ELSEVIER

# The impact of anthelmintic drugs on weight gain of smallholder goats in subtropical regions

Paul R. Bessell[a,*], Neil D. Sargison[b], Kichuki Mirende[c], Ranjit Dash[d], Sanjay Prasad[e], Lamyaa Al-Riyami[f], Neil Gammon[f], Kristin Stuke[g], Roy Woolley[f], Miftahul Barbaruah[e], Philemon Wambura[c]

[a] Epi Interventions, 17 Bangholm Avenue, Edinburgh, EH5 3AS, UK
[b] University of Edinburgh, Royal (Dick) School of Veterinary Studies, Easter Bush Veterinary Centre, Roslin, Midlothian, EH25 9RG, UK
[c] Department of Veterinary Microbiology and Parasitology, Faculty of Veterinary Medicine, Sokoine University of Agriculture, P.O. Box, 3019, Morogoro, Tanzania
[d] Gir Odisha Foundation, Kadei, Badachana, Jajapur, Odisha, India
[e] Vet Helpline India Pvt Ltd. H.No 31/32 Milanpur (Near Masjid No.1), Chandmari, Guwahati, 781021, Assam, India
[f] GALVmed, Doherty Building, Pentlands Science Park, Bush Loan, Penicuik, Edinburgh, EH26 0PZ, UK
[g] GALVmed, Galana Plaza, 4th Floor, Wing C, Suite B, Galana Road, Kilimani, Nairobi, Kenya

## ARTICLE INFO

## ABSTRACT

Helminth infections are recognised as a major impediment to the productivity of goats in smallholder production systems. We used a multilevel framework to estimate the impact that administration of locally available anthelminthic drugs can have on the weight gains of goats in smallholder settings in India and Tanzania.

We recruited 234 goats from 92 households from Odisha state in India and 253 goats from 15 households from Dodoma region in Tanzania. The goats were non-pregnant adult females, and from each household a minimum of two goats were recruited wherever possible. Each goat was randomly assigned to treatment with a locally available anthelminthic drug, or non-treatment. Each animal was tagged, weighed and had its body condition score (BCS) assessed. Animals were followed up after 28 and 56 days and re-weighed. To account for the local variations in exposure to helminths and for variations between households and herds, the data were analysed in a multilevel mixed model with herd in village as nested random effects.

Over the 56 days of study, the non-treated goats in India had gained a mean of 30.64 g per day (a daily gain of 0.23% baseline body weight) and in Tanzania 66.01 g per day (0.33% baseline body weight). From the mixed model, the treated goats in India gained a mean of 25.22 g per day more than non-treated goats, this is significantly greater than the weight gain in non-treated goats (p < 0.001). In Tanzania treated goats gained a mean of 9.878 g per day more than non-treated goats, which is also significantly greater than non-treated goats (p = 0.007). Furthermore, in India and Tanzania, goats with a lighter weight at the baseline survey gained greater amounts of weight. In both studies the BCS of the treated goats improved by a greater amount than the non-treated goats.

In this study we have demonstrated that in certain settings, the administration of anthelminthic drugs has a clear beneficial impact on goat weight.

## 1. Introduction

Smallholder farming is vital to agricultural production and the livelihoods of rural populations in subtropical countries, with goats being an important livestock species. Infections with helminths in goats are very common. Studies typically identify prevalences of infection that can be as high as 100% with very high burdens of infection in infected animals (Dixit et al., 2017; Rupa and Portugaliza, 2016; Sharma et al., 2016), but in other settings both the prevalence and burden of infection can be much lower (Haile et al., 2018). Helminth infections reduce weight gain, thus impacting on the time taken to reach target weights for slaughter or reproduction, and reducing the efficiency of conversion of nutritional inputs that are required for the animal to reach maturity (Sargison et al., 2017).

There are a number of anthelminthic drugs that are available off-the-shelf to smallholder farmers. Anthelminthics may be broad
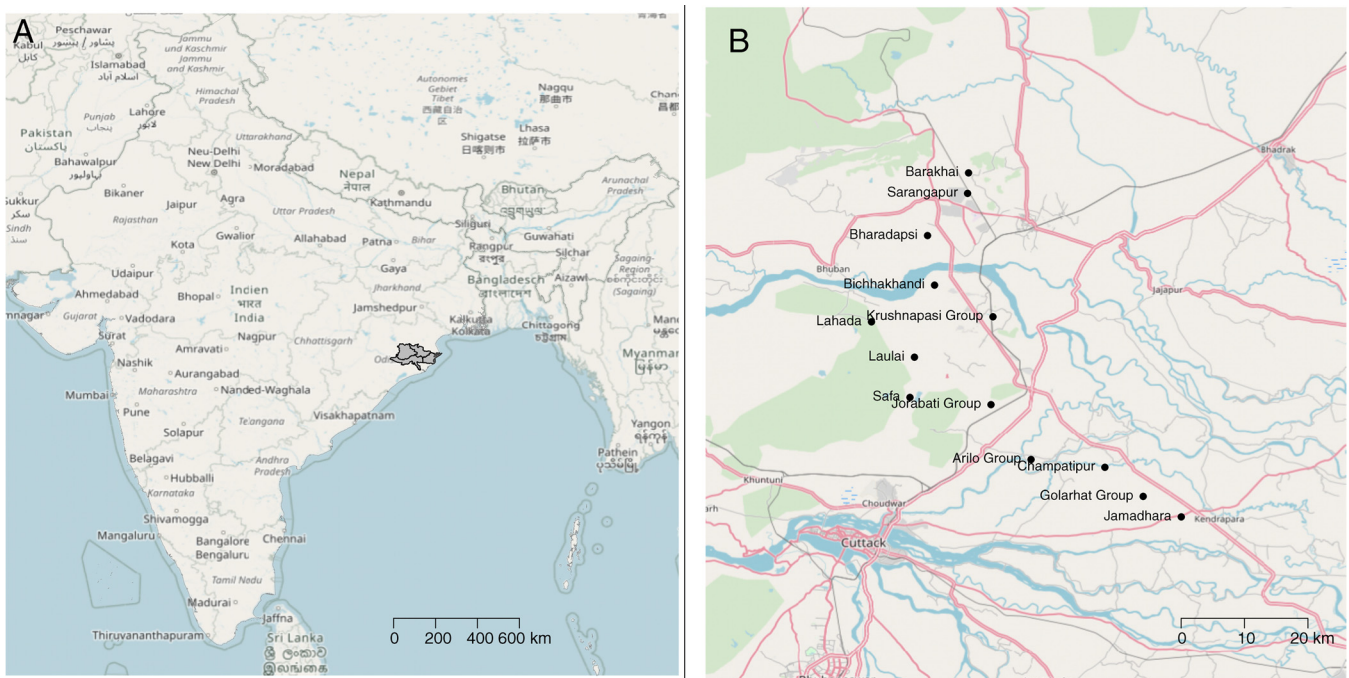
**Fig. 1.** Map of India, showing the study districts of Cuttack, Dhenkanal, Jajpur and Kendrapara (A) and a zoomed map showing the study villages (B). The basemaps are from Open Street Maps (Open Street Map © OpenStreetMap contributors under a Creative Commons Attribution-ShareAlike 2.0 licence (CC-BY-SA)).

spectrum, or target specific helminth species, but the efficacy of some mode of action groups may be reduced by anthelminthic resistance (Kaplan and Vidyashankar, 2012). In smallholder settings, anthelminthics are typically administered *en masse* without determining the need or strategy for treatment. For many smallholders, the packaging size of products makes anthelminthic drugs inaccessible, hence programmes are being developed whereby anthelminthics are sold by members of the local community that are trained in administration of vaccines and anthelminthics alongside vaccines (Bessell et al., 2017). A key outcome of treatment with anthelminthics should be improved weight gain in treated animals, but in this context only a small number of studies have sought to estimate the impact that anthelminthic drugs have on the weight gain of small ruminants (Busin and Sargison, 2014; Coop et al., 1982; Sharma et al., 2016).

The objective of this study was to evaluate the impact of the administration of locally available anthelminthic drugs on the weights of smallholder animals where there is no prior diagnosis of infection. There are a number of factors that must be controlled within this study framework, such as differences in exposures, genetics and feeding regime. Many of these factors are clustered at the level of the herd and the village, hence a randomised controlled trial was used in which treatment with anthelminthics was randomised at the level of the individual animal, and within each study herd some animals were randomly assigned to treatment or to non-treatment.

## 2. Materials and methods

### 2.1. Study hypothesis

We assume that animals that are treated with anthelminthics will clear infections, acknowledging that there is a risk of reinfection, particularly with *Haemonchus* spp. Subsequently, in the period following treatment there will be a significantly greater rate of growth in the treated animals compared to the untreated animals. So we hypothesise that treating animals with anthelminthics has a statistically significant effect on weight gain over a 56 day period.

### 2.2. Study design

All animals were weighed at the time of treatment and then followed up and reweighed 28 and 56 days after the baseline. These timepoints were selected to allow time for the drugs to have effect and the effect to be manifested in the body weight of the goats.

Any non-pregnant adult female goat was eligible for inclusion in the study, selected because adult females comprise the majority of the population, are at similar life stages, and will have more consistent histories of exposure to helminth infections. Pregnancy status was specified to avoid artificially altering the goat's weight. The pregnancy status of the goats was checked by transabdominal palpation by animal health professionals at all surveys, but it remains possible that some early pregnancies may have been missed due to the low sensitivity of this technique (Karadaev, 2015). Goats were enrolled at the level of the herd. We defined a herd as a group of goats that were managed together and were under the same ownership.

All enrolled animals were given uniquely numbered ear tags to accurately identify each animal at the follow-up visits. To minimise the loss to follow-up of animals that are sold or are consumed a small financial incentive (approximately 3USD) was offered for each goat present at the end of the study that was under the ownership of the same household.

### 2.3. Study areas and timing

In order to compare a range of appropriate situations, we selected rural areas that have smallholder farmers whose animals comprise a substantial proportion of income and assets. Study sites were selected in Tanzania and India.

In India, the project was implemented in the districts of Cuttack, Dhenkanal, Jajpur, Kendrapara in the state of Odisha (Fig. 1). From 12 administrative blocks, a total of 18 villages were sampled. The baseline survey was conducted in December 2016, this is shortly after the wet season when the roundworm challenge is likely to be greatest. Importantly, it is also when the villages are accessible without any locally observed religious festivals that may have been a cause to slaughter