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Household Financial Status and Gender Perspectives in Determining the Financial Impact of foot and Mouth Disease in Lao PDR

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Summary

The socioeconomic impacts of foot and mouth disease (FMD) during 2011–12 outbreaks on large ruminant smallholders in Laos were investigated, including examination of data on gender, household financial status and farmer husbandry practices. A mix of participatory tools and survey questionnaires at the village and household level, respectively, were conducted, involving individual farmer interviews ($n = 124$) and group meetings with village elders to establish criteria for classification of household financial status as being 'poor, medium or well off' according to rice sufficiency, assets and household incomes. FMD-attributable financial losses were determined by inclusion of losses due to: mortality, morbidity and costs of treatments. The estimated mean financial losses due to FMD were USD 436 (±92) in the 'poor' and USD 949 (±76) in the 'well off' household categories ($P < 0.001$), being 128% and 49% of income from the sale of large ruminants, respectively. Variation in financial losses reflected differences in morbidity, farmer husbandry practices including frequency of observation of animals and thus recognition of FMD and choice of treatments. Of concern were adverse financial impacts of treatment especially where antibiotics were used; delays in reporting of FMD cases after observation of signs (mean of 2 days); admission that 10% of farmers had sold FMD-affected livestock; and that 22% of respondents claimed their large ruminants were cared for by females. The findings confirm that FMD has the most severe financial impact on poorer households and that females have a significant role in large ruminant production. It is recommended that livestock extension activities promote the benefits of prevention rather than treatment for FMD and encourage participation of women in biosecurity and disease risk management interventions including rapid reporting and regulatory compliance, particularly with animal movement controls and other biosecurity practices that reduce the negative impacts of FMD on regional food security and poverty reduction in rural communities.

Introduction

Unlike the green revolution in cereal grains in the 1970s that was largely driven by increasing supply, the livestock revolution has been stimulated by increasing demand for animal products, particularly in Asia where economic growth has continued at a remarkable pace and is geographically widespread (Delgado, 2003; World Bank, 2012). In the Lao People's Democratic Republic (hereafter Laos), South-East Asia and China in 2009, total annual meat consumption was approximately 21, 26 and 58 kg per capita, respectively (FAO, 2012), with projections to reach 30 kg

in South-East Asia and 73 kg in China by 2020 (Delgado, 2003). Increasing demand for meat in both domestic and neighbouring markets especially China and Vietnam has been enhanced by the development of a regional road network throughout the Greater Mekong Subregion (GMS; ADB, 2005). These developments provide a trading opportunity for Lao smallholder farmers to increase livestock income through improving livestock productivity, contributing to the alleviation of rural poverty and improving regional food security (Windsor, 2011).

Despite increasing demand and trading opportunities for meat and red meat in particular, many Lao large ruminant farmers have yet to take advantage of these changing circumstances, remaining in a transition between livestock keepers and more market-oriented producers. To improve large ruminant production, smallholder farmers have to overcome many constraints, including feed deficiency in the dry season and endemic diseases such foot and mouth disease (FMD), widely acknowledged as a major limitation for efficient and sustainable livestock production and representing a failure of the global food security system (ADB, 2005; Rushton, 2009; Windsor, 2011). FMD is a highly contagious endemic infection affecting mainly large ruminants in Laos and other countries in the GMS, compromising the livelihoods of smallholder farmers (OIE Sub-Regional Representation for South-East Asia, 2011). FMD outbreaks have been recorded for many years throughout Laos (Perry et al., 2002; Khounsy et al., 2009; Rast et al., 2010; Nampanya et al., 2012). Recently, financial losses due to FMD in northern Laos were estimated to possibly exceed USD 1200 per household, based only on losses due to mortality and morbidity and the costs of treatment (Nampanya et al., 2013a). Inclusion of indirect costs such as the cost of additional feed and labour costs to recover the weight lost during and post-infection, future production losses due to changes in herd structure including infertility, plus opportunity costs of lost trade, suggest that FMD-attributable losses on large ruminant smallholders are likely to be much higher (Perry et al., 2002; Rushton, 2009; Rast et al., 2010).

The South-East Asia foot and mouth disease (SEAFMD) campaign, launched in 1997 and expanded in 2010 to include China thus renaming it as SEACFMD, aims to achieve FMD freedom in South-East Asia by 2020. The strategic framework of the SEACFMD campaign describes the need for surveillance, early detection and reporting, rapid response, plus improved understanding of livestock movement and trade in the GMS (OIE Sub-Regional Representation for South-East Asia, 2011). Gaining support for the programme from potential international donors as well as large ruminant smallholder farmers, both male and female, is important for success of FMD control programmes. This can be enhanced through improved understanding of the financial impact of the disease and particularly the impact on trade and livelihoods of male and female farmers and other stakeholders, including cattle and buffalo traders, village veterinary workers, extension staff, researchers and policy makers. Further, consideration of the key factors that led to the previously successful FMD control and eradication programmes in other countries in the region is important (Windsor, 2011).

This study aimed to progress the recently published estimates of the financial impact of FMD in the northern uplands of Laos (Nampanya et al., 2013a). Data were collected and analysed from the central lowland in Laos, information obtained on gender and social financial status of FMD-affected households, plus the measures taken by farmers to deal with the outbreaks were recorded. By exploring factors of relevance to adoption of household animal disease control interventions (including vaccination and biosecurity) such as gender and socioeconomic status, it was anticipated that important information could be obtained to assist the progression of recommendations on sustainable FMD control in the GMS for use in the SEACFMD campaign.

The reasoning for including gender issues in the survey relates to concerns that although women are often at the frontline of animal care, their labour and responsibilities in animal production remain under-recognised and unappreciated by those designing and implementing livestock policies and plans (IFAD, 2004). Women's poor access to markets, services, technologies, information and credit decreases their ability to improve productivity and benefit from a growing livestock sector (FAO, 2006). Further, women are less likely to participate in production group leadership roles due to lower levels of education, perceived lack of experience and their focus on unpaid activities such as caring for children and the elderly, cleaning, cooking and other household duties (ADB, 2012). This study aimed to improve understanding of the role of women in large ruminant production in Laos, following an initial finding conducted by SRR-SEA in a Lao northern province of Xieng Khouang in 2011 that urban migration of men for paid employment often leaves women with increased responsibilities for livestock keeping (OIE, unpublished). More effective participation of women, particularly poor and ethnic women, and reduction of gender disparities, is considered crucial in efforts to alleviate rural poverty and improve food security in Laos and the GMS (Ministry of Planning and Investment, 2011; ADB and World Bank, 2012).

Methodology

Survey period, location and farmer selection

The study used a mix of participatory tools at the village level and a survey questionnaire at the household level. The

survey was conducted between November and December 2013 in the three provinces of Luang Namtha (LNT) and Borkeo (BK) in northern upland and Savannakhet (SVK) in central lowland of Laos. In each province, 2 to 6 villages ($n = 12$) were studied following selection derived from consultations with local livestock authorities and examination of village records available at district offices of the Department of Livestock and Fisheries. Criteria for inclusion were that (i) a series of FMD outbreaks occurred in the villages in 2011–2013 but preferably within 6–12 months prior to the survey; (ii) an abundance of large ruminants were present in the village; (iii) there was considerable trading of large ruminants into and out of the village; (iv) local traders and/or slaughter points were operating in the village; (v) ethnicity of the village; and (vi) year round vehicular access. Following discussions with the village chief and village veterinary worker and consideration of farmer availability for the interview period, in each village, 6–15 farmers with FMD-affected livestock were interviewed ($n = 124$). The major criteria for inclusion of smallholder farmers were that they had large ruminants affected by FMD between 2011 and 2013 and were willing to participate.

Village chief, veterinary worker and elder villager interviews

In each interviewed village, a group of farmers consisting of the village chief, veterinary workers and elder villagers participated in a group meeting to obtain an overview of the impact of FMD at the village level. The discussion determined the total number of households in the village, the number of households with livestock, the number of households with livestock where a female headed the household and the number of farmers with FMD-affected livestock. Rice sufficiency and assets including the numbers of livestock per household have been used in assessing level of poverty (Government of Laos, 2005). In our survey, the farmers with FMD-affected livestock were classified into one of three categories, being poor, medium and well off. This was based on the participatory discussion and following criteria that: (i) 'poor' families were those that did not produce enough rice for the household need, owned 5 or fewer cattle and/or buffalo, had <1 ha of land and had limited extra incomes other than from agriculture and livestock; (ii) 'medium' families were those families that produced enough rice (or a little surplus) for household needs, owned 6–10 cattle and/or buffalo, owned 1–3 ha of land, owned valuable assets (i.e. a good house, hand tractor, television) and had income from other activities (i.e. traders, labourers, public officer); and (iii) 'well off' families were those that produced excess rice to family needs and had income from rice sales, owned 10 or more cattle and/or buffalo, owned more than 3 ha of land, owned many valuable assets (i.e. hand tractor, small truck, a good house, television, village shop) and had income from activities other than agriculture (i.e. traders, labourers, public officers).

Farmer with FMD-affected livestock interviews

A survey team of four district livestock extension staff, three provincial livestock staff and the senior author interviewed the head of each household, taking approximately 1 h per farmer and 1–2 days per village. The interviews were informal, offering open questions about the topic, followed by probing questions to clarify the answers to complete information requested in the questionnaire. Questions covered household financial status parameters (annual household incomes, number of large ruminants), treatment costs for each FMD-infected animals and financial losses due to mortalities and morbidities (expected sale price of animal pre-FMD and 1 month following the onset of FMD). Farmer knowledge on basic biosecurity practices and their responses during the FMD outbreaks were also recorded. Information on individual household income derived from the interviews was used to categorize each interviewed farmer household status as poor, medium or well off according to the financial criteria as outlined.

Data management and analysis

The data were transcribed into spreadsheets in Microsoft Excel 2010. Annual household incomes were classified according to livelihood activities that included income from sales of agricultural produce (rice, maize, sugarcane, rubber and vegetables) designated as 'cropping', small animals (pigs, poultry and goats), large ruminants and other activities including labouring, trading and sale of non-timber forest products (NTFP) designated as 'other'. Estimations of financial losses due to FMD used a published framework (Rushton, 2009) and were calculated following our previously reported method (Young et al., 2013; Nampanya et al., 2013a). Financial losses due to FMD at household level included those due to mortality (100% of pre-FMD sale value), production losses due to morbidity (but excluding values of animal for draught as few animals are used for draft in these provinces) and costs of treatment with medicines (but excluding time taken in the care of ill animals and loss of secondary employment as few interviewed farmers had secondary employment opportunities in these provinces). Losses due to mortality were calculated from consideration of 100% loss of the farmer-estimated pre-FMD sale value of

the animal if it had been sold prior to FMD, multiplied by the number of mortalities. Losses due to morbidity were calculated from consideration of the difference in estimated sale values pre-FMD and 1 month following the onset of FMD, multiplied by the number of sick animals.

For the knowledge questions, responses were assessed based on answer guidelines developed by the research team. A correct answer was given one mark, and an incorrect or an 'I-do-not-know' answer was given a zero mark. Scores were added to obtain knowledge scores for each interviewed farmer with total marks of 12. The farmer knowledge scores, attitudes and practices during the FMD were used for data analysis.

Quantitative traits were analysed using a restricted maximum likelihood (REML) in GenStat 14th edition statistical program (VSN International) with surveyed location region (lowland and upland), gender of respondents (male versus female) and gender of household large ruminant caretaker categories (male versus female) as a fixed effect and farmer identification as a random effect. Linearity, homoscedasticity and normality assumptions were checked by diagnostic plots of standardized residues of the quantitative traits on model checking options of REML. Log-transformations were conducted to some variables to satisfy the test criteria. Dichotomous qualitative traits on responses to farmer attitudes and practices towards FMD were analysed using a chi-squared test. Comparisons between surveyed location and gender of livestock caretaker categories were made to determine financial impact of FMD. Gender of respondent category was used to compare farmer knowledge scores on biosecurity and their husbandry practices and responses during FMD outbreaks.

Results

Numbers of interviewed farmers, rice produced and large ruminants owned

The number of interviewed farmers, their household rice production and number of large ruminants per household by region categories were tabulated (Table 1). The survey showed that 82% and 87% of the interviewed farmers in the lowland and upland categories, respectively, produced enough rice for their household needs. The average number of large ruminants per household was 12 (±11) and 9 (±7) in lowland and upland categories, respectively, with 21% and 22% of the interviewed farmers, indicating that either adult or elderly female was the household large ruminant primary caretaker, respectively. Of interest, there was only one single parent household identified amongst the interviewed farmers (a single father).

Table 1. Survey sites, number of interviewed farmers, rice produced and large ruminants owned

Variables	Lowland	Upland	Overall
Surveyed location			
No. interviewed district	2	2	4
No. interviewed village	4	8	12
No. interviewed farmer	61	63	124
No. interviewed female farmers	24	17	41
Mean age of interviewed farmers (years)	50 (±12)	48 (±13)	49 (±12)
Mean size of farmer hh (pers./hh)	7 (±3)	6 (±2)	7 (±2)
Mean no. females in hh (pers./hh)	4 (±2)	3 (±1)	3 (±1)
Primary large ruminant caretaker			
Female	13 (21%)	14 (22%)	27 (22%)
Male	48 (79%)	49 (78%)	97 (78%)
Household financial status categories			
Poor	7 (11%)	12 (19%)	19 (15%)
Medium	40 (66%)	37 (59%)	77 (62%)
Well-off	14 (23%)	14 (22%)	28 (23%)
Rice production			
Grown rice in paddy field (%)	95	88	90
Rice produced (Tone/hh)	4.9 (±2.7)	4.7 (±2.3)	4.8 (±2.5)
Cultivated areas (ha/hh)	2.5 (±1.6)	1.3 (±0.6)	1.9 (±1.3)
Produce enough rice to hh (%)	82	87	85
Number of large ruminants (head/hh)			
Total	12 (±11)	9 (±7)	10 (±9)
Female cattle and buffalo	7 (±7)	6 (±5)	7 (±6)
Cattle	9 (±9)	7 (±6.3)	8 (±8)
Cow	5 (±5)	5 (±5)	5 (±5)

hh, household; pers, persons; Mean ± standard deviation.

Annual cash income and financial impact of FMD at smallholder household level

There were no significant differences in total annual income and income from the sale of large ruminants in both region and livestock caretaker categories. The predicted mean of the total annual household income was USD 2789 (±314) and USD 3032 (±186) in the household where the primary large ruminant caretaker was a female and male, respectively ($P = 0.3$), with USD 932 (±135) and USD 1007 (±126) derived from the sale of large ruminants, respectively ($P = 0.07$; Table 2).

There was no significant difference in the number of large ruminants sold per household, both by region and livestock caretaker category where the number of large ruminants sold per annum was 3 ($P = 0.6$ and 0.7, respectively). When asked how the family decided when to sell their large ruminants, 83% of the farmers said this was discussed within their family to obtain consensus, with more than 70% of the farmers indicating the adult female in their family was responsible for managing the money from the sale of large ruminants.

Table 2. Smallholder household income and the financial impact of FMD region and livestock carer categories

	Region category			Livestock caretaker category		
Variables	Lowland	Upland	*P*-value	Female	Male	*P*-value
Annual household income (USD/hh)						
Cropping	522 (±233)	1563 (±226)	0.01	985 (±228)	1000 (±135)	0.2
Small animals*	115 (±141)	141 (±251)		142 (±217)	124 (±201)	
Large ruminants	965 (±177)	1040 (±172)	0.8	932 (±135)	1007 (±126)	0.7
Others	1445 (±170)	284 (±166)	<0.001	718 (±173)	895 (±102)	0.4
Total income	3001 (±331)	3057 (±322)	0.9	2789 (±314)	3032 (±186)	0.3
Large ruminant sale in 2013 (heads/hh)	3 (±1)	3 (±1)	0.6	3 (±1)	3 (±1)	0.7
Large ruminants during FMD outbreaks (head/hh)						
Mean large ruminants	7 (±1)	9 (±1)	0.2	8 (±1)	8 (±1)	0.9
Mean infected animals	2 (±1)	7 (±1)	<0.001	4 (±1)	4 (±1)	0.6
Mean animals died from FMD*	0 (±0)	0 (±1)		0 (±1)	0 (±1)	
Financial losses due to FMD infection						
Treatment cost per animal (USD/animal)	6 (±1)	6 (±1)	0.9	6 (±1)	6 (±1)	0.8
Total treatment (USD/hh)	11 (±5)	40 (±5)	<0.001	28 (±4)	23 (±3)	0.4
Morbidity loss (USD/hh)	208 (±91)	807 (±86)	<0.001	507 (±81)	508 (±48)	0.9
Mortality loss (USD/hh)*	0 (±56)	0 (±89)		0 (±89)	0 (±69)	
Total loss (USD/hh)	224 (±94)	902 (±88)	<0.001	574 (±83)	551 (±49)	0.8
Total loss and income from large ruminants (%)	23	86		61	55	
Total loss and annual household income (%)	7	29		20	18	

hh, household; Mean ± standard error. Exchange rate at USD 1 = Lao Kip 8000. *Due to failure to satisfy the test criteria of normality and constant variances only mean ± standard deviation presented. There were 1242 large ruminants owned by the interviewed farmers, with 649 (56% morbidity) and 24 (3% mortality) displaying clinical signs of FMD or reported as dying (mostly young calves), respectively.

The predicted mean number of large ruminants reported as displaying clinical signs of FMD was significantly different between lowland and upland region categories, despite no difference between the numbers of large ruminants per household prior to FMD outbreaks. The number of large ruminants reported displaying clinical signs of FMD was 2 (±1) and 7 (±1) in lowland and upland region categories, respectively ($P < 0.001$).

There was a significant difference in financial losses due to FMD between region categories, but not between livestock caretaker gender categories. The estimation of financial losses due to FMD per household was USD 224 (±94) and USD 902 (±88) in lowland and upland categories, respectively ($P < 0.001$), being 23% and 86% of the household income from the sale of large ruminants, respectively (Table 2). The cost of FMD by livestock caretaker gender was USD 574 (±83) and USD 551 (±49) in the household where the primary large ruminant caretaker was a female and male, respectively ($P = 0.8$), being 61% and 55% of their household income from the sale of large ruminants, respectively.

The comparison within the household financial status categories identified that there was a significant difference in the total annual household income, income from the sale of large ruminants and total losses due to FMD. The predicted mean of the total income was USD 1221 (±181), 2625 (±92) and USD 5388 (±151) in the poor, medium and well off household categories, respectively ($P < 0.001$), with USD 338 (±154), 829 (±79) and USD 1927 (±130) derived from the sale of large ruminants, respectively ($P < 0.001$). The estimation of financial losses due to FMD was USD 436 (±92), 445 (±46) and USD 949 (±76) in the poor, medium and well off household categories, respectively ($P < 0.001$), being 128%, 53% and 49% of their household income from the sale of large ruminants, respectively (Fig. 1).

Farmer knowledge and practices during FMD outbreaks

The comparison of the farmer knowledge scores on basic biosecurity practices by region category was not significantly different despite significance in the gender respondent category. The knowledge score between the female and male respondent was 6 (±0.3) and 7 (±0.2) of 12 possible marks, respectively ($P = 0.02$), with 70% and 81% of the female and male respondents able to recognize FMD clinical signs, respectively ($P = 0.1$, Table 3).

There was no significant difference in the proportion of interviewed farmers reporting FMD cases in both region and gender respondent categories, where 70% and 82% of the farmers in the lowland and upland categories reporting the FMD case after 2 days of observing the clinical signs. Of the interviewed farmers in the lowland and upland categories, 48% and 80%, respectively, reported

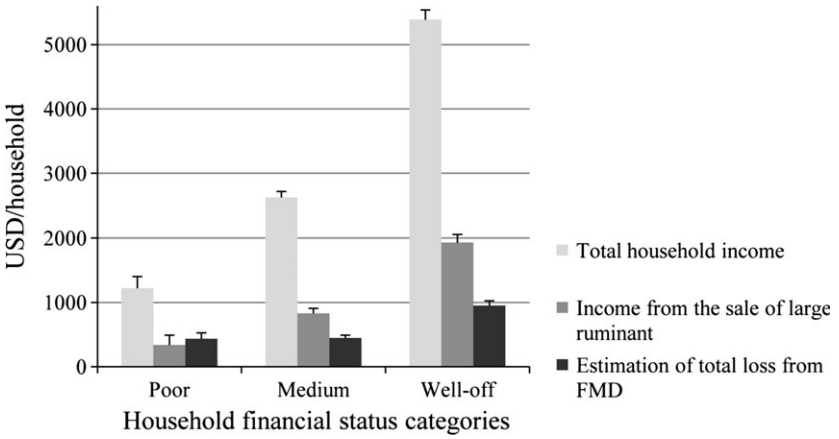

Fig. 1. Total income, income from the sale of large ruminant and estimation of total loss from FMD at smallholder household level. The bar chat represents the prediction means of variables in each household financial status categories. The error bars indicated standard error of the predictions.

Table 3. Farmer knowledge and practice responses during FMD outbreaks by region and gender of respondent categories

	Region category			Gender respondent category		
Variables	Lowland	Upland	*P*-value	Female	Male	*P*-value
Farmer knowledge on basic biosecurity practices (/12)	6 (±0.4)	7 (±0.4)	0.1	6 (±0.3)	7 (±0.2)	0.02
Recognized FMD clinical signs (%)	81	76	0.6	70	81	0.1
Reported FMD cases to village chief or district officer (%)	70	82	0.1	75	76	0.9
Delay after observing the disease to reporting (days)	2 (±0.4)	2 (±0.4)	0.5	2 (±0.3)	2 (±0.2)	0.1
Separation sick animals for treatment (%)	72	65	0.4	68	68	0.9
Treated FMD affected by (%)						
Farmer (self)	63	65	0.8	56	68	0.1
Other (VVW or district staff)	37	35		44	32	
Treatment used (%)						
Traditional	52	20	<0.001	40	44	0.5
Traditional + antibiotics	48	80		60	56	
Days of treatments	7 (±1.0)	14 (±1.0)	<0.001	11 (±0.7)	10 (±0.6)	0.1
Time to recover back to original value (months)	2 (±0.1)	2 (±0.1)	0.4	2 (±0.1)	2 (±0.1)	0.5
Admission of sale of FMD animals (%)	10	11	0.8	19	6	0.02
Had at least one animal die from FMD (%)	8	19	0.07	12	14	0.3
Handling of FMD-affected carcass (%)						
Bury/burn	80	75	0.8	60	83	0.3
Eat and/or sell	20	25		40	17	
Stock vaccinated for FMD in the last 6 months (%)	13	57	<0.001	29	32	0.3
Know where to contact for FMD vaccine (%)	24	55	<0.001	29	45	0.08

VVW, village veterinary workers.

they used antibiotics in addition to traditional medication to treat their FMD-affected stock ($P < 0.001$). In addition, 19% of the interviewed farmers in the upland categories, respectively, reported mortalities due to FMD ($P = 0.07$), with 10% (13 farmers: 8 females and 5 male respondent) of the total interviewed farmers admitting they had sold some of their FMD-affected livestock (Table 3), of which 3, 6 and 4 farmers were categorized as poor, medium and rich, respectively. Further, of these farmers, 8 (19% of the female respondent) and 5 (6% of the male respondents) were females and males, respectively ($P = 0.02$).

When questioned on FMD vaccination, more than half (55%) of the upland farmers mentioned they had their stock vaccinated for FMD and knew where to contact to obtain the vaccines ($P < 0.001$ and <0.001). When asked whether they still wished to have their stock vaccinated for FMD if they were required to pay part of the vaccine cost, 97% of the farmers expressed a positive response to the question with an ability to contribute to the vaccine cost of USD 0.7 (±0.3) per dose. (Cost of administering a single vaccination in northern Laos was estimated UDS 2.1–2.3 per animal by one of our coauthors, Khounsy, per. comm.).

Discussion

This study provides important information that progresses the recently published estimated financial impacts of FMD in the northern upland of Laos (Rast et al., 2010; Nampanya et al., 2013a) plus extends those studies to include central lowland Laos. It provides insights into impacts on households according to gender, financial status and information on farmer knowledge and practices during FMD outbreaks.

Our estimation of the financial impact of FMD confirms previous findings that the epidemic of FMD caused severe losses on smallholder farmer households in northern upland and central lowland Laos. Previous surveys in northern Laos and southern Cambodia indicated that FMD caused financial losses to smallholders in the order of 11% and 60% of their household annual income (Shankar et al., 2012; Young et al., 2013; Nampanya et al., 2013a). The major contributors to financial losses due to FMD identified in this study were losses due to morbidity of approximately 90% of the total losses, followed by the cost of treatment (especially antibiotics) and mortality, and this was in accord with previously published studies (Rast et al., 2010; Nampanya et al., 2013a). This information is important in educating smallholder farmers and especially those advisors providing livestock treatments. FMD causes significant financial impacts on household incomes from losses due to morbidity and mortality, compounded to extreme losses when expensive inappropriate treatments such as antibiotics are applied.

The cost of treatments for FMD is variable and depends on the duration of each FMD outbreak (Kitching, 2002) and the levels of smallholder losses due to the disease. Differences in financial losses between the surveyed region categories likely reflect variation in levels of morbidity, farmer husbandry practices (including the ability of farmers to recognize clinical signs of FMD) and the choice of animal treatments, particularly, as 80% of the interviewed farmers in the upland used antibiotics. In the dry season (December-May), when FMD outbreaks are more likely to occur (Nampanya et al., 2012) and large ruminants are free foraging, farmers in the lowland areas bring their stock back to overnight shelter in the evening. However, many farmers in the upland frequently leave their large ruminants to free graze in the forest and check them only once or twice per week in the dry season. These practices may contribute to the significantly higher morbidity and mortality from FMD, and when combined with high costs of treatment with antibiotics, there is a higher financial impact of the disease in the upland. In addition, other variables including climate and environmental variation between the regions may be important in the spread of FMD, particularly, as very cold weather enhances viral spread (Alexandersen et al., 2003) and may increase the susceptibility to FMD in animals suffering hypothermia as has been previously reported from the upland region (Khounsy, 2012).

In our survey, the difference in financial losses due to FMD between households, where males and female farmers were the primary livestock caretaker, was not significant. This suggests that both male and female livestock caretakers had similar but limited knowledge and understanding of FMD management. The significant difference in losses between the household financial status categories probably reflects the number of large ruminants and number of morbidities per household, with 'well off' households having more large ruminants and financial losses than other household classifications. However, in 'poor' households, the mean losses due to FMD exceeded the proportion of household income that accrues from the sale of large ruminants (128%) and as they have fewer assets, they are by far the most vulnerable to the financial impacts from FMD during outbreaks. Of interest is that only 10% of the interviewees admitted they had sold some of their FMD-infected animals. This is likely an underestimate of the true numbers of 'salvage sale' large ruminants as farmers are reluctant to reveal that they engaged in a prohibited activity. The significant difference in the proportion of female and male respondent admitting to having sold some their FMD-affected livestock suggested that female respondents were more inclined to discuss this issue openly than male respondents, although further study of this observation is recommended.

The low proportion of farmers having their livestock vaccinated for FMD is most likely the result of low availability of vaccines and veterinary services in Laos, where only 2% of rural villages have a veterinary clinic (Steering Committee for Lao Census of Agriculture, 2012). In recent years, strategic mass vaccination campaigns have only been implemented in northern Laos (Nampanya et al., 2012). The prevalence of endemic diseases including FMD is not only an indication of low vaccination coverage but more significantly reflects poor biosecurity practices (Larson, 2008). Our survey indicates there is limited farmer knowledge on large ruminant health and production as previously reported (Nampanya et al., 2010), with slow reporting of FMD cases, infrequent separation of infected animals for treatment, inappropriate treatment methods used and sale of FMD-affected animals identified. The results indicate that improved provision of information on farmer husbandry practices and disease management during FMD outbreaks as well as regulatory compliance (e.g. FMD-affected animals should not be sold), is required. In addition to vaccination when available, the biosecurity practices of quarantine and animal movement control, isolation of sick animals, attention to minimizing disease

transmission risks, proper disposal of infected materials, improved hygiene, surveillance and public awareness to encourage rapid disease recognition plus reporting of disease, should be promoted as essential elements of disease control programmes.

Our study indicates that women have a significant role in the care of household large ruminants, including as the primary career, in addition to their role as primary carer of pigs and poultry for their families (Chittavong et al., 2013). A recent Lao agricultural census identified that a third of women (32%) aged 15 and over spent more than 1 h per day on livestock activities (Steering Committee for Lao Census of Agriculture, 2012). Importantly, our survey indicated that women have a significant role in managing household finances, with 70% of farmers revealing that the money from the sale of large ruminant was kept by women, either the wife or elder female member in the family. This suggests that future extension activities requiring consideration of investments from household finances should include women. Of interest is that despite our attempt to include female-headed households with FMD-affected livestock in our survey, the team could not find any such persons in our study population. This probably reflects that in the northern and central region of Laos, only 3% and 6% of the total agricultural households were female-headed, respectively, with widowhood as the main reason for female headship (ADB and World Bank, 2012).

Significant variation in household income from cropping was observed between the surveyed lowland and upland categories in our study and could reflect differences in socioeconomic development between provinces and regions in Laos (Epprecht et al., 2008; Government of Laos and the United Nations, 2009). In upland Laos, commercial rubber, sugarcane, banana and maize cultivation is currently more prominent than in lowland areas due to proximity to borders with China and Thailand where there is high demand for these products, explaining the high income from cropping observed in this study. Although the planting of these commercial crops is an increasingly important source of income for upland farmers (Thongmanivong and Fujita, 2006), the establishment and expansion of commercial crops limits the available grazing land. This increases the pressure on the grazing large ruminant population, with some large ruminant smallholders choosing to sell some of their livestock, rather than be fined when their animals trespass into cash crop plantations of other farmers. For instance, the buffalo population in LNT in 2011 declined to the total of 8800 heads, less than half the number reported in 1999 (Steering Committee for Lao Census of Agriculture, 2012). A decline in the large ruminant population is counterproductive to attempts to improve productivity and smallholder livestock income through knowledge-based interventions, with farmers less likely to respond to extension messages that aim to control FMD by vaccination and biosecurity (Nampanya et al., 2013b).

The pathway for smallholder farmers from livestock keepers to more market-oriented producers requires a strategic approach promoting multiple interventions that involve major improvements in animal health and production practices (Nampanya et al., 2011, 2013b; Windsor, 2011). The development of value chain linkages that support market access is also needed as increasing productivity will have limited success if farmers are not increasingly linked to more enhanced markets (Arias et al., 2013). Efforts to improve public and private investment, livestock research and extension and human resource development to enhance production capacities, plus animal movement control, surveillance, vaccination and public awareness programmes to manage transboundary disease risk, have previously been recommended (Windsor, 2011). The strategy of promoting multiple interventions has enabled some Lao smallholder farmers to improve large ruminant production, health, biosecurity and disease risk management practices, contributing to improved household incomes (Nampanya et al., 2013b). Expansion of this strategy through rural development projects will likely contribute to improved regional food security and help alleviate poverty in the GMS. To enhance these extension efforts, it is recommended that learning activities should include women in the process due to their important roles as livestock caretakers and financial managers in smallholder households.

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