



## Research paper

# The endoparasitism challenge in developing countries as goat raising develops from smallholder to commercial production systems: A study from Laos



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## ABSTRACT

Progressing economic development in Southeast Asia has increased regional demand for goat meat, leading to expanding production by smallholders and recently, development of commercial farms. In Laos, an emerging export market for goats into Vietnam has led to increased goat numbers, with potential increases in risk of disease, particularly endoparasitism. A cross-sectional survey investigated the prevalence of gastrointestinal parasites in indigenous Kambing-Katjang goats on smallholder farms ( $n = 389$ ) in 8 villages where no anthelmintic treatments were in use, providing comparisons with a case study of imported Boer crossbred goats ( $n = 45$ ) on a commercial farm where intensive anthelmintic treatments were required to manage mortalities attributable to Haemonchosis. Clinical examinations, collection of faecal samples, and pathological examination on the commercial farm, accompanied collection of information on animal gender, age and body weight, with data analyses performed in Genstat. Faecal samples contained eggs of multiple endoparasitic species, with *Strongyles* spp. and coccidian oocysts of *Eimeria* spp. most prevalent. Significant associations between the presence of endoparasites and the farm type (smallholder versus commercial;  $p < 0.008$  and  $0.001$ ) were observed, with the odds ratios of the commercial farm having *Strongyles* spp. and *Eimeria* spp. of 1.3 (CI = 0.6–2.9) and 4.8 (CI = 2.5–9.1). Mortalities from endoparasitism were only recorded at the commercial farm, with the loss of 24 goats in the final 3 months of the dry season (Feb–April). This study identified a moderate prevalence of multiple endoparasitic species in smallholder goat farms that appeared well-tolerated, whereas in the developing commercial system, endoparasites posed significant risks to enterprise viability, even with use of anthelmintics. Further studies on endoparasite control are required if commercial tropical goat meat production is to prove sustainable and assist in addressing regional food security, plus provide a pathway to improve the livelihoods of Lao goat smallholders seeking to expand and intensify their enterprises.

## 1. Introduction

Goats are increasingly important for subsistence food production with over 90% of the global goat population found in developing countries (Glimp, 1995; FAO, 2005; World Bank, 2013). As goats produce several livestock products with lower inputs than cattle and buffalo, smallholder goat farmers in developing countries, particularly in Asia and Africa, have increasingly been recruited to goat raising, with goats described as an 'entry point' on the 'pathway from poverty'. Goats are considered more easily managed than cattle, especially by resource poor farmers, including women. Goat raising offers households nutritional benefits as meat protein for hunger alleviation, enhanced

livelihoods from animal trading income, more effective utilisation of family labour, and increased livelihood stability and resilience in rural communities due to more self-reliance (FAO, 2005; World Bank, 2013). Further, goats provide nutrients for soil fertility as manure fertiliser for croplands, plus reproduce quickly and are in considerable demand in many countries, particularly where Islamic festivals occur. In Southeast Asia, goats have been of increasing importance, particularly in countries with large Islamic populations, including Indonesia, Malaysia, and parts of the Philippines and Thailand. However, in recent years, increasing demand for consumption of goat meat in Vietnam and China has created opportunities for increasing production in the Lao People's Democratic Republic (Laos, henceforth). Currently, the government of

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Laos is attempting to obtain an average meat supply for local consumption of 60 kg/capita/year, plus increase meat exports to a value of USD50 million by 2020 (FAO, 2005).

In Laos, goat production is traditionally extensive with low inputs, and subsequently low outputs (Kounnavongsa et al., 2010). Four major goat management systems have been described, including: free range; semi-free range; semi-rotational grazing; and permanent grazing with or without tethering. Free range is the most commonly observed system, although semi-free range can be found in areas where cropping predominates (Kounnavongsa et al., 2010; Phengvichith and Preston, 2011). In most systems, goats are herded back to the village and kept in small hutches overnight for protection, although housing is only considered beneficial if it is kept clean (Phengsavanh, 2003). The system used by an individual farmer will depend upon feed and labour availability plus local community agreements, particularly related to cropping and use of common grazing areas (Kounnavongsa et al., 2010; Phengvichith and Preston, 2011).

Typically, Lao goat herds consist of 3–10 animals (Kounnavongsa et al., 2010; Phengvichith and Preston, 2011), although there are some recent examples of developing herds with as many as 200 animals raised on semi and fully commercial farms. Approximately 215,600 goats were recorded in Laos in the 2011 agricultural census (Steering Committee for Lao Census of Agriculture, 2012). This data is likely to be underestimated the actual numbers of goat currently as the Lao goat is widely considered to have been increasing rapidly due to recent expanding regional demand for goat meat, particularly from Vietnam, with estimates that between 2000 – 3000 goats per month are being exported (Phengsavanh and Hoang, pers. comm.).

Increasing demand for consumption of goat meat in Laos and neighbouring Vietnam and China, is providing opportunities for smallholder farmers to increase productivity and has led to the development of semi to full commercial production systems to capitalise on the growth in this emerging livestock sector, particularly if biosecure transboundary trade can be enhanced (Stur et al., 2000; Windsor, 2011; Nampanya et al., 2015). However, introducing goats and expanding small goat herds where smallholders and potential commercial operators have limited experience of small ruminants, can be exceedingly challenging. In recent years, many international development agencies have promoted smallholder goat-raising programs with distribution of goats to untrained farmers, often accompanied by severe mortality and morbidity problems (Windsor et al., 2017). Unfortunately, these incidents have generally been poorly investigated, as numerous goat-raising programs have been established without adequate veterinary advice and in countries such as Laos where veterinary services are poor and knowledge of goat diseases is low or non-existent. Where investigations have occurred, these have mostly been performed by non-veterinarians, with spurious conclusions and interventions, including that animals have died from bloat and diarrhoea of undetermined aetiology, and animals being treated with antibiotics without regard to food safety and antimicrobial residue issues. Recent observations suggest that the main constraints to raising goats in Laos include high mortality rates of kids, with disease issues including internal parasitism, Contagious Ecthyma (Orf virus), pasteurellosis and other infectious and metabolic diseases, plus potential risk of endemic foot-and-mouth disease (FMD) and incursion of Pestes des Petits Ruminants (PPR) from neighbouring countries to the north (Windsor et al., 2017).

Further, lack of reliable feeding systems with seasonal deficiencies in both quantity and quality of nutrition are issues requiring attention. Improving goat production in Laos requires systematic caprine studies to provide the evidence-basis for the practical approaches that can assist smallholder goat farmers improve their husbandry and health practices for increasing goat productivity. For this reason, a cross-sectional study was undertaken aimed at estimating the likely prevalence and risk association of internal parasites in goats on smallholder farms compared to a commercial farm in Laos, plus determine baseline live weights of various age categories for future benchmarking following

**Table 1**  
Number of villages, farmers and faecal samples collected.

Variables	Location		Farm type		Total
	Lowland	Upland	Smallholder	Commercial	
No. sampled villages	4	4			8
No. sampled farmers	35	32	66	1	67
No. faecal sample collected	227	207	389	45	434

likely interventions to improve the efficiency of Lao goat production systems.

## 2. Materials and methods

### 2.1. Study site, farmer and goat selection

This cross-sectional survey was conducted between February 2015 and May 2017, involving 4 lowland and 4 upland villages with 66 smallholder farms, and one commercial farm ( $n = 67$ ; Table 1). We defined goat smallholder farmers as those farmers with less than 20 goats where their goats are free or semi-free grazing extensively on the common grassland, forest and paddy fields in the dry seasons, with limited inputs, and where reproduction and management interventions including supplementary feeding (such as salt and minerals), anthelmintics and vaccinations, are rarely provided. Four smallholder villages and the commercial farm were located in the lowland Xathany district of Vientiane Capital (VTE) and an additional 4 smallholder villages were located in Pakseng district in upland Lung Prabang Province (LPB). The selection of each smallholder site for investigation was based on discussions with senior veterinarians and district officials to establish the following selection criteria: (1) there is a presence of goats (> 50 heads) in the village; (2) ethnicity and language acceptability; and (3) year round vehicular access.

In each village, 5–10 goat farmers were selected for participation, based on the list of the farmers with goats in the village provided by village chief. A sample size of 434 goats was determined within the expected prevalence of disease in the population of 0.01 and 95% confidence and population size of > 10,000 (Foggate, 2009; Dohoo et al., 2010). The selection of animals at the smallholder farms was dependent on the number and availability of animals per farmer, although no more than 6 samples were taken from the sampled herd, with gender and age considered. From detailed discussions with the goat owners it was considered highly unlikely that any of these goats had previously been treated with anthelmintics. Most (if not all) goats were free-grazed during the day and housed overnight.

The commercial farm was selected on the basis of proximity to the National University of Laos (NUOL) campus for agricultural studies (at Nabong near Vientiane) and willingness to be involved in applied research on goat health and production. Approximately 20% of the herd (consisting of about 220 goats) was randomly selected, with gender and age also considered. All animals in this herd were Boer-crossbred goats imported from Thailand and their progeny, although more detailed information on their genetic basis was unknown. These animals were also housed overnight and provided with a range of feed supplements, with grazing during the day in a silvopastoral system where goats had access to weeds growing beneath a Eucalyptus tree plantation. The use of anthelmintics, particularly ivermectin (1cc per 30 kg bodyweight) and mebendazole (13–15 mg/bodyweight or 1 tablet of 500 mg per 30 kg bodyweight), administered at doses widely considered as therapeutic in this species (sometimes twice the recommended dose rate for sheep as advised by the manufacturer), was instituted on commencement of the operation in 2015. The farm operator administered anthelmintic treatments to his herd two to four times per year (rotating between ivermectin and mebendazole) with further treatments with

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