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Why are simple control options for *Toxocara vitulorum* not being implemented by cattle and buffalo smallholder farmers in South-East Asia?

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ABSTRACT

Toxocara vitulorum infection in large ruminants is endemic in many tropical countries and particularly in South-East Asia. A single treatment of calves with pyrantel at 14–21 days of age effectively controls the parasite. Despite this treatment being readily available, *T. vitulorum* infection remains common and widespread. To understand drivers of effective control of *T. vitulorum* infection, we examined treatment practices and knowledge of smallholder farmers of this parasite plus determined annual calf morbidity and mortality and identified potential risk factors for these estimates. Interviews were conducted with 273 smallholder farmers who had calves tested for *T. vitulorum* 4–6 months earlier. Reproductive rates of 0.6 and 0.4 calf per annum in cattle and buffalo respectively, and annual calf morbidity and mortality of 42.6% (CI 0.38–0.47) and 37.3% (CI 0.33–0.42) respectively, were identified. Interviewed farmers had either none (80.6%) or only minimal (19.4%) knowledge about *T. vitulorum* and only 2.5% of the farmers treated their calves for *T. vitulorum* using the recommended control regime. Multivariable logistic regression analyses with random effects showed that the number of adult cattle per household, *T. vitulorum* infection status of the household herd and farmer knowledge of *T. vitulorum* were significantly associated with calf morbidity and mortality. Financial analysis using partial budgeting showed a net benefit of USD 3.69, 7.46, 11.09 or 14.86 per calf when treating calves with pyrantel and attributing 25%, 50%, 75% or 100% of morbidity and mortality to *T. vitulorum* infection. The study identified that poor reproduction, high calf morbidity and mortality combined with very limited farmer knowledge and effective control of endemic Toxocariasis, contribute to suboptimal large ruminant production in mixed smallholder farming systems in South-East Asia. The large net benefit per calf achievable by a single pyrantel treatment should drive implementation of this intervention by smallholder farmers, especially as demand for livestock products continues to increase in this region and forces a change to more production oriented farming. To support this, continued capacity building that ensures knowledge transfer of best practice *T. vitulorum* control to smallholder farmers is required.

1. Introduction

In South-East Asia but especially in the less developed countries of the region, agricultural production is dominated by smallholder farming systems that are mixed enterprises producing crops (predominantly rice)

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and livestock. The farmers use basic traditional farming methods operating at subsistence levels. They face many constraints, including low land availability, isolation, poor infrastructure, limited knowledge of livestock production and animal health practices, endemic diseases, low capacity animal health systems, poorly developed market systems and widespread poverty. These constraints are evident in the mountainous north of Lao PDR (Lao People's Democratic Republic, or Laos). Smallholders typically own 6–7 cattle and/or buffalo (Nampanya et al., 2010), may have access to between 1.1 and 1.8 ha of unirrigated land and rely on farming for their livelihood (Lao Department of Statistics, 2010). Cattle and buffalo are an important asset, providing manure for fertilising crops, meat, draft power and most importantly a cash reserve. Animals are sold when the household requires cash rather than for optimal returns. Despite the importance of large ruminants, animal health inputs are minimal and supplementary feeding or routine animal health preventative measures such as vaccination are rarely practised. Records are rarely kept resulting in a lack of baseline production information (including reproductive performance, calf morbidity and mortality) to inform understanding of the clinical and financial impact of diseases such as *Toxocara vitulorum*.

There is an increasing demand for animal products including red meat in South-East Asia. This is driven by the rapidly growing regional economies and urbanisation, both of which are projected to continue (Delgado et al., 1999; Steinfeld et al., 2006). An opportunity exists for smallholder farmers in the region to increase large ruminant productivity and their income by the provision of more and better quality large ruminants to this market (Windsor, 2011). However this requires a change from traditional low-input low output-livestock production systems to more productive livestock farming using modern technologies that enable livestock to generate income rather than being an asset for storage of wealth.

T. vitulorum is an endemic nematode infection of young (<3–4 months) cattle and buffalo calves in tropical regions. A major impact of *T. vitulorum* infection is the associated mortalities as well as morbidity, leading to uncompensated stunted growth in calves that survive (Starke-Buzetti, 2006). Control of *T. vitulorum* may provide a simple intervention for smallholder farmers to increase productivity of their large ruminants. This is especially as a single treatment of pyrantel given to calves when they are 14–21 days old effectively controls the parasite and reduces environmental contamination with eggs (Roberts, 1993). Pyrantel is readily available in South-East Asia and is relatively cheap with a dose for a calf costing 0.25–0.37 USD. However widespread effective and continuous control of *T. vitulorum* is lacking, with a survey conducted between September 2009 and June 2010 in northern Laos reporting prevalence of 22.6% in cattle and buffalo calves <3 months of age and widespread infection with 76.8% of villages where calves were sampled having at least one positive calf (Rast et al., 2013).

The objective of this study in northern Laos was to (1) assess smallholder farmer knowledge and practices of large ruminant production and management of animal diseases especially *T. vitulorum*, (2) assess calf morbidity and mortality and its association with *T. vitulorum* infection and farmer knowledge and practices and (3) analyse the financial impact of *T. vitulorum* treatment of calves.

2. Materials and methods

2.1. Study design and area

Face-to-face interviews were conducted with 273 or 45.0% of smallholder farmers that owned calves tested for *T. vitulorum* 4–6 months earlier, located in 34 villages in 17 districts of the five northern Laos provinces of Bokeo, Houaphan, Luang Namtha, Luang Prabang and Xieng Khouang. Villages were randomly selected using a random generator calculator (http://www.random.org) from those that had participated in the prior prevalence survey and had more than eight households with calves tested for *T. vitulorum*. In each selected village, eight households were randomly selected from the list of households that had calves sampled previously. Lao Department of Livestock and Fisheries (DLF) district staff arranged permission to visit the village with the local authorities and the village headmen.

2.2. Questionnaire and interviews

The questionnaire was designed in English, translated into Lao and pilot tested with two DLF district extension staff to ensure appropriate local terminology especially related to *T. vitulorum* was used. The final questionnaire contained 21 open and closed questions that aimed to elicit data on the location of the household; household income for the past five years; number, age, gender, species and monetary value of large ruminants owned; number of calves born to each female whilst owned; calf morbidity and mortality over the last 12 months; and knowledge and practices of farmers about *T. vitulorum* and control. A copy of the questionnaire is available as a supplementary material. Interviews were conducted face-to-face in Lao with the household member responsible for the large ruminants in July and August 2010. Interviews took approximately one hour per farmer to complete and responses were recorded in Lao. The interview team consisted of the same two researchers for all interviews, plus one or two different DLF district staff in each of the 17 districts where interviews were conducted. The local DLF staff members of each district were trained on the purpose of the study, the interview process and the questionnaire on the day before the interviews were conducted in their district. Prior to the interview, an explanation was provided to the farmers about the survey purpose and the importance of providing accurate answers to the questions and stating if they were unsure or did not know an answer.

2.3. Data entry and management

Completed interviews were translated into English by an independent translator and data entered into a