne bacterial pathogens; molecular typing of human and animal pathogens; disease control strategies, and; HACCP training in food-producing industries. Stan is actively involved in teaching training overseas graduate students from Asian and Middle Eastern countries and in is involved in projects based in Indonesia and other ASEAN countries aimed at capacity development in the area of epidemiology and public health.

13.3 Appendix 3 Ministry of Agriculture

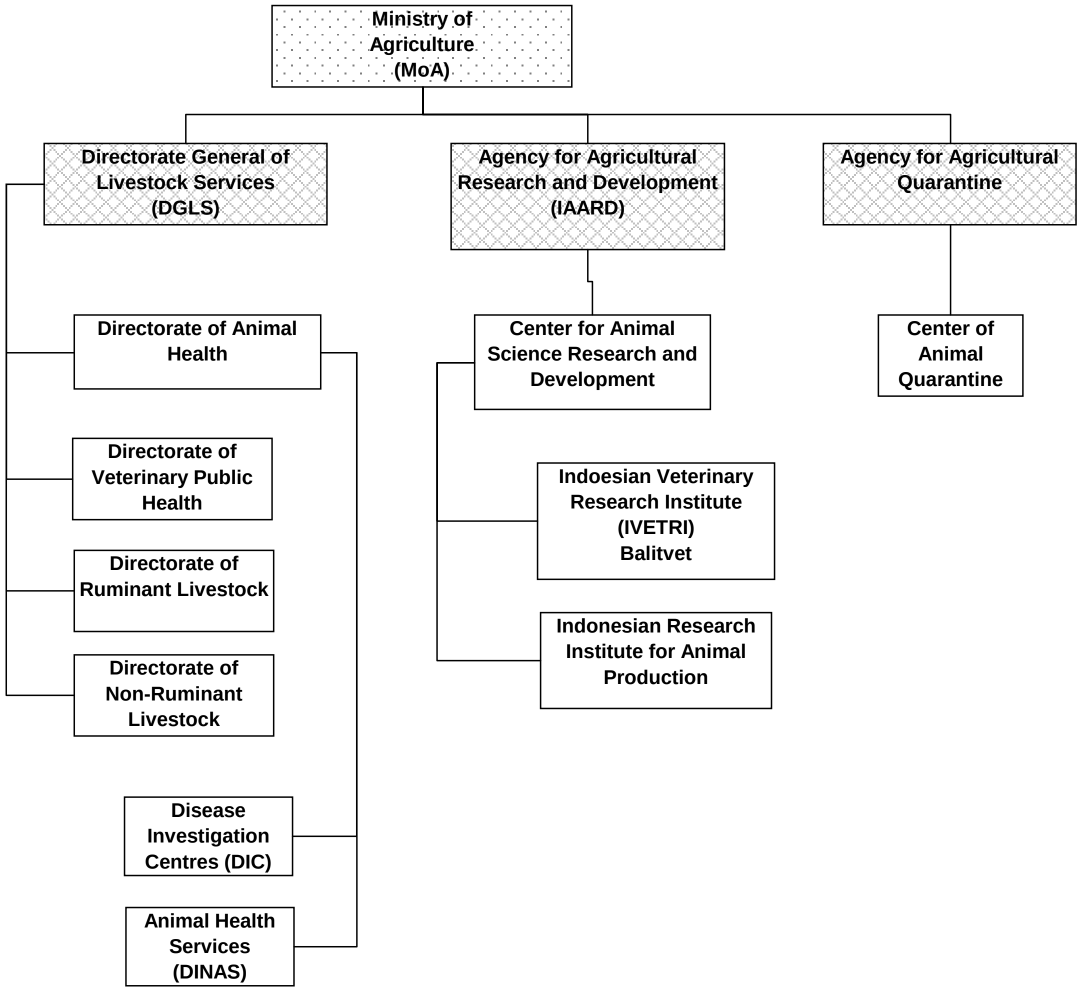

Figure 1: Animal health services within the Department of Agriculture

The Directorate-General of Livestock Services (DGLS) is the central government authority responsible on behalf of the Ministry of Agriculture (MoA) for the planning, implementation and monitoring of national livestock production. DGLS comprises five Directorates: Animal Breeding, Livestock Production, Animal Health, Veterinary Public Health, and Programs. Each Directorate has a number of Sub-Directorates involved with specific functions and programs. This central organisational structure is replicated at the provincial, District (Kabupaten) and Subdistrict (Kecematen) levels as the Dinas Livestock Services (Dinas Peternakan), until decentralisation in 2001. Decentralisation granted autonomy to District and Subdistrict governments to reorganize into autonomous units, and an important consequence of this has been the restructuring or even abolishment of many DINAS units in response to varying decisions on local priorities and available resources. DGLS, on behalf of MoA, has the legal and operational authority to carry out livestock policy, staff accreditation, program standardization, disease surveillance and control, testing and quality control, and food safety. This national authority overrides any local authority concerning food safety measures carried out by local governments.

Three semi-autonomous agencies that report to MoA are responsible for livestock research, livestock extension and staff development.

- The Agency for Agricultural Research and Development (AARD) focuses on three disciplines: livestock research through the Central Research Institute for Animal Sciences (CRIAS), which coordinates research activities of the Research Institute for Animal Diseases (Balitvet) and the Research Institute for Animal Production, Balitnak), all located in or near Bogor, West Java.
- The National Center for Agricultural Extension Development (NCAED) trains livestock extension officers and develops extension methodology.
- The Agency for Agricultural Human Resources and Development (AAHRD) provides support in human resource planning, need assessment and skills development.

The Directorate of Veterinary Public Health (DVPH) has a strong regulatory mandate, with two important responsibilities: (a) animal disease surveillance and control, and (b) food safety and quality control of food processing.

The Directorate of Animal Health (DAH) oversees a network of seven regional (Type A) disease investigation laboratories (DICs), approximately 26 Type B and C District or Subdistrict diagnostic laboratories, Dinas Animal Health Services in almost all districts, and a network of approximately 400 sub-district animal health posts (poskeswan), which provide the service provision interface between government veterinary services and the livestock owner. DAH also supervises the national livestock vaccine laboratory (Pusvetma) in Surabaya, inspects local livestock markets, and carries out national vaccination programs (anthrax, brucellosis, rabies, hemorrhagic septicaemia). DAH also collaborates with the Ministry of Health on the control of zoonotic diseases.
The seven regional Disease Investigation Centers (DICs) are located at:

- Sumatra
  - Medan: DIC 1
  - Bukitinggi, near Padang: DIC 2
  - Bandar Lampung (formerly called Tanjungkarang-Telukbetung): DIC 3
- Java
  - Wates, near Yogyakarta: DIC 4
- Kalimantan
  - Banjarbaru: DIC 5
- Bali
  - Denpasar: DIC 6
- Sulawesi
  - Maros, near Makassar (formerly Ujungpandang): DIC 7.

These DICs are important providers of diagnostic services to farmed livestock with varying but generally more limited roles in providing services to aquatic livestock production and research. Universities with veterinary, medical and science faculties may also provide services on occasions. The Research Institute for Veterinary Science, Balitvet, at Bogor, is a national research and diagnostic centre. It reports along an entirely different route to a different Director General.

Under local government autonomy, each District now determines the type and scope of Livestock Production and/or Animal Health Services at the District, Sub-District and village levels. Some Districts may elect not to support livestock production or animal health services; others increase and upgrade such services, based on local need or demand. Such changes have the potential to adversely impact animal disease surveillance if for example local government chooses (as some apparently have) to abolish or reorganize Type C laboratories, poskeswan and other service resources as they see fit.

The DAH supervises five Subdirectorates: Disease Surveillance, Disease Control and Eradication, Animal Biosecurity, Veterinary Drug Control, and Veterinary Services. At the provincial and subprovincial levels, each Dinas Provincial Animal Health office (Kantor Dinas Kesehatan Propinsi) oversees provincial programs through District Subdinas offices, responsible for the implementation of Sub-Directorate programs at the field level. However, the provincial offices have lost their operational mandate for District and Sub-District services to local government autonomy, while retaining responsibility for enforcing regulatory programs. This divergence of responsibility is considered likely to hamper effective disease control, where one agency monitors and identifies threats while a different agency is tasked with responding to the threat.

Provincial Dinas Animal Health Services (Dinas Propinsi Kesehatwan Hewan) have been most significantly affected by decentralisation as they have transferred field programs to the District governments. The Head of each District government, the Bupati, now has the authority to pass local ordinances (Peraturan Daerah, PERDA) concerning the operations and organization of all District level (Tinggat II) animal health services and Type C laboratories, leaving Dinas Propinsi in charge of regulatory affairs, although its authority over these presently remain unclear and is therefore often subject to dispute. Government budgets allocated to municipal (Kota) and District governments were once distributed by the provincial governments, but are now passed directly by Jakarta to the Districts, sometimes with sufficient delays as to paralyse operations.

Decision making at the local government (District) level is at risk of being influenced by short-term budget constraints and there may also be support for moving service to cost recovery, potentially placing poorer producers at a disadvantage.

The Ministry of Interior is responsible for provision of animal health field services and regulation through its provincial, district and sub-district network. The provincial and district networks have substantial autonomy and these networks answer primarily to the relevant provincial government and secondarily to the central government. The Ministry of Agriculture has an advisory role to this system, providing policy, science and technical inputs, but has no direct managerial or control responsibility.

The two ministry, decentralised matrix system appears to have presented challenges in the collection of surveillance data and implementation of effective diagnostic, prevention and control methods for animal diseases. It is anticipated that this system will also present challenges in the collection of valid and representative data on animal health events.

13.4 Appendix 4 Ministry of Health

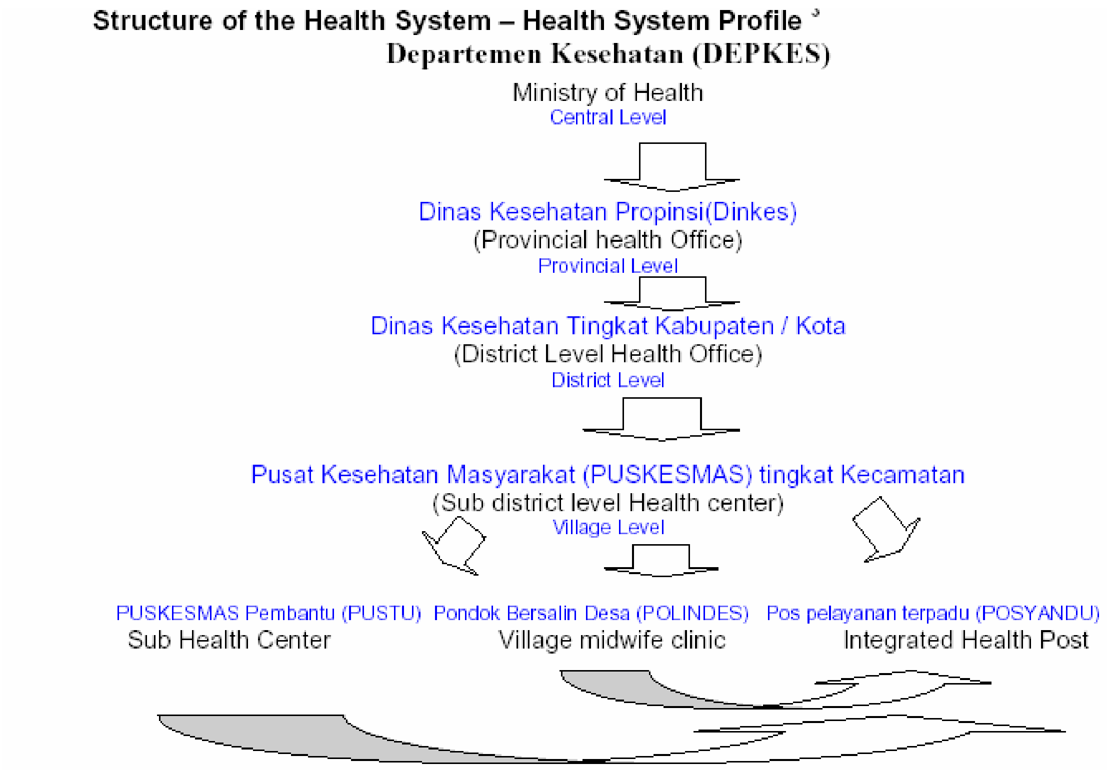

Figure 2: Structure of the public health system in Indonesia. Information drawn from WHO sources[23], [24].

Table 19: Structure of Indonesian health system

Political Structure		Health Structure	
Level	Position	Level	Position
Central (Pusat)	Government of Indonesia (Pemerintah Indonesia)	Ministry of Health (Departemen Kesehatan)	Minister of Health (Mentri Kesehatan)
Provincial (Propinsi)	Governor (Gubernur)	Provincial Health Office (Dinsa Kesehatan Propinsi)	Head of Provincial Health Office (Kepala Dinas Kesehatan Propinsi)
District / Municipality (Kabupaten)	Head of District / Major (Bupati / Walikota)	District Health Office (Dinas Kesehatan Kabupaten)	Head of District Health Office (Kepala Dinas Kesehatan Kabupaten)
Subdistrict (Kecamatan)	Head of Subdistrict (Camat)	Health Center (PUSKEMAS)	Head of Health Center (Kepala PUSKEMAS)

[23] http://www.who.int/healthmetrics/library/indonesia_05apr.doc
[24] http://www.who.int/disasters/repo/9062.pdf

Each sub-district in Indonesia has at least one health centre headed by a doctor, usually supported by two or three sub-centres, the majority of which are headed by nurses. Most health centres are equipped with four-wheel drive vehicles or motorboats to serve as mobile health units and provide services to underserved populations in urban and remote rural areas. At the village level, the integrated Family Health Post provides preventive health services. These health posts are established and managed by the community with the assistance of health center staff.

Responsibility and authority for planning, budgeting, implementing, and monitoring the delivery of primary health care and family planning services were transferred to districts and municipalities in 2001. Within the health sector, the district health offices are given authority to manage the health system in their respective districts. Communicable diseases (including HIV/AIDS and tuberculosis) are now district government responsibilities – though the Minister of Health's Communicable Disease Control programme includes support for strategic planning, resource mobilization, and provision of essential logistics (e.g., selected drugs, vaccines, and equipment). Transfer of authority to the district level implies that decisions on planning and resource allocation will be made at the local level. This constitutes a risk for programmes strongly influenced by issues that need to be addressed beyond the district boundary. Nevertheless, decentralization also presents significant opportunities to encourage effective local planning and management of HIV/AIDS activities.

13.5 Appendix 5 Disease cards

13.5.1 Anthrax

Causative agent

Bacillus anthracis: large, gram positive, rod-shaped, spore-forming bacterium.

Susceptible species

Anthrax is most common in wild and domestic herbivores (eg, cattle, sheep, goats, camels, antelopes) but can also be seen in humans exposed to tissue from infected animals, contaminated animal products or directly to *B anthracis* spores under certain conditions. Cases are less common in pigs, goats and horses so most cases are assumed to be in cattle and sheep.

Clinical signs:

The most common presentation in herbivores is sudden death with no prior signs of illness. Animals often bleed from orifices after death and blood does not clot. Pigs may show fever and signs of illness before dying or recovering.
Humans mostly show cutaneous anthrax (>90% of cases). Two alternative types of disease are seen less commonly: intestinal form following consumption of contaminated and undercooked meat and inhalational (pulmonary) form which may produce severe and fatal disease.

Diagnosis:

Definitive diagnosis in cases of acute death is based on microscopic examination of a direct blood smear fore the presence of large numbers of capsulated bacilli.
Serological tests to detect antibody to anthrax antigen is mostly used in monitoring response to vaccination.

Vaccination

In Australia the anthrax vaccine contains living spores of the non-capsulated naturally avirulent (live) Sterne 34F2 strain of *B. anthracis*. A single vaccination is usually effective for 6–12 months, provided that animals receive the full dose and are not under antibiotic therapy within 10–14 days before or after vaccination. Animals that receive two vaccinations at least 6-months apart are probably immune for life.

Epidemiology

The most common route of exposure for animals is believed to be through ingestion of the spores while grazing though some animals may be exposed through contamination of wounds (perhaps by flies) and inhalation/ingestion of spores in more heavily contaminated areas. Intermittent outbreaks may follow soil disturbance due to flooding, erosion, clearing, ploughing etc all of which may allow spores to move from under the soil surface to the surface. In addition it seems that immediately following an outbreak high awareness and vaccination may reduce risk and over time these preventive measures are generally not adhered to making the animal population susceptible again.

Human cases may follow contact with contaminated animals or animal products. The risk of human disease in these settings is comparatively small in developed countries, partly because humans are relatively resistant to infection and less likely to be exposed to virulent spores. However, in Africa each affected cow can result in up to 10 human cases with increased exposure due to a variety of behaviours including dressing and eating affected animals as well as exposure to skin and environmental contamination.
Most human cases are cutaneous disease (>95% of cases). GI anthrax (including pharyngeal anthrax) may be seen among human populations following consumption of contaminated raw or undercooked meat. Under certain conditions (eg, laboratories, animal hair processing facilities, heavy contamination during processing of infected animals, exposure to weaponized spore products), humans may develop a highly fatal form of disease known as inhalational anthrax or woolsorter's disease.

Control

Anthrax is controlled through vaccination programs, rapid detection and reporting, quarantine, treatment of asymptomatic animals (postexposure prophylaxis), and burning or burial of suspect and confirmed cases.

In-contact livestock can be treated with a long-acting antibiotic (penicillin or oxytetracycline) to stop all potential incubating infections. This can be followed by vaccination ~14 days after antibiotic treatment. Any animals becoming sick after initial treatment and/or vaccination should be retreated immediately and revaccinated a month later. Simultaneous use of antibiotics and vaccine is inappropriate, as the Sterne vaccine is live. Animals should be moved to another pasture away from where the bodies had lain and any possible soil contamination. Suspected contaminated feed should be immediately removed. In endemic areas annual vaccination of all grazing animals is an important component of control and prevention.

Anthrax spores on the surface are believed to deteriorate over time and probably lose their infectivity over ~3 years. Spores buried deep within soil may remain viable for centuries. This has led to modified control programs in some regions where carcasses of animals dying from anthrax are not buried and are destroyed by burning or are disinfected and allowed to decompose on the soil surface.

For humans, post-exposure prophylaxis against *B anthracis* is recommended following an aerosol exposure to *B anthracis* spores. Such exposure may occur following a laboratory accident or a terrorist incident. Prophylaxis may consist of antibiotic therapy alone or the combination of antibiotic therapy and vaccination, if vaccine is available, as most human

vaccines are not live. Though there is no approved regimen, the CDC has suggested that antibiotics may be discontinued after 3 doses of vaccine have been administered according to the standard schedule (0, 2, and 4 wk). Because of availability and ease of dosing, doxycycline or ciprofloxacin may be chosen initially for antibiotic chemoprophylaxis until the susceptibility of the infecting organism is determined. Penicillin and doxycycline are approved by the FDA for the treatment of human anthrax, and have traditionally been considered the drugs of choice.
Most human cases in Indonesia appear to be cutaneous and people in affected regions have become accustomed to it, and may self diagnose and then obtain penicillin for treatment. There is therefore some risk that cases may be likely to be under-reported.

AUSVETPLAN: Anthrax. Version 3.2, 2005. Accessed 19 March 2007.
http://www.animalhealthaustralia.com.au

13.5.2 Avian Influenza

Causative agent

type A influenza virus
Avian influenza viruses are classified as low pathogenic (LPAI) and high pathogenic (HPAI) forms based on the severity of the illness caused in chickens. Most AI viruses are low pathogenic and typically cause little or no clinical signs in infected birds. Only H5 and H7 subtypes are known to have become high pathogenic in avian species. The major subtype active in Asia currently is H5N1.

Susceptible species

All birds are thought to be susceptible to infection with avian influenza, though some species are more resistant to infection than others. Migratory waterfowl – most notably wild ducks – are the natural reservoir of avian influenza viruses, and these birds are also the most resistant to infection. Domestic poultry, including chickens and turkeys, are particularly susceptible to epidemics of rapidly fatal influenza.

Avian influenza viruses do not normally infect species other than birds and pigs. Human cases that occurred in Hong Kong in 1997 were the first cases where avian influenza was believed to have jumped directly from birds to humans.

A small number of mammalian species, including cats, captive tigers and leopards, pigs, seals, whales, mink, and ferrets, are susceptible to natural infection with AI viruses.

Clinical signs

Susceptible birds

Infection causes a wide spectrum of symptoms in birds, ranging from mild illness to a highly contagious and rapidly fatal disease resulting in severe epidemics. The latter is known as highly pathogenic avian influenza or HPAI. This form is characterized by sudden onset, severe illness, and rapid death, with a mortality that can approach 100%.
LPAI infection can cause deaths in birds as well ranging from very low levels (0 to 3%) up to 15% with occasional higher death rates in susceptible birds eg 90% death in young turkeys.

Other animals

Unusual cause of respiratory illness and death in other species such as cats

Humans

Humans infected with HPAI may develop symptoms of fever, sore throat, cough and, in several of the fatal cases, severe respiratory distress secondary to viral pneumonia.

Previously healthy adults and children, and some with chronic medical conditions, were affected.

Global pandemic

Of the 15 avian influenza virus subtypes, H5N1 is of particular concern for several reasons. H5N1 mutates rapidly and has a documented propensity to acquire genes from viruses infecting other animal species. Its ability to cause severe disease in humans is now well documented though to date there has been no evidence to indicate that the virus has attained the capability to spread by aerosol from human to human. Continued spread of infection in the bird population and increased exposure of humans to avian influenza offers the opportunity for genetic reassortment or mutation that may result in emergence of a novel subtype with sufficient human genes to be easily transmitted from person to person. The fear in this case is that this could mark the start of a global pandemic of a highly contagious and serious disease that could result in the death of very large numbers of people.

Diagnosis

Pathological changes are not definitive.

Outbreaks of HPAI often result in very high levels of acute death with no opportunity for seroconversion. HPAI may be suspected based on clinical signs and severity of outbreak but a definitive diagnosis is based on detection of viral antigen using immunofluorescence or molecular techniques such as PCR and isolation and characterisation of the causative virus. A great deal of effort is being directed towards development of rapid, field tests such as strip-based tests that can be applied in the field to obtain immediate results.

Epidemiology

Wild aquatic birds, such as waterfowl and seabirds, are important reservoirs and can shed AI virus for up to one month, compared with two weeks in domestic species and it is believed that wild waterbirds may be responsible for spreading HPAI in some outbreaks (but not all).

In recent times, dissemination of HPAI virus between flocks has been primarily attributed to:

- the movement of infected birds (including vaccinated birds)
- the actions of humans in moving feedstuff, personnel, equipment and vehicles into and from premises that are contaminated with infected faeces or respiratory secretions.

Control

The basis for eradication of HPAI as outlined in the AUSVETPLAN is:

- the rapid imposition of effective quarantine
- stamping out by isolation of infected and potentially infected birds, followed as rapidly as possible by slaughter and sanitary disposal of carcases
- decontamination
- prevention of movement of contaminated materials
- rapid surveillance to ensure that all sources and the extent of infection are detected.

These principles will need to be combined with the following other strategies:

- comprehensive, integrated national surveillance and diagnostic programs

- enhanced biosecurity practised at all levels of production and processing by all employees of companies, diagnostic laboratories and government agencies that have contact with poultry or equipment from poultry operations
- education of poultry farmers and other workers about AI control, and sharing of information on surveillance and control strategies at all levels in the production process.

In some specific circumstances, where other control and eradication measures are not succeeding, vaccination, with government control, may be considered as one element of a comprehensive control program.

Vaccines are available but the constant risk of genetic shift in the virus means that there is a similarly constant need to check and ensure that the vaccine being used is conferring protection against the particular subtype of virus that is causing an outbreak. A number of difficulties are associated with vaccination including the risk of non-sterile protection ie vaccinated birds may still be infected with wild virus and shed virus to contribute to further spread of disease and difficulties in determining disease freedom since vaccinated birds are seropositive.

FAO classifies poultry systems as:

Classification	Sector 1	Sector 2	Sector 3	Sector 4
System	Industrial integrated	Commercial	Commercial	Village
Biosecurity	High	Mod to high	low to minimal	minimial
Product	Commercial	Usually commercial	Live markets	consumed locally

The highest risk of HPAI infection in Asian countries is believed to be in Sectors 3 and 4.

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13.5.3 Brucellosis

Causative agent:

Brucella abortus	Bovine brucellosis
Brucella suis	Swine brucellosis
Brucella melitensis	Causes disease in sheep and goats

Brucellae are generally quite host-specific with minor risk of different species causing infection in animal species other than the main hosts identified above.

Clinical signs:

A combination of virulence, level of exposure and host resistance means that infection may result in no disease or varying levels of disease up to typical acute infection. It appears that in a completely naïve population, introduction of Brucellosis may result in abortion storms (30-50%) but once the disease is endemic there is a fair level of circulating immunity and only the young and susceptible animals may abort.

Swine brucellosis

Common manifestations are abortion, temporary or permanent sterility, orchitis, lameness, posterior paralysis, spondylitis, and occasionally metritis and abscess formation. The incidence of abortion may be 0-80%. Abortions may also occur early in gestation and be undetected. Usually, sows or gilts that abort early in gestation return to estrus soon afterward and are rebred.

Sterility in sows, gilts, and boars is common and may be the only manifestation. Sterility in sows is more frequently temporary but may be permanent. In boars, orchitis, usually unilateral, may occur, and fertility appears to be reduced.

Bovine brucellosis

Abortion is the most obvious manifestation. Infections may also cause stillborn or weak calves, retained placentas, and reduced milk yield. Usually, general health is not impaired in uncomplicated abortions.

Seminal vesicles, ampullae, testicles, and epididymides may be infected in bulls; resulting in reduced fertility and infective semen. Longstanding infections may result in arthritic joints in some cattle.

Brucella melitensis

Causes abortion and birth of weak-born or dead neonates in sheep and goats as well as subsequent infertility.

Humans

The disease is described as "Undulant Fever", in that fever waxes and wanes like a wave. The disease does not have precise symptoms besides general malaise, making it difficult to diagnose clinically. Brucellosis is characterized by an intense fever, strong sweats, headaches, and symptoms that may be confused with the flu. The disease can have severe complications if not treated. The bacteria reach the lymph nodes, liver and spleen and may cause endocarditis, encephalitis and orchitis in man. However, there is no evidence of abortion in infected women.

Diagnosis

Simple screening tests such as the Rose Bengal Test (RBT) are highly effective in bovine control programs. The RBT involves mixing serum from suspect animals with antigen and examining the solution with the naked eye for presence of agglutination. Alternative tests can be performed on bulk milk samples or card tests in other species. These tests are highly sensitive and are useful for ruling out disease (negative test result indicates disease freedom with high level of confidence). However, false positives are more common and positive test results on the screening test are usually followed up by a more specific test such as the complement fixation test (CFT) or ELISA tests.

Diagnosis in individual cases may also be performed by bacterial culture of causative organisms from aborted foetal or placental material or semen.

The diagnosis in humans is dependent on laboratory analyses, typically serological tests and blood cultures.

Epidemiology

Animals develop self-limiting infections or they become asymptomatic latent carriers and potential shedders of the bacteria. The disease is characterized by either elimination of the organism or, more frequently, by a persistent infection of mammary glands and supramammary and genital lymph nodes with constant or intermittent shedding of the organisms in the milk and genital secretions. Animals generally abort once during midgestation, but reinvasion of the uterus may occur in subsequent pregnancies with shedding in fluids and membranes. The pregnancy can also continue to full term.

Susceptibility to brucellosis is associated with two main factors. First, brucellosis primarily affects sexually mature animals. Second, susceptibility increases dramatically with pregnancy. The incubation period is shorter in pregnant animals and abortions take place frequently.

The main pathway for disease transmission is through exposure of animals to organisms through uterine fluids and the placenta expelled by infected animals, either when they abort or have full term parturition. Worldwide, most infections or reinfections in disease-free herds originate from buying infected animals. Another major risk factor is the proximity of infected herds/flocks. The disease may be eliminated from a farm but if the neighbours have infected animals, despite all efforts made, sooner or later the disease will come back. Community pastures should be treated as one herd/flock and control measures must be applied to all animals. Other factors to be considered include the ability of Brucella to persist outside the mammalian hosts under suitable conditions. For example, when environmental conditions are favourable, such as high humidity, low temperature and absence of direct sunlight, Brucella may retain infectivity for several months in water, aborted foetuses, placental membranes, liquid manure, hay, buildings, equipment and clothes.

Dairy animals have a much greater chance of contracting brucellosis and of spreading it faster than beef animals due to the higher density and closer confinement of dairy management systems.

The main routes of Brucella transmission to man are ingestion, inhalation, or direct contact with infected animals or materials. Infection by ingestion is usually due to contaminated food. The consumption of untreated milk or cheeses in many places around the world is the cause of brucellosis outbreaks in man. Human infections may develop in people who are frequently in contact with infected herds of goats, goat manure, or who consume infected goat milk or its products. Infection by close contact may occur when humans assist animals during parturition or abortions, or handle stillbirths or in processing carcasses in slaughterhouse procedures.

Estimation of the economic impact of human brucellosis is calculated using as indicators the cost for each new patient based on days or months of leave, medical and laboratory examinations and treatments. The duration of the human illness and convalescence indicate that brucellosis is not only a medical problem but also an economic problem because of time lost from normal activities. Although antibiotics reduce the time that a patient could be incapacitated, there are still many regions where medicines are not available and programmes for the detection and prevention of the infection in man and animals are not adequately carried out. In these areas, the animal disease remains an important threat to human welfare.

Control

There is no effective treatment for animals. Control is therefore by elimination of infected animals through test and removal programs. Vaccinations are available for *B. abortus* and *B. melitensis* (not for *B. suis*) and may be important parts of a control program particularly in the early stages when prevalence is higher.

Effective control requires an integrated campaign with the support of livestock producers. It is particularly important to appreciate that in endemic areas where animal disease levels are relatively low, the requirements and costs of a control program may not be viewed positively by producers who may fail to appreciate the broader benefits of eradication vs the direct costs of losing their animals in a test and slaughter program. Control requires animal identification, effective surveillance systems, integration between animal and public health, a well-planned and marketed campaign, ability to impose effective quarantine and movement controls, and usually some level of compensation for animals removed through the program. These components are well described.

Disease Impact

The economic loss from brucellosis in developed counties arises from the slaughter of cattle herds that are infected with Brucella. The economic loss from brucellosis in developing countries arises from the actual abortion of calves and resulting decreased milk yield, birth of weak calves that die soon after birth, retention of the placenta, impaired fertility and sometimes arthritis or bursitis. It is difficult to estimate the financial loss caused by brucellosis, as it depends on the type of cattle farming, herd size, and whether it is an intensive or extensive cattle farm. Furthermore, although it is very difficult to estimate the financial loss incurred by human brucellosis there is no doubt that it is substantial.

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13.5.4 Cysticercosis and Taeniasis

Causative agent:

The terms cysticercosis and taeniasis refer to food-borne zoonotic infections with larval and adult tapeworms, respectively.
Taenia saginata: beef tapeworm
Taenia saginata asiatica: Taiwan taenia
Taenia solium: pork tapeworm

Susceptible species

Domestic animals and humans.

Clinical signs

The presence of adult tapeworms in the intestinal lumen of humans generally causes little or no clinical sign other than mild abdominal discomfort.

Cysticercosis refers to the presence of larval tapeworms in tissues and may occur in pigs, cattle and humans as well as in other species. In animals the presence of cystercercosis can result in lost productivity and in condemnation of offal and carcass.

The pathology associated with cystercercosis in humans depends on which organs are infected and the number of cysticerci. An infection consisting of a few small cysticerci in the liver or muscles would likely result in no overt pathology and go unnoticed. Those that form in voluntary muscle tend to be asymptomatic, but may cause myositis, with accompanying fever and eosinophilia. On the other hand, a few cysticerci, if located in a particularly "sensitive" area of the body, might result in irreparable damage. For instance, a cysticercus in the eye might lead to blindness, a cysticercus in the spinal cord could lead to paralysis, or a cysticercus in the brain (neurocysticercosis) could lead to traumatic neurological damage or epileptic seizures. For this reason, cysticerci gather more attention when they occur in the central nervous system or the eye rather than when they develop in voluntary muscles. In humans cysticercosis of the central nervous system is the most important neurological disease of parasitic origin. It causes serious morbidity in areas where *T. solium* is endemic, and is known to be a leading cause of epilepsy, which has profound social, physical and psychological consequences.

Diagnosis

Diagnosis in animals is mainly through meat inspection.

In people, Taenia eggs and proglottids can be identified though microscopic identification of faeces. Serological tests are used for evidence of presence of cysticerci and improved imaging techniques such as CAT and MRI can be very useful in detecting cysticerci in various organs.

Epidemiology

The major risk factors related to transmission of *T. solium* eggs to pigs can be summarized as follows:

- Extensive or free-range pig rearing in households lacking latrines, and outdoor human defecation near or in pig-rearing areas.
- Allowing pigs to scavenge and eat human faeces (sanitary policeman).
- Deliberate use of human faeces as pig feed.
- Connecting pigpens to human latrines (pigsty privies).
- Use of sewage effluent, sludge or "night soil" to irrigate and/or fertilize pig pastures and food crops.
- Human carriers involved in pig rearing and care.

The risk factors important to the transmission of cysticerci to humans are:

- Lack of comprehensive and satisfactory meat inspection at pig slaughter.
- Clandestine marketing of pigs to avoid inspection.

- Cultural preferences for eating raw or improperly cooked pork. Studies have shown that uncontrolled or illegal slaughter and marketing are widespread and their solution will require substantial efforts in veterinary control. The habit of eating raw or improperly cooked pork is also a very intractable trait, but hopefully, this can change through education.
- Low economic status, low level of household sanitation and low personal hygiene standards.

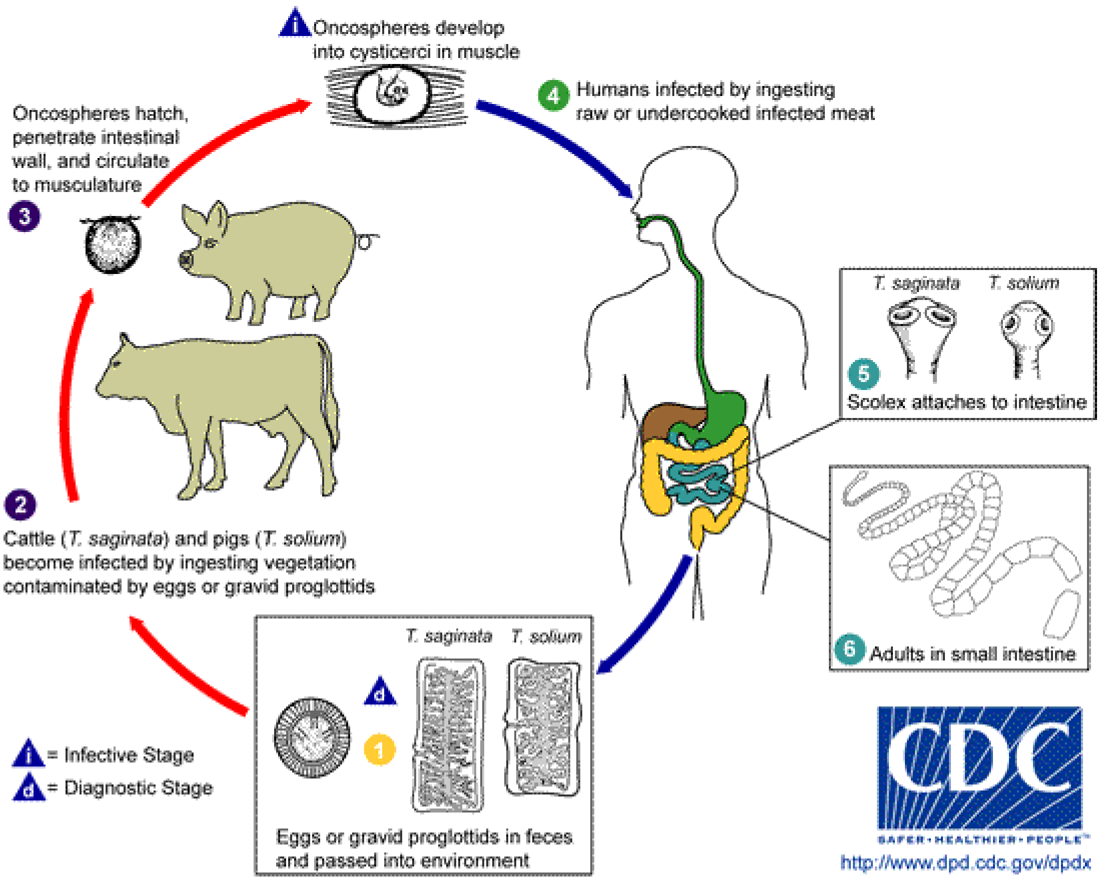

Figure 3: Life cycle for Cysticercosis

Control

Key aspects of control include:

- meat inspection to prevent human infection
- improved farm management to ensure that pigs and cattle are protected from ingesting feed or water contaminated with human faeces to prevent cysticercosis in animals
- screening of farm workers for taeniasis, and treatment if warranted
- proper treatment of sewage effluent and sludge to kill Taenia eggs, and regulation of the use of effluent and sludge for agricultural purposes
- control of pig and cattle marketing systems, including the provision of incentives to ensure owner compliance
- health education of both farmer and consumer.

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13.5.5 Rabies

Causative agent

Rabies virus
Family Rhabdoviridae, genus Lyssavirus
Single stranded RNA genome
Multiple serotypes.

Susceptible species:

All mammals though susceptibility varies between species. Birds play no role in transmission.

Clinical signs

Dogs

Dogs generally show behavioural changes (become friendly or aggressive) as the disease progresses and enter either dumb or furious forms of rabies. Once clinical signs develop the progression of disease is rapid with progressive ataxia, convulsions, ascending paralysis and death within 3 to 10 days.

Other animals

Animals generally show a loss of normal shyness and fear of people. Animals may show signs consistent with dumb or furious forms of rabies or simply show progressive ataxia and paralysis.

Humans

Incubation period between 20-90 days in most (90%+) cases though it may be years in some cases. Prodromal stage of non-specific symptoms of malaise is followed by an encephalitic phase, brain stem dysfunction, coma and death generally due to respiratory failure. Median survival after onset of symptoms is about 4 days.

Rabies is assumed to be 100% fatal once clinical signs develop.

Diagnosis

Rabies is suspected in animals showing typical clinical signs followed by death within 10 days of onset of signs. Diagnosis must be confirmed by laboratory tests. The major diagnostic test is fluorescent antibody tests performed on brain tissue to demonstrate presence of rabies antigen.

Vaccination

Vaccination is capable of inducing a high level of immunity in dogs, cats and domestic animals. Available vaccines include modified live and inactivated vaccines. Modified live vaccines have been incorporated into oral baits distributed for vaccination of wildlife reservoirs such as foxes in Switzerland. Occasional reports of vaccine induced rabies have followed use of modified live vaccines.

An inactivated human diploid cell vaccine is available for use in people.

Post-exposure treatment (PET)

PET is used in people after they have been potentially exposed typically by being bitten by a dog for example. PET involves multiple injections of anti-rabies immunoglobulin.

Epidemiology

Rabies virus is comparatively fragile and does not survive for long periods outside the host. Infected animals begin to excrete virus in saliva up to 14 days prior to onset of signs and continue to excrete until death. The major method of transmission is by biting.

The epidemiology of rabies in a particular country depends on the reservoir hosts involved ie whether wildlife (foxes, skunks, raccoons etc) are involved or dogs. The major reservoir in Indonesia is the dog though cats and monkeys may play minor roles in some areas. Cattle are the livestock species most commonly infected with rabies.

Control

Control of rabies generally is based on vaccination of dogs and control of the stray or wild dog population particularly in those areas where dogs are the main reservoir of infection. Mass vaccination of dogs and cats, along with elimination of stray animals and control over the movement of owned animals, are integral parts of urban cycle rabies eradication. Rabies can be effectively controlled when 70-80% of the dog population is vaccinated. Switzerland has successfully eradicated rabies in foxes by using an oral bait vaccine.

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13.5.6 Toxoplasmosis

Causative agent

Toxoplasma gondii the only known member of the genus Toxoplasma, a protozoan parasite

Susceptible species

Felids are the only definitive hosts of *T gondii* ; both wild and domestic cats therefore serve as the main reservoir of infection. The parasite is capable of infecting humans and other warm-blooded animals, including birds. It has been found worldwide from Alaska to Australia.

Clinical signs

Cats

Most cats show no clinical signs of infection with Toxoplasma.

However, in young animals, particularly puppies, kittens, and piglets, tachyzoites spread systemically and cause interstitial pneumonia, myocarditis, hepatic necrosis, meningoencephalomyelitis, chorioretinitis, lymphadenopathy, and myositis. The corresponding clinical signs include fever, diarrhea, cough, dyspnea, icterus, seizures, and death. Immunocompromised adult animals (eg, cats infected with feline immunodeficiency virus) are extremely susceptible to developing acute generalized toxoplasmosis.

Other animals

T gondii is capable of causing severe disease in animals other than human beings and is responsible for great losses to the livestock industry. In sheep and goats, it may cause embryonic death and resorption, fetal death and mummification, abortion, stillbirth, and neonatal death. Disease is more severe in goats than in sheep. Outbreaks of toxoplasmosis in pigs have been reported from several countries, especially Japan, and mortality is more common in young pigs than in adult pigs. Pneumonia, myocarditis, encephalitis, and placental necrosis occur in infected pigs. Cattle and horses are more resistant to clinical toxoplasmosis than are other species of livestock; there is no confirmed report of clinical toxoplasmosis in cattle, horses, and water buffaloes. Chickens may also be infected with cysts and may serve as a source of infectivity for people.

Goats are more susceptible to Toxoplasmosis than sheep and between 3-30% of breeding females in a susceptible flock may abort following infection. In endemic areas the rate will be lower due to circulating infection and immunity. A proportion of infected females will deliver neonates that have been congenitally infected and these animals may suffer from a range of problems associated with reduced life span and lowered productivity.

Humans

In immunocompetent humans *Toxoplasma gondii* infection is common but clinical disease is rare. Infection produces an asymptomatic illness or a mild, febrile illness. Up to 30 to 50 percent of the world's human population has been infected with Toxoplasma and harbors the clinically inapparent cyst form.

Congenital infection is of greatest concern in humans. Women who are seropositive for *Toxoplasma gondii* prior to pregnancy but who are healthy and immunocompetent do not transmit the parasite to their foetuses. However, approximately 40% of women infected during pregnancy will transfer the infection to the developing foetus. The probability of this occurring increases with the trimester of pregnancy; 17% in the first, 24% in the second and 62% in the third. Severity of disease is more significant the earlier infection occurs. The vast majority of women infected during pregnancy have no symptoms of the infection themselves.

Three to four percent of infected neonates die, while the remainder will suffer from various forms of long term disease (mental retardation, blindness and epilepsy). It has been estimated that in congenital infections of babies 8-10% have brain and eye lesions while 10-13% become visually impaired. Nearly all those born with subclinical disease will develop symptoms later on.

Immunocompromised people (those suffering from AIDS or undergoing immunosuppressive therapy) also appear to be at risk from activation of a previously subclinical infection. Reactivation most often involves the central nervous system and symptoms can include meningoencephalitis. It has been estimated that 30% of AIDS patients who are seropositive will develop toxoplasmic encephalitis.

Diagnosis

A presumptive diagnosis may be made by demonstration of a fourfold or greater increase in antibody titers to Toxoplasma (indicating a recent infection) over a three- or four-week period in a cat showing signs suggestive of toxoplasmosis. A definitive diagnosis requires either microscopic examination of tissues or tissue impression smears for distinctive pathologic changes and the presence of tachyzoites or inoculation of suspect material into laboratory mice.

The presence of significant antibody levels in a healthy cat suggests that the cat has been previously infected and now is most likely immune and not excreting oocysts. The absence of antibody in a healthy cat suggests that the cat is susceptible to infection and thus would shed oocysts for one to two weeks following exposure.

The diagnosis of toxoplasmosis in people may include:

- Serologic testing is the routine method of diagnosis
- Observation of parasites in patient specimens, such as bronchoalveolar lavage material from immunocompromised patients, or lymph node biopsy
- Isolation of parasites from blood or other body fluids, by intraperitoneal inoculation into mice or tissue culture
- Detection of parasite genetic material by PCR, especially in detecting congenital infections in utero.

Epidemiology

Contact with oocyst-contaminated soil is probably the major means by which many different species—rodents, ground-feeding birds, sheep, goats, pigs, and cattle, as well as humans living in developing countries—are exposed to Toxoplasma. In the industrialized nations most transmission to humans is probably due to eating undercooked infected meat, particularly lamb and pork (in many areas of the world, approximately 10 percent of lamb and 25 percent of pork products contain Toxoplasma cysts). The organism may also on occasion be present in some unpasteurized dairy products, such as goat's milk.

Oocysts are first seen in the faeces of infected cats at 3 days after infection and may be released for up to 20 days. Oocysts sporulate (become infectious) outside the cat within 1-5 days, depending on aeration and temperature, and remain viable in the environment for several months. Cats generally develop immunity to *T gondii* after the initial infection and therefore shed oocysts only once in their lifetime.

Following consumption of uncooked meat containing tissue cysts (carnivores) or feed or drink contaminated with cat faeces containing oocysts (all warm-blooded animals), T gondii initiates extraintestinal replication. Bradyzoites and sporozoites, respectively, are released and infect intestinal epithelium. Young and immunocompromised animals may succumb to generalized toxoplasmosis at this stage. Older animals mount a powerful cell-mediated immune response to the tachyzoites (mediated by cytokines) and control infection, driving the tachyzoites into the tissue cyst or bradyzoite stage. Tissue cysts in the host remain viable for many years, and possibly for the life of the host.

The tachyzoite is the stage responsible for tissue damage; therefore, clinical signs depend on the number of tachyzoites released, the ability of the host immune system to limit tachyzoite spread, and the organs damaged by the tachyzoites. Because adult immunocompetent animals control tachyzoite spread efficiently, toxoplasmosis is usually a subclinical illness.

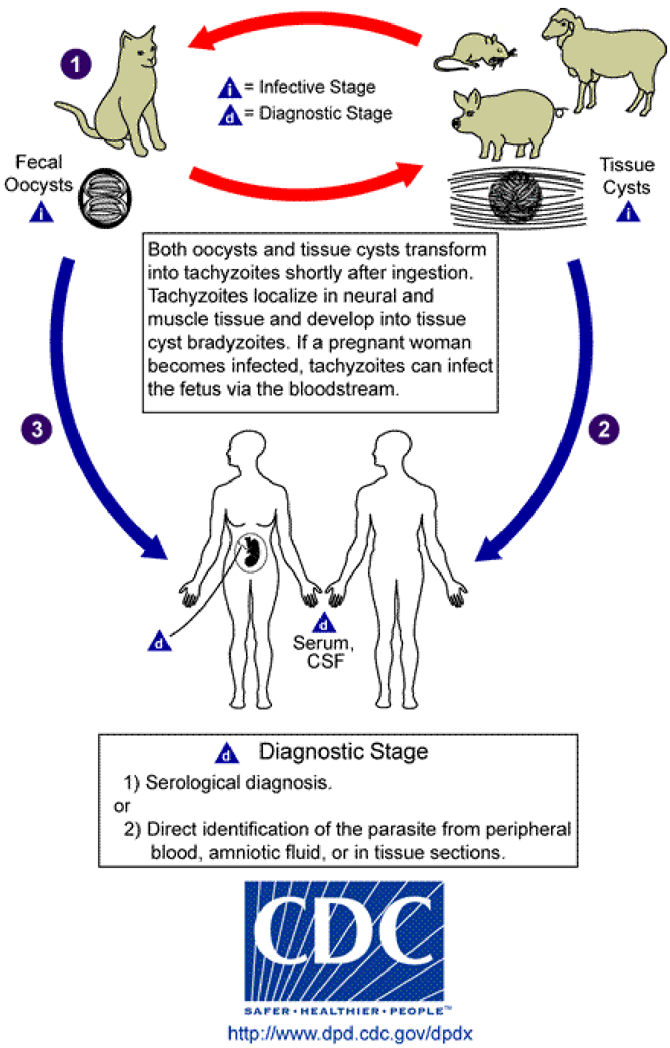

Figure 5: Life cycle for Toxoplasmosis

Control

Treatment of cats generally involves pyrimethamine and sulfadiazine, drugs that act together to inhibit Toxoplasma reproduction. Treatment must be started as soon as possible after diagnosis and continued for several days after signs have disappeared. In acute illness, treatment is sometimes started on the basis of a high antibody titer in the first test. If clinical improvement is not seen within two to three days, the diagnosis of toxoplasmosis should be questioned. No vaccine is as yet available to prevent either

Toxoplasma infection or toxoplasmosis in cats, humans, or other species. Research in this area is in progress.

Treatment is not needed for a healthy person who is not pregnant. Symptoms will usually go away within a few weeks. Treatment may be recommended for pregnant women or persons who have weakened immune systems.

Tissue cysts can be destroyed by thoroughly cooking meat to an internal temperature of 70°C (158°F) for at least 15 to 30 minutes.

Because excreted oocysts are highly resistant to environmental conditions and millions may be present in a single stool, contamination of garden soil, flower beds, children's sandboxes, cats' litter boxes, and other areas of loose, moist soil where cats defecate may be extensive. Under such conditions transmission of oocysts to humans can be minimized by the following measures:

- Avoid contact with potentially contaminated soil, or wear rubber gloves during contact, and follow by washing hands vigorously and thoroughly with soap and water
- clean vegetables and fruit before eating
- Cover children's sandboxes to prevent contamination by cats
- Dispose of faeces from litter boxes daily or every other day to remove oocysts before they sporulate and become infective
- Disinfect potentially contaminated litter boxes with scalding water or with dry-heat sterilization (55°C, 131°F)
- Chemical disinfection does not reliably destroy oocysts.

Pregnant women (or women planning pregnancies) may take extra precautions including:

- Excluding rare or undercooked meat and unpasteurized dairy products from the diet
- Testing household cats for antibodies to Toxoplasma
- Being tested for antibodies, preferably before becoming pregnant
- Protecting cats from infection (or reinfection) by preventing access to birds, rodents, uncooked meat, and unpasteurized dairy products
- Avoiding handling litter boxes
- Avoiding handling free-roaming cats or any cat showing signs of illness
- Wearing rubber gloves if working with garden soil. Uncooked vegetables, whether grown in a home garden or supplied commercially, should be washed thoroughly before ingestion, in case they have been contaminated by cat faeces
- Making a habit of vigorously and thoroughly washing hands with soap and water after contact with soil, cats, unpasteurized dairy products, or uncooked meat or vegetables.

At present there is no vaccine to prevent toxoplasmosis in humans.

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