Risk based strategies for the control of emerging strains of Foot-and-Mouth Disease virus in Bhutan

Kinzang Dukpa
Veterinary epidemiologist
National Centre for Animal Health
Department of Livestock
Ministry of Agriculture and Forests

Paper presented at the International conference on scientific developments and technical challenges in the progressive control of FMD in South Asia, New Delhi, India 13-15 Feb 2012.

ROAD MAP

- Introduction
- Approaches
- Disease epidemiology
- Conclusions

Introduction

- Frequent outbreaks in the country
- Disease epidemiology not clearly understood
- Risks (risk hotspots) not identified and assessed
- Risk-based approaches based on disease epidemiology

Approaches

- Research conducted as part of the PhD project

- Studies conducted under the FAO supported TCP (TCP/BHU/3301: June 2010-December 2011)

FAO FIAT PANIS	منظمة الأغذية والزراعة للأمم المتحدة	联合国粮食及农业组织	Food and Agriculture Organization of the United Nations	Organisation des Nations Unies pour l'alimentation et l'agriculture	Organización de las Naciones Unidas para la Agricultura y la Alimentación

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

TECHNICAL COOPERATION PROGRAMME

Country: Royal Government of Bhutan

Project title: Risk Based strategies for the control of emerging strains of Foot-and-Mouth Disease (FMD) virus in Bhutan

Project symbol: **TCP/BHU/3301 (D)**

Starting date: **June 2010**

Completion date: **September 2011**

Government Ministry responsible for project execution: Department of Livestock, Ministry of Agriculture and Forests

Budget covering FAO contribution: US$ 256 000

Approaches

- Retrospective analysis of existing data from passive surveillance system (1996 – 2008), active disease investigation reports.

- Prospective epidemiological studies

  - Cross sectional seroprevalence and risk factor studies

  - Livestock trading and animal movement pattern study

  - FMD vaccine immune status

FAO-FMD TCP/BHU/3301

Specific activities conducted

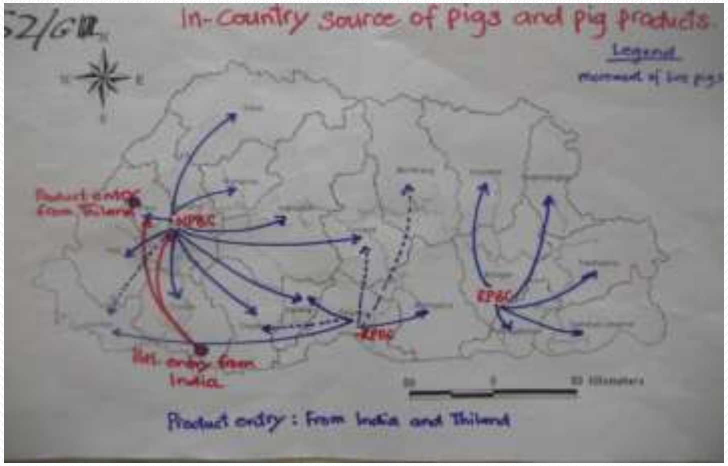
- Market chain analysis for FMD in pigs in Bhutan

- Design and implementation of vaccine efficacy studies

- Design and implementation of a surveillance plan

- Capacity build-up of laboratory diagnosis

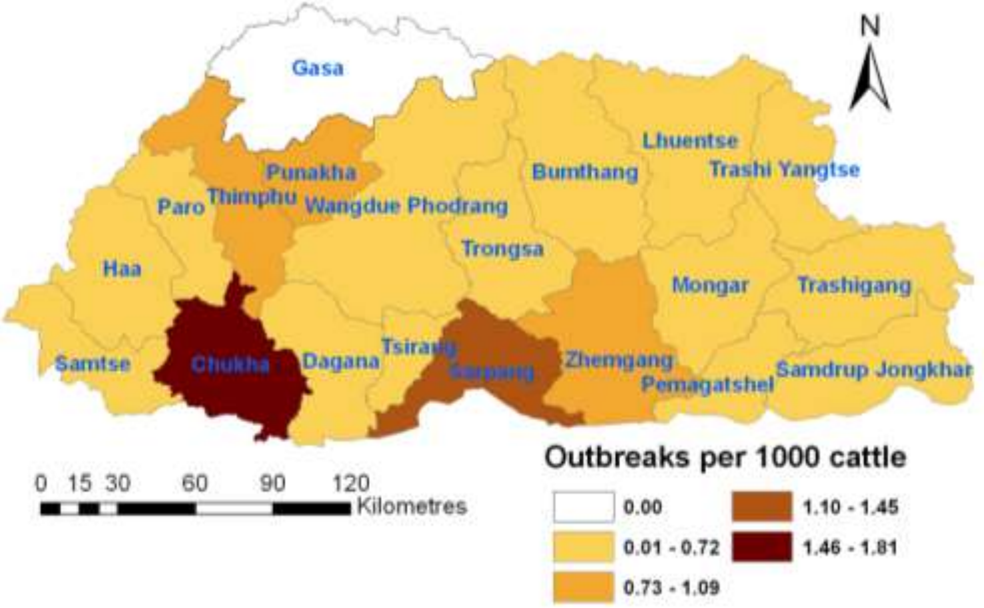
- Revision and reorientation of the current control plan.



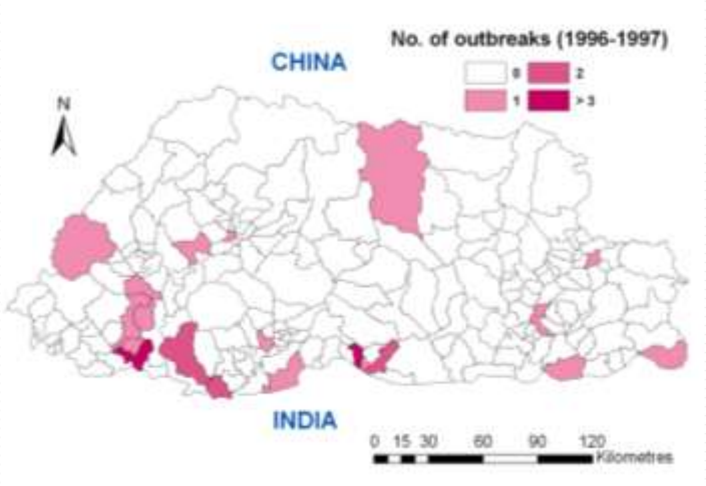
Disease epidemiology

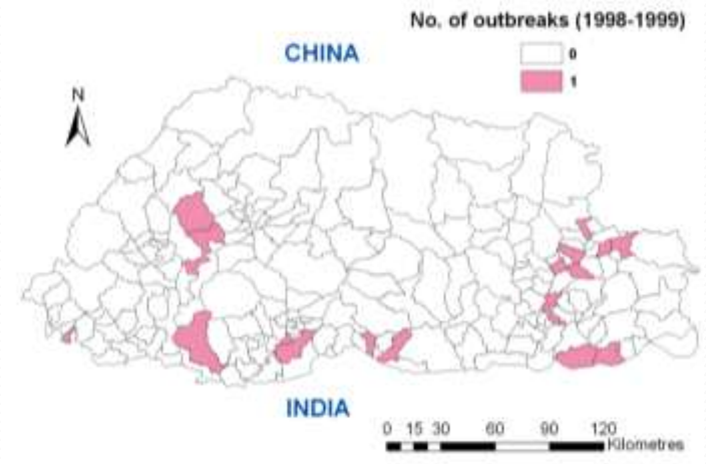
Districts/Sub-districts in south had more outbreaks than the interior ones

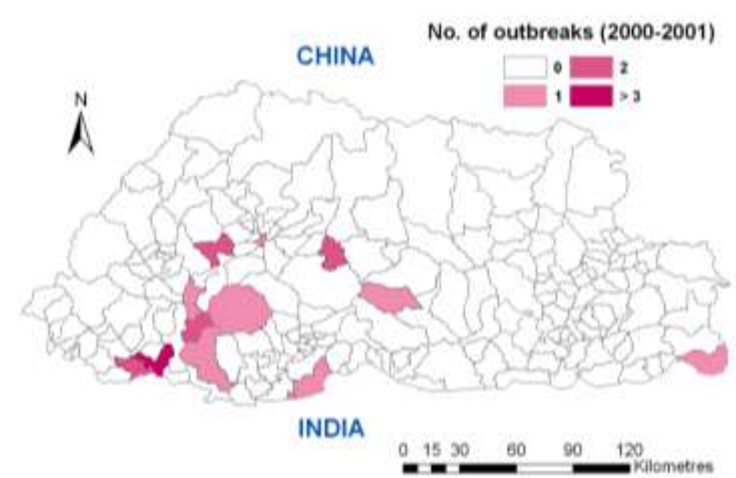
Sub-districts bordering India had higher seroprevalence 17.6% (95% CI: 14.7, 20.9) than the interior sub-districts (13.8%, 95% CI: 12, 15.8)



Spatial patterns

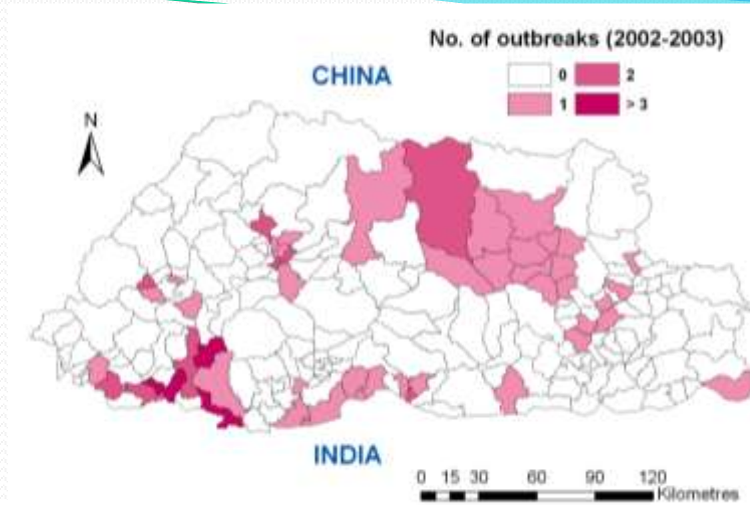


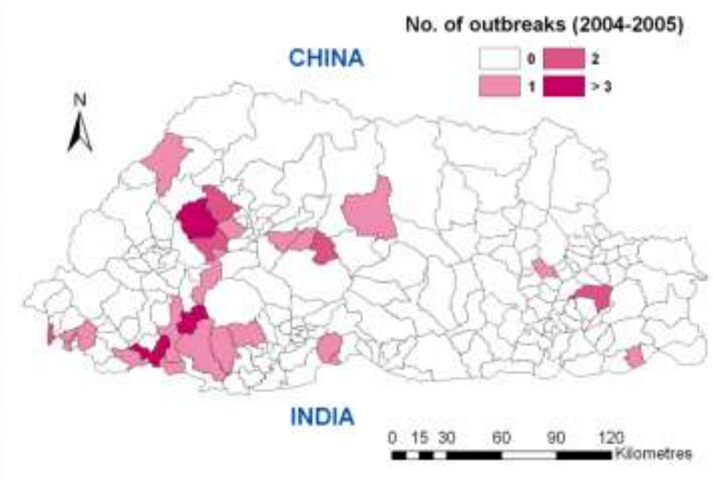


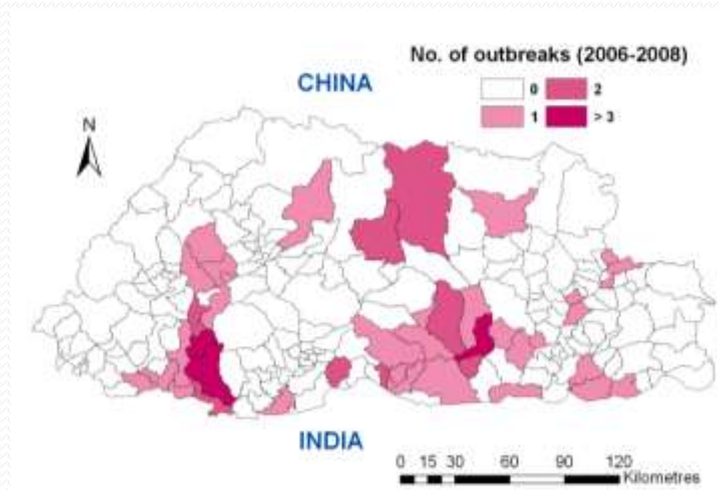


Choropleth maps showing the spatial distribution of outbreaks of FMD in Bhutan (sub-district level) over 2-year periods (Except for 2006-2008)

Spatial patterns

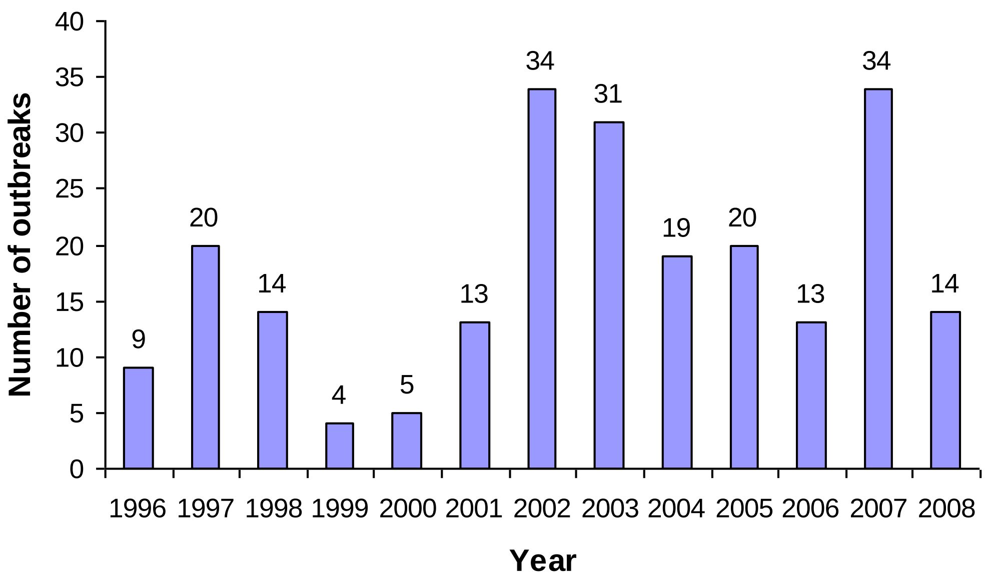


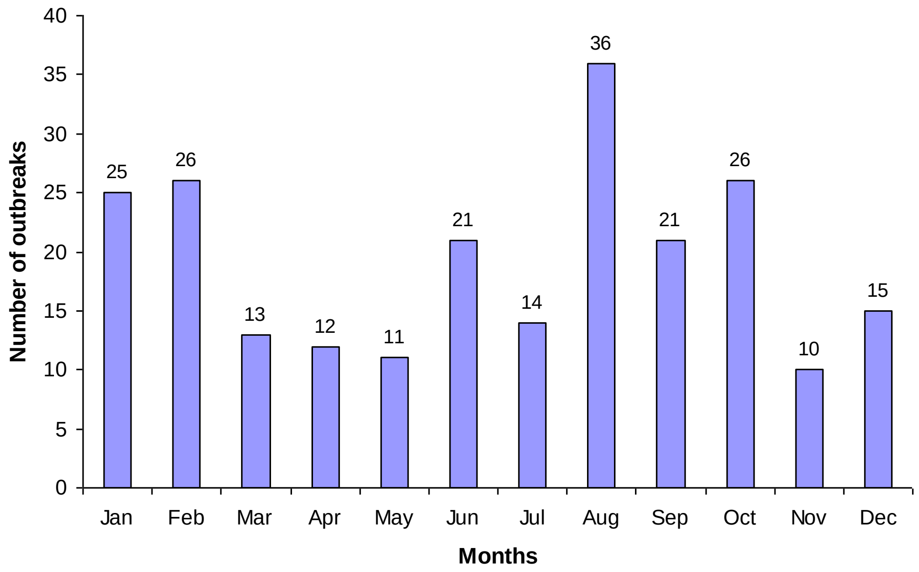




Choropleth maps showing the spatial distribution of outbreaks of FMD in Bhutan (sub-district level) over 2-year periods (Except for 2006-2008)

Temporal pattern





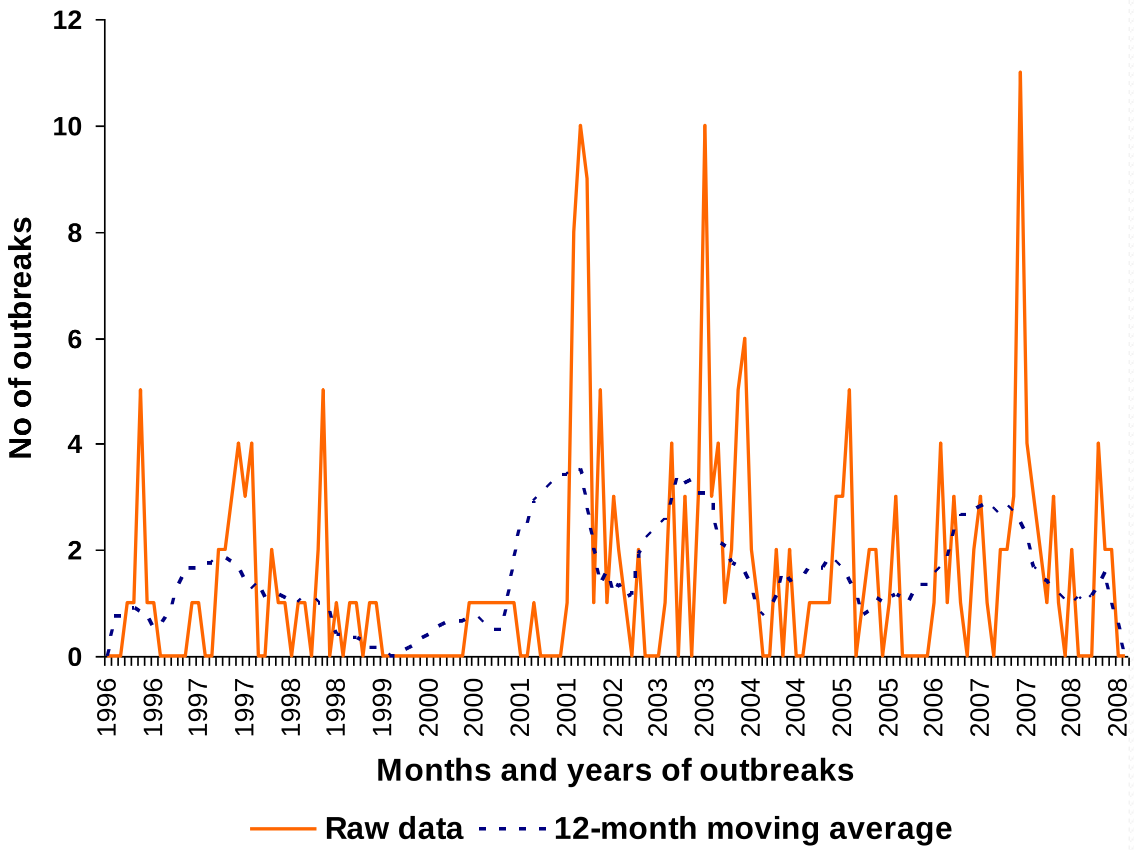
- Average of 18 outbreaks at sub-district level annually

- The sub-districts in the south had more outbreaks in summer

- The sub-districts in the north had significantly more outbreaks in winter

Temporal pattern

- Waves of outbreaks in epidemic proportions seen every 4 to 5 years
- 34 outbreaks in 1997/98; 65 outbreaks in 2002/03; 48 in 2007/08
- Incursion of the PanAsia strain of the O Serotype
- Transboundary movement of animals likely source of the incursion



Time series distribution of outbreaks of FMD in Bhutan

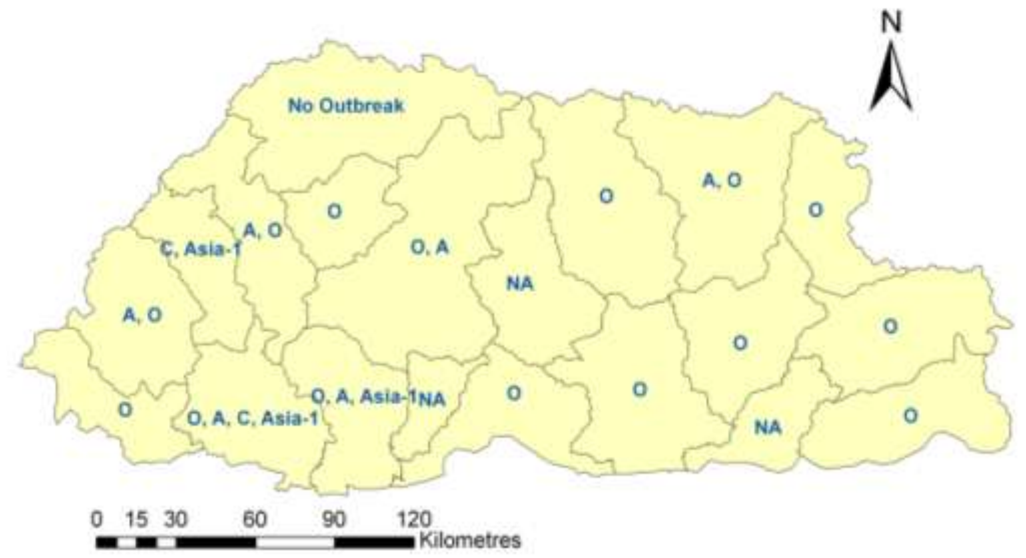
Species susceptibility

- Cattle - main susceptible species
  - Retrospective studies show that cattle was involved in all 230 outbreaks; Pigs (18 outbreaks); goats (13); and sheep (3)
  - Cattle (17.6%) had the highest seroprevalence followed by goats (11.9%), sheep (11.9%) and pigs (1.9%)

Small ruminants and pigs seem to play an insignificant role in disease epidemiology

Serotype distribution

- Serotype O (70.6%) the most prevalent serotype and C (3.9%) the least
- Last recorded occurrence of serotypes A in 2003, Asia 1 in 2002 and C in 1991
- The PanAsia strain of the ME-SA topotype of the O serotype recorded from 1998 onwards



Distribution of serotypes of FMDV in Bhutan (1982 to 2008)

The epidemic behaviour of the PanAsia strain of the O serotype

- The devastating capacity of the PanAsia strain was demonstrated during the 2007 FMD epidemic in Bhutan

- The strain caused significantly higher cumulative incidence in Zhemgang district (26.9%, 95% CI: 26.1, 27.8) as compared with Sarpang district (6.5%, 95% CI: 6.0, 7.0)

- The cumulative mortality in cattle was also significantly higher in Zhemgang (4.2%, 95% CI: 3.8, 4.6) than Sarpang (0.24%, 95% CI: 0.2, 0.4)

The PanAsia strain of the O serotype

Contrasting epidemiological features

- Unprecedented deaths
  - 404 cattle and 13 pigs in Zhemgang district
  - Only 21 cattle in Sarpang district
  - Calves accounted for 60% of total deaths in cattle

Findings

The risk factors

Description of variable	β[a]	SE[b]	Wald[c]	Sig[d]	OR[e] (95% CI)
1. Cattle always housed in shed during day	-3.41	1.65	4.27	0.039	0.03 (0.001, 0.83)
2. Cattle always housed in shed at night	-1.23	0.53	5.38	0.020	0.29 (0.10, 0.82)
3. Cattle fed kitchen wastes	2.64	0.47	31.73	0.000	14.1 (5.6, 35.23)
4. Cattle sent for grazing in forest	1.12	0.45	6.07	0.014	3.1 (1.25, 7.46)
5. Cattle mixed with herds from other villages at grazing	3.67	0.48	57.93	0.000	39.28 (15.26, 101.08)
6. Cattle mixed with more than 6 herds in same village at grazing	1.66	0.45	13.57	0.000	5.30 (2.18, 12.89)
7. Interaction between "Cattle sent for grazing in forest" and "Cattle mixing with herds from other villages"	-2.38	0.90	7.02	0.008	0.092 (0.016, 0.537)
8. Constant	0.17	1.60	0.01	0.913	1.19

Final logistic regression model

- Sub-districts bordering India significantly more outbreaks than interior ones
- Unrestricted mixing of animals at grazing and watering areas
- Mixing of cattle within villages

Animal movement patterns

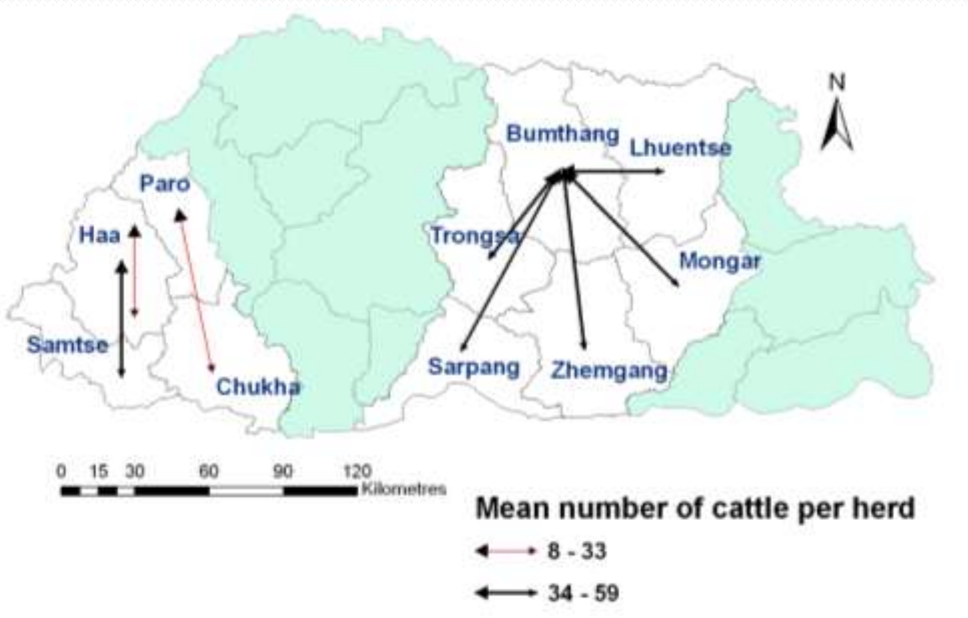
- Animal movements occur in multiple forms and varying magnitude

- Unrestricted animal movements within and between villages, sub-districts and districts

- Daily movements for grazing and watering purposes

Animal movement patterns

- Seasonal long-distance migration (transhumance)

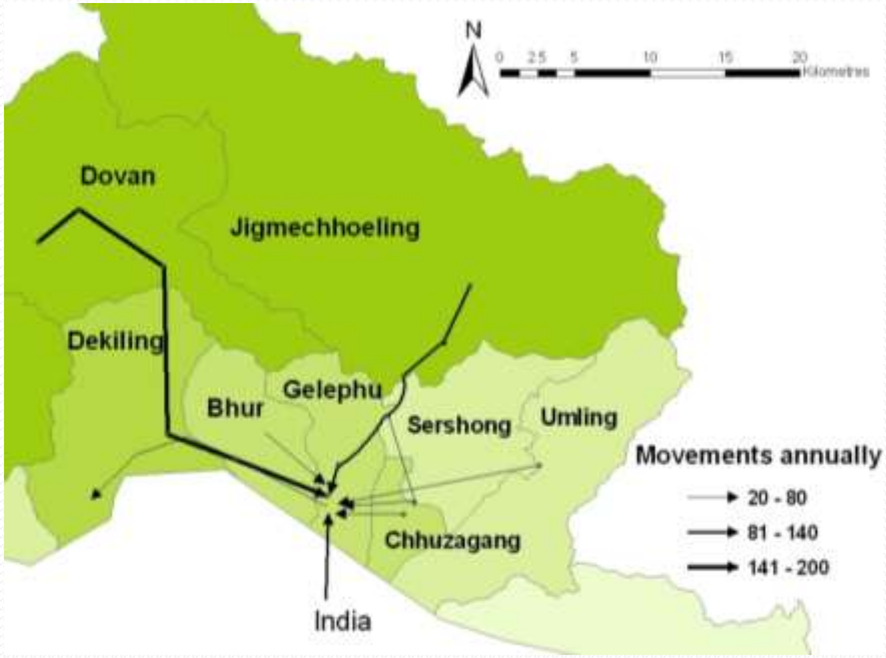


Overall migration patterns in the study area at the district level

All these pose significant challenges to disease control

Animal movement patterns

- Movements for livestock trading purposes



Trading pathways of cattle destined for Gelephu sub-district in Tsirang

A farmer from Tsirang walking his piglet (bought from Dagana district) along the highway

All these pose significant challenges to disease control

Animal movement patterns

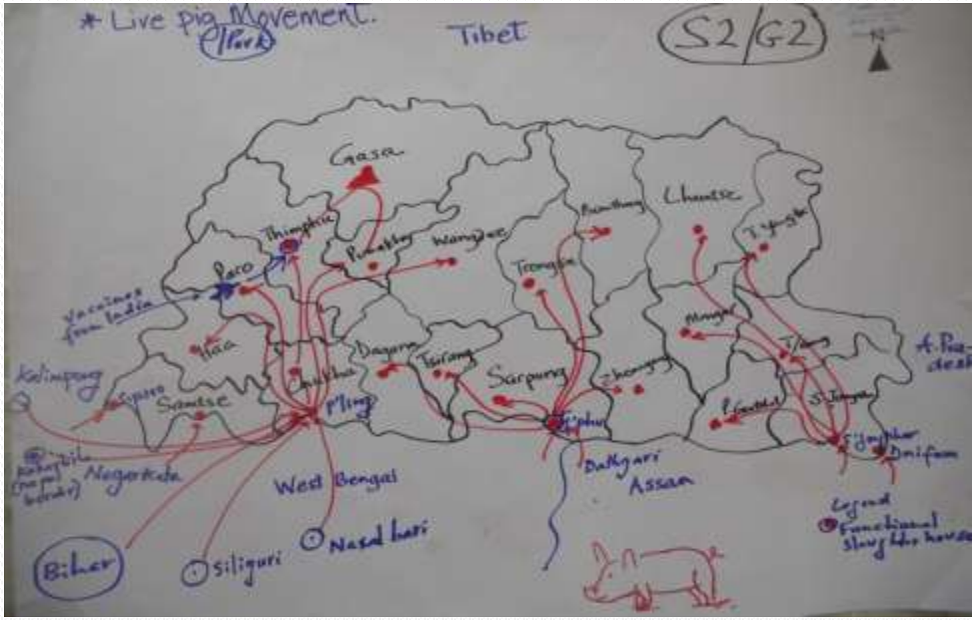
- Market chain analyses of pigs in Bhutan

•Risk from pig products higher in the south

• New strains from international imports

• Distribution pathways for livestock could facilitate rapid spread

• Emphasis on preventing swill feeding and particularly in the south



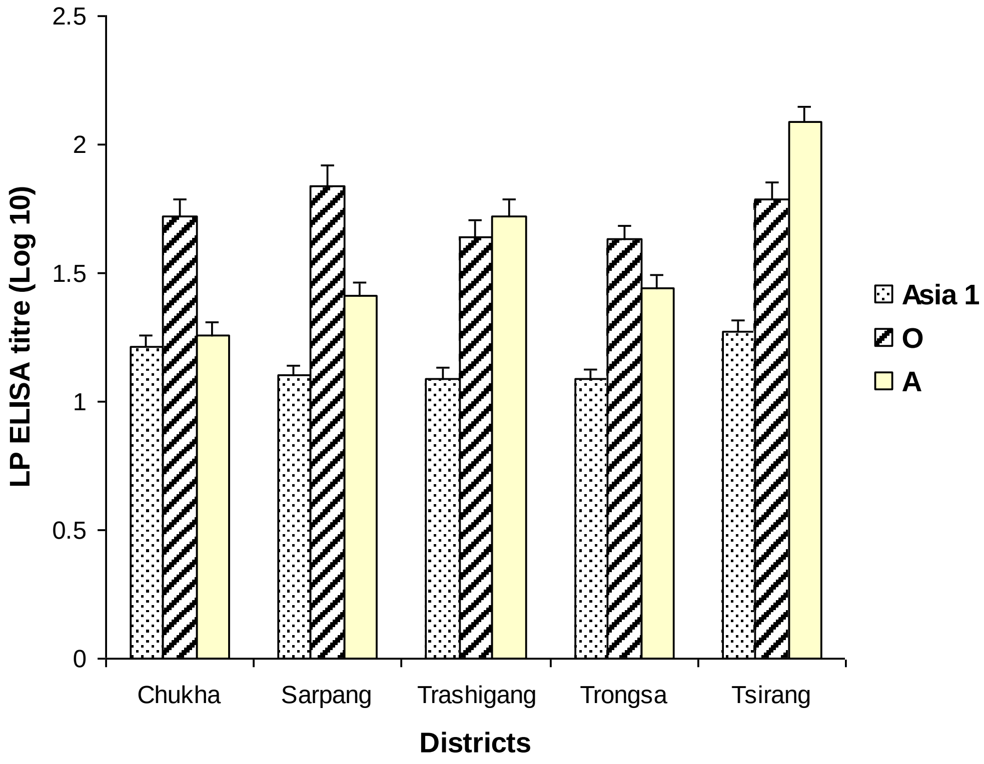
FMD vaccine induced immune status

- Overall very low immune status with seropositivity to serotype O (62.7%) being the highest, serotype A (55.7%) and Asia 1 (19.6%)

- Cattle in Tsirang (FMD-free) had significantly higher seropositivity to serotypes A and Asia 1 compared with endemic districts

- Except for serotype A in Tsirang, none of the districts had protective antibody titre (mean log titre >2.0)

- High proportion of cattle would be susceptible if FMDV gain entry into the population



Conclusions

- Districts and sub-districts bordering India more at risk of infection than interior districts
- Sub-districts bordering India act as primary endemic areas (areas for disease incursion and persistence)
- The interior districts appear to act as secondary endemic areas (areas for disease propagation)
- Disease incursion through the international borders via unrestricted mixing of animals – a real threat

Conclusions

- Animal movements, at all levels, pose significant challenge to the disease control efforts
- The devastating capacity of the PanAsia strain of the O serotype – need for sustained vaccination and increased surveillance
- Increased level of confidence in the current passive surveillance system although needs to be backed up through routine active surveillances
- Low immunity in vaccinated animals

Acknowledgements

- The FAO for the financial and technical support
- Professor Ian Robertson, Dr Trevor Ellis, Professor John Edwards, Murdoch University
- Director General, Department of Livestock, Bhutan.
- Drs Tashi, Pasang, Karma Rinzin, Dahal, Rinzin Pem, Basant, Chamling, Thapa, Raika, and Bir Doj of NCAH/RLDCs
- All DLOs/extension officials/laboratory technicians of the study area Dzongkhags
- All concerned laboratory technicians of NCAH/RLDCs/SVLs
- Chris Morrissy, Ross Lunt, and Leanne McNabb, of the Australian Animal Health Laboratory, Geelong
- Drs. Shih-Ping Chen, Michael Lee, Yeou-Liang Lin, Taiwan.
- Dr Evan Sergeant, AustVet Animal Health Services
- Australian Biosecurity CRC for the financial support
- PD-Mukteshwar, India, for the support
- The WRLFMD, Pirbright, UK