Smallholder large ruminant health and production in Lao PDR: challenges and opportunities for improving domestic and regional beef supply

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Abstract. Indigenous yellow cattle (*Bos indicus*) and Asiatic swamp buffalo (*Bubalus bubalis*) are important livestock species in the Lao People’s Democratic Republic (Laos). Data from 2011 estimated there was a national herd of 1 586 200 cattle and 774 200 buffalo, with average numbers of 5.3 cattle and 3.4 buffalo per farm household, indicating that the majority of farm households with large ruminants were smallholders, retaining large ruminants as a storage of wealth, for sale as meat, and as a source of manure fertiliser. Increasing demand for red meat in both domestic and neighbouring markets, driven by rapidly growing economies and urbanisation, offers opportunities for Lao smallholders to gain more income from their livestock. However, improving cattle and buffalo production and a more sustainable supply of safe beef and buffalo meat, requires that numerous production, health and welfare constraints be addressed, including: prevalence of important infectious and parasitic diseases, nutritional deficits particularly in the dry season, undeveloped trading, meat processing and marketing systems, limited veterinary and extension service capacity, adverse impacts from climate change and cultural practices specific to buffalo husbandry, plus policy developments that recognise and adapt to changes in land use. Improvements in large ruminant health, processing and marketing are of particular importance as these will enable poor smallholder farmers to participate in emerging beef markets and expand other agricultural enterprises, improving rural livelihoods, with potential reductions in rural poverty and increased food security. This paper identifies the strategic interventions that may increase the supply of cattle and buffalo and improve rural livelihoods in Laos and the Greater Mekong Subregion.

Additional keywords: Asiatic swamp buffalo (*Bubalus bubalis*), food security, large ruminant health and production, yellow cattle (*Bos indicus*).

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Introduction

Lao People’s Democratic Republic (Lao PDR or Laos) is a land-locked country located in the Greater Mekong Subregion (GMS), sharing borders with five countries (China, Myanmar, Thailand, Vietnam, and Cambodia). There are multiple ethnic groups in the Lao population of 6.5 million (Lao Statistics Bureau 2016). The majority of the population is dependent on agriculture, using natural resources and engaging in livestock, fishery and forestry activities for their livelihoods (Ministry of Planning and Investment 2011). The agricultural sector contributed ~33% of the total national Gross Domestic Product and employed ~75% of the workforce in 2010 (Ministry of Planning and Investment 2011; FAO 2012). Although rice production dominates the agricultural sector and accounts for 40% of land under cultivation (Ministry of Agriculture and Forestry 2010; FAO 2012), smallholder large ruminant production is increasingly important, providing animals and meat for sale or consumption, a storage of wealth, fertiliser for crops, participation in cultural festivities (e.g. bull fighting), and of decreasing importance, draught power for transport and cultivation. Livestock rearing, including cattle and buffalo, provides up to 50% of smallholder household annual cash income (Nampanya et al. 2013a; ADB 2005). Improving livestock productivity is an important national goal that can provide sustainable development of the economy and potentially, reduce rural poverty and food insecurity (Khounsy and Conlan 2008; Nampanya et al. 2010; Windsor 2011).

However, large ruminant production in Laos remains underdeveloped, with most rural households owning cattle and buffalo, best considered as livestock ‘keepers’ rather than ‘producers’ (Millar and Phoutakhoun 2008; Nampanya et al. 2010). There are multiple constraints to more modern and optimal production, including limited land availability, inadequate nutrition with poor quality fodder (e.g. rice straw), major...
transboundary and endemic diseases, poor animal husbandry skills, inadequate agricultural extension services, and a low capacity animal health reporting and disease response system (with suboptimal disease surveillance, few outbreak investigations, minimal confirmation of disease diagnoses, plus poor disease prevention and control management programs) (Windsor 2011). These constraints and subsistence production attitudes and practices, decrease the ability of many Lao smallholder farmers to achieve optimal production and increases their vulnerability to both endemic disease and climate shocks affecting their livestock and crops (Khounsy et al. 2012; Nampanya et al. 2014a, 2014b).

Despite recent price decreases for beef cattle, the current rapid rate of economic development appears to be continuous in the medium term in Laos and the wider GMS, with the expanding domestic and regional markets for food requiring a more biosecure and sustainable supply of safe meat (Nampanya et al. 2014b). Improving large ruminant health and production can enable poor rural smallholders to participate in and access these growing markets. The likely benefits include improved rural livelihoods with reductions in poverty and food insecurity.

A recently published paper has reviewed available information on these constraints pertaining to buffalo meat production in Laos (Nampanya et al. 2014b). We now update this information and identify remaining gaps in knowledge and practices that limit the supply of ‘red’ meat from both cattle and buffalo to the increasing domestic and regional demand. Suitable strategic interventions for improvement to assist in achieving a more sustainable food supply in Laos are discussed.

Meat consumption and opportunities for trade in Lao large ruminants

Increasing demand for products from farmed animals has been described as the ‘livestock revolution’ and is driven by the expansion of regional economies following urbanisation in rapidly developing countries, particularly in China and Vietnam (World Bank 2013; Nampanya et al. 2014b). Higher urban consumer incomes have led to diversified diets with inclusion of more meat and meat products (WHO 2007; FAO 2012). Total meat consumption per capita per year in China increased from 43 kg to 58 kg and in South-east Asia from 18 kg to 26 kg between 1997 and 2009, respectively. Projections are that this will grow at ~3.1% and 3.0% per annum to reach 73 kg and 30 kg by 2020, respectively (Delgado 2003; FAO 2012), although policies suggesting limits to meat intake are being discussed. In Laos, the total meat consumed per capita per year in 2009 was ~21 kg, with projections to grow ~4.5% (Ministry of Agriculture and Forestry 2010; FAO 2012). Increasing demand for meat in both domestic and neighbouring markets is now being supported by the development of a regional road network throughout the GMS (Ministry of Planning and Investment 2011). This provides livestock trading opportunities for many Lao smallholder farmers to increase household incomes from their cattle and buffalo, particularly if large ruminant productivity can be improved (Arias et al. 2013; Nampanya et al. 2014b).

Total meat production per capita increased steadily in Laos and its neighbouring countries between 2005 and 2009, with the exception of Thailand (Table 1). Total meat production in Laos increased from 17.4 kg to 21.3 kg per capita per year between 2005 and 2009 and in that period, bovine meat production was stable at ~7 kg per capita (Ministry of Agriculture and Forestry 2010; FAO 2012; Nampanya et al. 2014b). The Lao Agricultural Development Plan of 2011–2020 aims for sustainable development, food and income security, with an increase in total meat supply to 40–50 kg per capita and a per annum increase of 5% (Ministry of Agriculture and Forestry 2010). Achieving this goal is challenging and may require a systems approach with multiple interventions that address the numerous deficits in animal health services, production and processing practices, plus weak farmer to market linkages. However, many of these constraints could be addressed by knowledge-based interventions and should enable smallholder livestock farmers to improve productivity and market access (Windsor 2011; Arias et al. 2013; Nampanya et al. 2014a, 2014b).

<table>
<thead>
<tr>
<th>Countries/total and bovine meat</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>% change per annum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambodia Bovine meat</td>
<td>5.0</td>
<td>5.2</td>
<td>5.2</td>
<td>5.3</td>
<td>5.4</td>
<td>1.6</td>
</tr>
<tr>
<td>Total</td>
<td>16.1</td>
<td>16.1</td>
<td>16.2</td>
<td>16.2</td>
<td>16.6</td>
<td>0.6</td>
</tr>
<tr>
<td>China Bovine meat</td>
<td>4.3</td>
<td>4.4</td>
<td>4.6</td>
<td>4.6</td>
<td>4.8</td>
<td>2.3</td>
</tr>
<tr>
<td>Total</td>
<td>53.4</td>
<td>54.4</td>
<td>52.9</td>
<td>56.3</td>
<td>58.2</td>
<td>1.8</td>
</tr>
<tr>
<td>Laos Bovine meat</td>
<td>7.1</td>
<td>7.1</td>
<td>7.1</td>
<td>7.5</td>
<td>7.4</td>
<td>0.8</td>
</tr>
<tr>
<td>Total</td>
<td>17.4</td>
<td>18.1</td>
<td>18.5</td>
<td>20.2</td>
<td>21.3</td>
<td>4.5</td>
</tr>
<tr>
<td>Myanmar Bovine meat</td>
<td>2.8</td>
<td>3.2</td>
<td>3.4</td>
<td>3.6</td>
<td>3.7</td>
<td>6.4</td>
</tr>
<tr>
<td>Total</td>
<td>23.6</td>
<td>26.8</td>
<td>29.6</td>
<td>32.4</td>
<td>32.1</td>
<td>7.2</td>
</tr>
<tr>
<td>Thailand Bovine meat</td>
<td>2.3</td>
<td>2.5</td>
<td>2.7</td>
<td>2.9</td>
<td>2.9</td>
<td>5.2</td>
</tr>
<tr>
<td>Total</td>
<td>27.4</td>
<td>28.4</td>
<td>29.9</td>
<td>27.2</td>
<td>25.8</td>
<td>1.2</td>
</tr>
<tr>
<td>Vietnam Bovine meat</td>
<td>3.0</td>
<td>3.1</td>
<td>3.7</td>
<td>3.9</td>
<td>4.3</td>
<td>8.7</td>
</tr>
<tr>
<td>Total</td>
<td>35.5</td>
<td>38.6</td>
<td>42.5</td>
<td>45.6</td>
<td>49.9</td>
<td>8.1</td>
</tr>
</tbody>
</table>

Table 1. Meat production in Laos and its neighbouring countries, 2005–2009 (kg per capita per year)

Source: FAOSTAT online database, FAOSTAT (2013)

Trends in the population of smallholder large ruminants in Laos

Although estimated numbers of farming households with cattle and buffalo and the national large ruminant herd statistics differ slightly, this likely reflects the difficulties of obtaining accurate livestock data from smallholder farmers in Laos, particularly due to ethnic diversity, low educational standards and availability, and limited resources for regular data collection. In this paper, we used data from the most recent Lao Agriculture Census (Steering Committee for Lao Census of Agriculture 2012), demonstrating that the national cattle herd increased by 68% (4.4% per annum) from 944 100 in 1999 to 1 586 200 in 2011 (Table 2). The census also showed that in 2011, farm households with cattle had an average of 5.3 cattle, with 58% of these households having a herd size of four or fewer (Steering Committee for Lao Census of Agriculture 2012).

As previously reported (Nampanya et al. 2014b), both the number of farm households with buffalo and the numbers of buffalo declined significantly from 1999 to 2011. Of 782 800 total farm households, 226 400 (29%) kept buffalo, and the total buffalo population in 2011 was 774 200; demonstrating a buffalo
population decrease of 22% from 1999 (Steering Committee for Lao Census of Agriculture 2012; Nampanya et al. 2014a). Of farm households with buffalo, 78% had a herd size of four or fewer, with an average buffalo herd per household of 3.4. This reduction in buffalo numbers likely reflects several factors, including: replacement of draught animals due to increased farm mechanisation; expansion of the regional demand for buffalo meat; infectious disease outbreaks; and the occurrence of major mortality events due to hypothermia, as was reported following an extreme cold exposure event of March 2011 that resulted in cattle and buffalo between seasons, reflecting the negative energy balance from declining quality of feed during the dry season from December to May (Nampanya et al. 2014a). A carcass composition study was recently conducted, indicating carcass weights of cattle of 65–84 kg compared with 104–176 kg in buffalo; with dressing percentages of 39–42% and 37–40%, respectively (Nampanya et al. 2015a). These findings likely reflect the low level husbandry practices in a low input management system in much of Laos (Nampanya et al. 2014a, 2014b) as they are lower than those reported from neighbouring countries in the region, where the dressing percentages of buffalo and cattle were 45–50% (Dung et al. 2013; FAOSTAT 2013; Uriyapongson 2013; Nampanya et al. 2014b).

Improving Lao cattle and buffalo productivity will be difficult to achieve without provision of a more seasonally balanced supply of nutrients and improved farm management (Nampanya et al. 2010; Bush et al. 2014). Forage plantations have been promoted to assist management of feed shortages and provide a resource for fattening of large ruminants before sale to increase animal values. An on-farm fattening trial demonstrated that cattle and buffalo in fattening stalls (320 and 217 g/day) had significantly greater ADG than those free grazing (40 and 85 g/day), respectively (Nampanya et al. 2014a, 2014b), encouraging the participating farmers to continue livestock fattening activities to increase household incomes. The recruitment of other farmers requires their gaining knowledge on the planting, care and harvesting of forages, the level of investment required, plus the improved husbandry and basic biosecurity practices that are necessary to protect the increased investment. For those with available land, capital to invest and willingness to learn, higher returns from fattening activities can be used to further strengthen both their emerging large ruminant production and other livestock enterprises (Dorward et al. 2009; Nampanya et al. 2014b). Further investigations into methods of improving nutritional and feeding management, including silage preservation of forage and use of agricultural industry by-products (Napasirth et al. 2015) for cattle and buffalo calves pre- and post-weaning, is recommended.

Improved husbandry practices and nutritional management are increasingly important for smallholder farmers to more efficiently manage increasing climate variability and potentially worsening environmental degradation. Although buffalo are well adapted to the tropics they have less physiological adaptation to extremes of heat than various breeds of Bos indicus cattle if unable to access water soaks (Ahmad and Tariq 2010; Maria and Haeb 2010). Increased climate variability with higher temperatures may well lead to heat stress occurring when total body heat exceeds heat loss and thermoregulation fails, resulting in excessive heat load and an increase in core temperature (Gaughan et al. 2008).

In contrast to heat stress, cold stress has been shown to severely compromise large ruminant health and production in Laos, as previously noted in the devastating hypothermia episode in March 2011 that was estimated to have caused losses of US$2.5 million due to the deaths of over 10 000

### Table 2. Number of cattle and buffalo 2011 (× 1000) and their population change (%), 1999–2011 by regions

Source: Steering Committee for Lao Census of Agriculture (2012)

<table>
<thead>
<tr>
<th>Region</th>
<th>Cattle</th>
<th>Buffalo</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>355.3</td>
<td>78.9</td>
</tr>
<tr>
<td>Central</td>
<td>958.2</td>
<td>83.5</td>
</tr>
<tr>
<td>South</td>
<td>272.7</td>
<td>37.0</td>
</tr>
<tr>
<td>Total</td>
<td>1586.2</td>
<td>68.0</td>
</tr>
</tbody>
</table>

Of farm households with buffalo, 78% had a herd size of four or fewer, with an average buffalo herd per household of 3.4. This reduction in buffalo numbers likely reflects several factors, including: replacement of draught animals due to increased farm mechanisation; expansion of the regional demand for buffalo meat; infectious disease outbreaks; and the occurrence of major mortality events due to hypothermia, as was reported following an extreme cold exposure event of March 2011 that resulted in death of tens of thousands of buffalo and cattle (Khounsy et al. 2012). Further, reduced availability of grasslands from expansion of crop cash plantations is also likely to compromised buffalo production, as previously described (Nampanya et al. 2014a, 2014b). For example, maize, rubber, and banana plantations that were developed in recent years in Oudomxay, Luang Namtha and Bokeo provinces, forced many buffalo owners to sell some of their stock rather than be fined when their stocks trespassed into cash crop plantations of other farmers. Finally, another reason for declining buffalo numbers may include the preference for the slaughter of pregnant buffalo females for local consumption (Nampanya et al. 2014b, 2015a). Slaughtering of pregnant animals is of concern as it compromises breeding management through calf wastage and poor reproductive rates. Although it has been suggested that smallholder farmers may be unaware that their female buffalo are pregnant when sold, soup made from the gravid buffalo uterus is considered a delicacy in Laos (Nampanya et al. 2014b).

### Current smallholder large ruminant production in Laos

Smallholder farmers typically manage their large ruminants within a mixed crop and livestock system according to the rice cultivation calendar (McDermott et al. 2010; Nampanya et al. 2014a, 2014b). Three main husbandry systems have been described, including: (1) year-round free grazing; (2) seasonal free grazing; and (3) a seasonal daytime free grazing with opportunistic fattening (Nampanya et al. 2014a, 2014b). Variations in cattle and buffalo husbandry management practices reflect crop and livestock management, availability of land resources, seasonal feed availability and farmer knowledge of large ruminant health and production practices (McDermott et al. 2010; Nampanya et al. 2014a, 2014b).

The free grazing system in Laos was recently documented from a study of over 1500 local cattle and buffalo with baseline production parameters recorded between 2008 and 2011 (Nampanya et al. 2014a). This study provided evidence of low mean weight (182–204 kg in cattle and 325–357 kg in buffalo) and average daily weight gains (ADG) (55–84 g/day in cattle and 92–106 g/day in buffalo). Major variations were noted in bodyweights and ADG between seasons, reflecting the negative energy balance from declining quality of feed during the dry season from December to May (Nampanya et al. 2014a). A carcass composition study was recently conducted, indicating carcass weights of cattle of 65–84 kg compared with 104–176 kg in buffalo; with dressing percentages of 39–42% and 37–40%, respectively (Nampanya et al. 2015a). These findings likely reflect the low level husbandry practices in a low input management system in much of Laos (Nampanya et al. 2014a, 2014b) as they are lower than those reported from neighbouring countries in the region, where the dressing percentages of buffalo and cattle were 45–50% (Dung et al. 2013; FAOSTAT 2013; Uriyapongson 2013; Nampanya et al. 2014b).

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Another unseasonal cold shock event occurred again in February 2016, resulting in over 2000 cattle and buffalo deaths in many villages in northern and central Laos (Department of Livestock and Fisheries, unpubl. report). Of interest, it has been estimated that the impact of climate change due to associated risks with unpredictable floods and drought could lead to 1.1% reduction to the Lao Gross Domestic Product, particularly from impacts on the agricultural sector (Ministry of Planning and Investment 2011; ADB 2012).

**Important endemic diseases of large ruminants and their financial cost**

The endemic infectious diseases of Foot and Mouth Disease (FMD) and Haemorrhagic Septicaemia (HS), plus the parasitic infestations of *Toxocara vitulorum* and *Fasciola gigantica* are considered as important constraints on large ruminant health and production in Laos (Windsor 2011; Rast et al. 2013; Nampanya et al. 2014a, 2014b; Rast et al. 2015). Although there are few records of production losses due to these diseases in Laos, it has been estimated there is a combined mortality rate due to FMD and HS of ~10% annually (ADB 2005). Further, the financial losses from HS infection in 1990 involving 7500 cattle and buffalo mortalities were estimated at US$1.4 million (Patten et al. 1993). Liver fluke infestation has been estimated to cause annual losses between US$26 and US$52 million with a prevalence of between 15% and 26% (Copeman and Copland 2008), yet there is minimal knowledge of this parasite and its control by smallholder farmers (Rast et al. 2015). The endemic nature of these diseases negatively influences the production capability of large ruminants through high morbidity, increased mortality rates (Rast et al. 2013), slow growth rates and generally low body condition scores (Nampanya et al. 2014a, 2014b).

The financial impact of FMD varies between regions and countries depending on the production system in which the disease occurs, the size and the degree of re-infection risks, the capacity of local authorities to respond to the outbreaks (Kitching 2002; Nampanya et al. 2013a, 2013b) and importantly, negative impacts on trade. Recently, several studies have been published that demonstrate the extent of the financial impact of FMD on smallholders and illustrate the importance of disease prevention. Case studies in northern Laos and southern Cambodia show a reduction in sale values of 30–92% of pre-FMD values, following FMD infection (Shankar et al. 2012; Nampanya et al. 2013a; Young et al. 2013). The latest estimated financial losses due to outbreaks of FMD in 2011 in Laos was over US$13 million at the national level, based on the number of villages that were reported with FMD outbreaks. However, when the likelihood of FMD under-reporting was accounted for, the estimated potential financial losses at the national level increased to over US$100 million, being almost 12% of the estimated farm gate value of the national large ruminant herd (Young et al. 2014; Nampanya et al. 2015a, 2015c). These findings indicate that the financial impact of FMD on smallholder farmers is more significant than has been generally recognised and research to better understand the socioeconomic impacts of the disease in relation to food security and poverty reduction is recommended.

**Improvement of smallholder large ruminant health and production**

Despite livestock vaccination rates increasing nationally between 1999 and 2011, the vaccination coverage rate for cattle and buffalo in Laos is below 60% and is mainly for HS, reflecting the low availability of vaccines and veterinary services in Laos where only 2% of rural villages have access to a veterinary clinic (Steering Committee for Lao Census of Agriculture 2012; Nampanya et al. 2014b). However, the occurrence of diseases is not only an indication of low vaccination coverage but importantly, reflects absent or inadequate biosecurity practices (Nampanya et al. 2014a, 2014b). The concept of biosecurity refers to all the hygienic practices designed to reduce the risk of infectious diseases occurring or being introduced into a herd, or a country and includes practices to control the spread of infectious agents within a herd (Larson 2008). The introduction of village-level biosecurity and vaccination programs accompanied by farmer knowledge training through farmer ‘cross-visits’, applied research and ‘on the job’ training, is considered the highest priority, followed by nutritional management, parasite control and reproductive management (Khounsy et al. 2012; Nampanya et al. 2014b). Importantly, the introduction of village-level biosecurity practices should be conducted at an appropriate pace using participatory approaches to ensure the acceptance and sustainability of the programs (Nampanya et al. 2010). Depending on vaccine availability and level of farmer participation, FMD and HS vaccination should be implemented twice annually, preferably in May–June and November–December as these were identified as high risk periods for disease transmission (Nampanya et al. 2013a, 2013b).

Land and labour availability are also important considerations for individual farmers when adopting intervention activities. The average land holding per farm household in Laos in 2011 was 2.4 ha, with substantial variation between regions and provinces (Steering Committee for Lao Census of Agriculture 2012) including reductions in natural grazing and communal land due to leasing of land by the state for cash crops (Thongmanivong and Fujita 2006; Ministry of Agriculture and Forestry 2010).

Harmonisation of government and aid donor support and extension policies that are effective at national, provincial and district levels, is crucial for the development of the red meat industry in Laos (Nampanya et al. 2014b). There is also a need for formation of farmer co-learning and livestock marketing groups for animals and their products, enabling the sharing of resources and increasing the ability of smallholders to deal with cattle traders. Further, the development of a professional meat processing sector is urgently required in addition to attention to critical constraints in large ruminant health, production, welfare and trade (Windsor 2011).

The transition pathway between livestock keepers and more market-oriented producers, requires substantial improvements in farmer knowledge and practices of livestock husbandry, disease prevention and marketing (Nampanya et al. 2014b). Of interest to attempts to encourage adoption of productivity interventions by smallholder farmers, is the findings from a recent survey that women have a significant role in managing household finances, with 70% of farmers reporting that the money from the sale of large ruminant was retained by women, either the
wife or elder female member in the family (Nampanya et al. 2015c). This indicates that future extension activities requiring consideration of investments from household financial resources should include women. Further, public and private investments to achieve continuously improving livestock research and extension services, plus substantial human resource development, are critical in assisting large ruminant smallholder farmers during this transition period towards a more optimal large ruminant livestock productivity system (Windsor 2011).

Conclusion

Improving bovine productivity in Laos requires numerous management constraints to be addressed, including: health issues (parasites and endemic diseases, particularly Fascioliasis, Toxocariosis and HS control); biosecurity and transboundary disease management (particularly FMD); nutritional deficits particularly in the dry season; low reproductive performance and absent or poor breeding management; land-use issues; high slaughter rates of pregnant cows; undeveloped trade and marketing systems; limited veterinary and extension service capacity; and importantly, failures in regulatory compliance. The development of a professional meat processing sector is urgently required in addition to attention to critical constraints in large ruminant health, production, welfare and trade. Addressing these large ruminant system constraints is an enormous challenge for Laos. However, if substantial progress on these issues can be made, the emerging opportunities for leading large ruminant smallholders to develop small to medium-sized beef livestock enterprises, offers a likely viable pathway to improve the meat supply for Laos and the GMS.

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