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Original Article

Effectiveness of an integrated intervention in the control of endo- and ectoparasites of pigs kept by smallholder farmers in Mbeya rural and Mbozi districts, Tanzania

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ABSTRACT

This study was conducted to evaluate effectiveness of an integrated management intervention in the control of endo- and ectoparasites of pigs kept by smallholder farmers in Mbeya Rural and Mbozi districts of southern highlands of Tanzania.

A repeated cross-sectional group randomization design was employed, with 10 villages in the intervention group and six villages in the control group. The intervention consisted of improving pig confinement, feeds and feeding practices, and strategic anthelmintic treatment of pigs with oxfendazole, to primarily control *Taenia solium* (porcine) cysticercosis and nematodes; and with ivermectin to control ectoparasites and nematodes. Blood and faecal samples, ectoparasite specimens and skin scrapings were collected at baseline and two follow-up rounds, at an interval of seven months. A total of 482, 460 and 421 pigs were sampled in 221, 196 and 139 households at baseline, first and second follow-up visits respectively. Sero-prevalence of PC, prevalence and burden of gastrointestinal (GI) nematodes and prevalence of ectoparasites were determined using Ag-ELISA, McMaster faecal egg counting technique and body searches/skin scrapings, respectively. Mann Whitney test was used to measure intervention effect by comparing changes from baseline values of prevalence and faecal egg counts between the two groups. No significant difference ($p > 0.05$) was observed between the two groups, in changes from baseline of sero-prevalence of PC. The intervention significantly reduced prevalence of *Trichuris suis* ($p = 0.044$) and mean faecal egg counts of *Ascaris suum* ($p = 0.02$) from baseline to first follow-up. The intervention showed a substantial effect on the prevalence of ectoparasites as it significantly reduced overall prevalence of ectoparasites ($p = 0.026$), lice ($p = 0.045$), ticks ($p = 0.049$) and mites ($p = 0.013$) from baseline to first follow-up, and prevalence of ectoparasites, lice and mites from baseline to second follow-up ($p = 0.052$, $p = 0.03$, $p = 0.017$ respectively).

This study has demonstrated a moderate effect of the intervention on controlling GI nematodes and ectoparasites, but no effect on sero-prevalence of PC. The reported ineffectiveness of the intervention against PC is probably an underestimation because serology is not able to provide quantitative data. It may also be a result of reduced compliance as this was a field study. Nevertheless, further studies are needed to better understand transmission dynamics of PC and explore One Health approaches including treatment of the human population against taeniosis to better secure public health.

1. Introduction

In the recent decades, pig sector has been reported to be the fastest growing livestock sub-sector in sub-Saharan Africa and Asia (Phiri et al., 2003; Riedel et al., 2012). For example, in Tanzania, during a period of 2008 to 2015 pig population increased by an annual average

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of 6.5%, as compared to, for example, cattle population which increased by 2.6% (URT, 2012; MLFD, 2015). This is because of increasing preference towards pork consumption coupled with pig's high fecundity, early maturing, short generation interval and the ability of pigs to produce optimally under minimal inputs (Lekule and Kyvsgaard, 2003; URT, 2012).

Pig population in Tanzania is estimated to be 2.4 million (MLFD, 2015) of which > 90% are kept by smallholder farmers who mainly (90%) have herd sizes of < 10 pigs (Kimbi et al., 2015). Smallholder pig production in Tanzania and elsewhere in Africa is characterized by low productivity and profitability (Lekule and Kyvsgaard, 2003; Ngowi et al., 2004). This is caused by many factors, among them being diseases and inadequate nutrition (Wabacha et al., 2004; Karimuribo et al., 2011; Muhanguzi et al., 2012). Other important constraints are lack of genetically high quality breeding stocks, poor husbandry practices, limited knowledge on pig husbandry due to limited access to quality extension services and lack or limited access to credit facilities (Mutua et al., 2011; Muhanguzi et al., 2012; Obonyo et al., 2012). Apart from African swine fever (ASF), parasitic diseases are important constraints to profitable pig production. They compromise pig welfare and pose a public health threat with porcine cysticercosis (PC), helminthosis and ectoparasites considered to be the most important (Phiri et al., 2003; Kagira et al., 2010; Nissen et al., 2011; Muhanguzi et al., 2012).

As the pig production constraints are interrelated, integrated interventions against pig parasites are likely to be more efficient and cost-effective (Carabin and Traoré, 2014). For example, pig confinement is expected to reduce chances of pigs getting infected with PC but puts a necessity on the farmer to feed the pigs (Lekule and Kyvsgaard, 2003; Sikasunge et al., 2007; Komba et al., 2013). In turn, confining pigs and providing them with good quality feeds put pigs in good body condition and make them more resistant and/or tolerant to parasitoses (Damriyasa et al., 2004; Kabululu et al., 2015). On the other hand, oxfendazole has been shown to be efficacious against nematodes and *T. solium* cysts in the muscles of infected pigs (Sikasunge et al., 2008; Mkupasi et al., 2013).

In view of that an integrated intervention comprised of improving pig confinement, feeds and feeding practices and antiparasitic treatment with oxfendazole (OFZ) was implemented and evaluated. The aim was to reduce prevalence of PC and minimize chances of having pigs infected with live *T. solium* cysts at slaughter, by treating pigs with OFZ. Additionally the aim was to reduce prevalence and burdens of nematodes, which if abundant, lower productivity. This strategy was combined with ivermectin treatment to reduce level of ectoparasites, which also may have a considerable effect on productivity.

2. Materials and methods

2.1. Study area

The study was conducted in Mbozi and Mbeya Rural districts of Songwe and Mbeya regions respectively (Fig. 1) which are located between latitudes 8°14′ and 9°24′S and longitudes 32°04′ and 33°49′E in the south western highlands of Tanzania. Mbeya and Songwe were selected because of their importance in pig keeping, as it is estimated that 22% of the national herd is found in the regions (URT, 2012). The two regions cover an area of 63,420 km^2 and have a human population of 2,707,410 (NBS, 2013). The climate is subtropical with an altitude between 900 and 2750 m above sea level, an average temperature of 16 °C and an annual average precipitation of 900 mm. Rainy season extends from November to May with the heaviest rain occurring from December to March. In 2012, the human populations were recorded to be 446,339 in Mbozi District and 305,319 in Mbeya Rural District (NBS, 2013). In 2007/2008, pig populations were estimated to be 117,483 in Mbozi District and 31,190 in Mbeya District (URT, 2012). Pig production in the two districts is predominantly on a smallholder scale.

2.2. Study design and selection of study units

This study employed a repeated cross sectional group randomization design. Randomization was done at a village level for ethical reasons and to prevent spillover effects within villages. In each district a list of villages with relatively high number of pigs (> 50) was made with help of District Livestock Office. From the list, based on the willingness of the villages to participate and number of pigs, eight villages were selected in each district. Selected villages from both districts were randomly allocated into an intervention group (10 villages) group and a control group (six villages). In each village, a list of all pig keepers was drawn by the help of local administrative and agricultural/livestock extension officers. All listed pig keepers were gathered in formal meetings where the purpose of the study was explained to them. Pig keepers gave informed verbal consent to participate in the study. In each village of the intervention group, 12 households (pig keepers) were randomly selected while in each village of the control group 20 households were selected. Therefore, a total of 120 households in each group were recruited for the study.

2.3. The intervention

Before the onset of baseline collection, all pig keepers in the study area were provided with a training on general aspects of good pig husbandry. Then the selected farmers in the intervention villages received a) specific training and technology transfer of improved pig pens, b) improved pig feeds and feeding practices, and c) treatment with OFZ and IVM as elaborated below. Farmers in the control group were left to continue with their normal pig rearing practices but had their pigs treated with IVM as explained below. In addition, during household visits specific advice on pig husbandry was given to pig keepers in both intervention and control groups, depending on the pig husbandry status in each household. The study villages were visited monthly for the purpose of providing feed supplements and supervising feed compounding. OFZ treatment and collection of samples were done at baseline (month 0) and at two follow-up rounds (month 7 and 14).

2.3.1. Construction of model pig pens

Three model pens were constructed in each village in three different households selected by farmers themselves. They consisted of at least one with a concrete floor and one with a raised timber off-cuts floor (Fig. 2). The size of each pen was 2 × 2.5 m, designed to accommodate one sow and her litter up to weaning. Construction of the first pen was demonstrated by the researcher. The second was built with the active participation of the farmers and the third was built by farmers themselves under supervision of the researcher. In all cases a local mason/carpenter was assisting in technical aspects. Apart from providing labour, farmers also provided locally available building materials, such as tree poles, timber off-cuts, sand, gravel, stones and bricks. Industrial made materials such as cement, nails and iron sheets were provided by the funding project. Thereafter, at each household visit farmers were advised and encouraged to simulate and build pens at their homesteads and confine their pigs all year round.

2.3.2. Improved feeds and feeding practices

In the first instance, farmers were trained on important ingredients of a pig feed, how to compound feeds and how to feed pigs. Trainings were done on site, at selected homesteads where feed compounding would be done. Illustrations were done on flip charts and farmers were provided with booklets and posters describing important aspects of pig feeds and feeding. Thereafter, feed compounding training exercises were done in three stages. In the first stage, the researcher demonstrated the procedure, followed by active participation of the farmers in the second stage and lastly farmers themselves did the compounding during third phase, under supervision of the researcher. Farmers provided maize bran as a main source of energy while protein and mineral/