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Epidemiology of *Fasciola gigantica* and Amphistomes in Cattle on Traditional, Small-scale Dairy and Large-scale Dairy Farms in the Southern Highlands of Tanzania

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ABSTRACT

A longitudinal descriptive study was conducted to determine the prevalence and distribution of flukes (*Fasciola gigantica* and amphistomes) on traditional, large-scale and small-scale dairy cattle farms in Iringa district, southern highlands of Tanzania. Coprological examinations of different cohorts for the presence of fluke eggs were recorded monthly. Results indicated a significant influence of the type of management on the prevalence of both *Fasciola* and amphistomes. The prevalence of flukes was highest in the traditional system, moderate in the large-scale dairy system and lowest in the small-scale dairy system in most parts of the year. Adults and yearlings had the highest prevalence of flukes in all management systems throughout the year. The proportion of animals excreting amphistome eggs was always higher than that of animals excreting *Fasciola* eggs in all zones, villages, management systems, farms and age groups. The proportion of animals passing fluke eggs increased gradually from the early dry season and peaked at the end of the dry season and the early part of the rainy season. Strategic treatments against flukes are recommended in adults and yearlings only in traditional and large-scale dairy farms. Routine treatments of calves/weanlings in large-scale and traditional farms and zero-grazed small-scale dairy cattle farms might be unnecessary. For a cost-effective helminth control programme in the area, strategic treatments at the beginning of the dry season (June) and at the end of the dry/early rainy season (November/December) are recommended.

Keywords: epidemiology, *Fasciola*, management system, paramphistomes, trematodes

INTRODUCTION

Fasciolosis and amphistomosis (paramphistomosis) are two important parasitoses of farm livestock (Mage *et al.*, 2002). *Fasciola gigantica* is the most common *Fasciola* species found in Africa and Asia (Wamae *et al.*, 1998) and is widely distributed in tropical and subtropical areas, where it is recognized as a major source of production losses in domestic ruminants (Losos, 1986; Hammond and Sewell, 1990; Mage *et al.*, 2002). While the epidemiology and economic losses of fasciolosis are well known in

most countries, amphistomosis is still a neglected helminth infection in many countries and the parasites are sometimes considered to have no effect on animals (Dinnik, 1964; Mage *et al*., 2002; Keyyu *et al*., 2004). However, amphistomes can limit livestock productivity and account for high economic losses (Al-khshali and Altaif, 1979) in cattle (Spence *et al*., 1996), and immature flukes cause disease (Dinnik, 1964; Horak, 1971; Spence *et al*., 1996). The most important species responsible for outbreaks of acute amphistomosis in ruminants in Africa is *Paramphistomum microbothrium* (Dinnik, 1964; Horak, 1971). Data on the prevalence of amphistomes are scarce, even from Europe (Mereminski, 1970; Mereminski and Gluzman, 1979). A recent study conducted in Iringa district indicated a high prevalence of *F. gigantica* and amphistomes (*Calicophoron microbothrium* and *Paramphistomum jacksoni*) in grazing cattle (Keyyu *et al*., 2004). The same study indicated a significant influence of the type of management on the prevalence of *Fasciola* and amphistomes and that the prevalence of amphistomes was always higher than that of *F. gigantica* in all farms and villages (Keyyu *et al*., 2004). For a rational and sustainable helminth control programme, a comprehensive knowledge of the epidemiology of parasites and their interaction with the host in a specific climate and management system is a prerequisite (Barger, 1999). The epidemiology of amphistomes in any class of livestock in Tanzania has not been investigated. The aim of this study was to determine the epidemiology of *F. gigantica* and amphistomes of cattle in three management systems in Iringa district. A greater understanding of their epidemiology will enable the design of appropriate control measures for each production system.

MATERIALS AND METHODS

Study area

The study was conducted in Iringa district, Iringa region in the southern highlands of Tanzania. The district has three main agro-climatic zones, namely the lower plain (lowland zone), central plain (central zone) and the highland zone (temperate plateau). The lowland zone lies 900–1200 m above sea level and the annual rainfall is below 600 mm; the central zone lies 1200–1600 m above sea level and the annual rainfall is 600–1000 mm; the temperate plateau lies 1600–2700 m above sea level and the annual rainfall is 1000–1600 mm. Vegetation cover in the lower plain is mainly thickets and scattered bushes. Derived savannah grasslands predominate in the central zone, while typical rainfall forests are predominant in the highland zone. This study was conducted in the central zone and the highland zone. The district has a unimodal rainfall; the rainy season is between December and May, while the dry season is between June and November. The study was conducted from January to December 2002.

Cattle management systems

The management systems studied were large-scale dairy, small-scale dairy and traditional (indigenous) systems. The large-scale dairy farms had improved or semi-improved management systems. They had their own grazing land that was fenced or not fenced and animals were given concentrates, chopped grass and mineral supplementation. The common breeds were Ayrshire and Friesian and their crosses. The small-scale dairy system mainly practised zero-grazing with occasional semi-zero and tethering systems. Animals were permanently housed, while those in the semi-zero system were housed during the rainy season and taken out for grazing during the dry season. The commonest feeding practice was the 'cut and carry system' whereby fodder was obtained by cutting from various places and carried back to the housed animals. Supplementation was low, irregular and confined to milking cows. The common breeds were crosses of Ayrshire and Friesian with Boran or Zebu.

Traditional farms investigated were sedentary (stationary) herds where traditional farmers also practised agricultural activities. Animals were grazed and watered on communal land during the day and housed around households in open kraals or 'bomas' at night. The indigenous breed, the Tanzania Short Horn Zebu (TSHZ, Iringa red ecotype) was the only breed in all traditional farms. Traditional cattle were denied any supplementation or effective disease control.

Study design, selection of farms and sampling

The study was an observational descriptive longitudinal study conducted in the highland and central zones of Iringa district. A multi-stage stratified random sampling method was used to select animals from zones, villages, management systems, farms and age groups. Farms in each zone/village were categorized into large-scale, small-scale and traditional. The study was carried out on five large-scale dairy farms (three in the highland zone (Tommy, Muhesa and Turlia) and two in the central zone (Mshughulika and Igumbiro)) and in five villages (three in the highland zone (Lulanzi, Ihimbo and Kidabaga) and two in the central zone (Ilula and Ifunda)). The selected villages were those that had both small-scale dairy and traditional farms and were within one-day return trip from the Iringa municipality (63 km radius). At least two traditional and five small-scale dairy farms were selected in each village. Animals on each farm were categorized into three age groups, i.e. calves (<8 months), weaners/yearlings (9–24 months) and adults (>24 months). A total of 138 animals on 5 large-scale dairy farms, 69 animals on 24 small-scale dairy farms and 94 animals on 11 traditional farms (301 overall) were selected and included in the study. The selected animals on each farm were individually ear-tagged in the first sampling month (January 2002) to ease their identification in subsequent monthly samplings. The ear-tagged animals were sampled every month for a period of one year (January–December 2002).

Only one village had a communal dip tank for traditional cattle; farmers in other villages hand-sprayed animals or took them long distances to dip tanks in other

villages. All large-scale dairy farms had dip tanks. For this study, a farm was defined as any livestock establishment with a minimum of one cow/animal. During the study, each farm continued with its normal management practices, including anthelmintic treatments.

Samples and sample processing

Faecal samples were collected per rectum using gloved fingers from each ear-tagged animal for determination of the presence of *Fasciola* and/or amphistome eggs. The samples were labelled and placed in a cool box and transported to the Veterinary Investigation Centre (VIC) in Iringa for examination. The presence of *Fasciola*/amphistome eggs was determined by a sedimentation technique (Hansen and Perry, 1994). Occasionally, adult liver flukes (*Fasciola*) and stomach flukes (amphistomes) were collected from slaughtered cattle at the regional abattoir for identification of common species in the district.

Data analysis

Data were entered and validated in Microsoft Excel, and then imported into Statistix for Windows (Statistix, 1994) for analysis. The proportion of animals passing *Fasciola* and/or amphistomes eggs in faeces by zone, village, management system, month, age and sex was analysed using the chi-square (χ^2) test.

RESULTS

Epidemiology of Fasciola gigantica

The monthly rainfall in the highland, mid and lowland zones of Iringa district during the study period is indicated in Figure 1. The rainfall pattern during the year of the study in the highland and mid zones where the study was conducted generally followed the normal rainfall pattern for those areas. The proportion of animals excreting *Fasciola* eggs in faeces within and between age groups and management systems is shown in Figure 2. The proportion of egg-positive animals was high in the traditional system in all age groups throughout the year. Only adults and weaners/yearlings in large-scale dairy farms had a high prevalence throughout the year. Except for adults, which had a moderate proportion, low numbers of animals were found passing *Fasciola* eggs in the small-scale dairy system throughout the year. There was a seasonal trend in the proportion of animals passing *Fasciola* eggs. The proportion of egg-positive animals decreased towards the end of the rainy season, then increased gradually through the dry season and peaked towards the beginning of the rainy season (December).

The prevalence was generally associated with the type of management, especially the grazing habit ($\chi^2 = 124$, df = 2, $p = 0.001$). The prevalence was highest in the

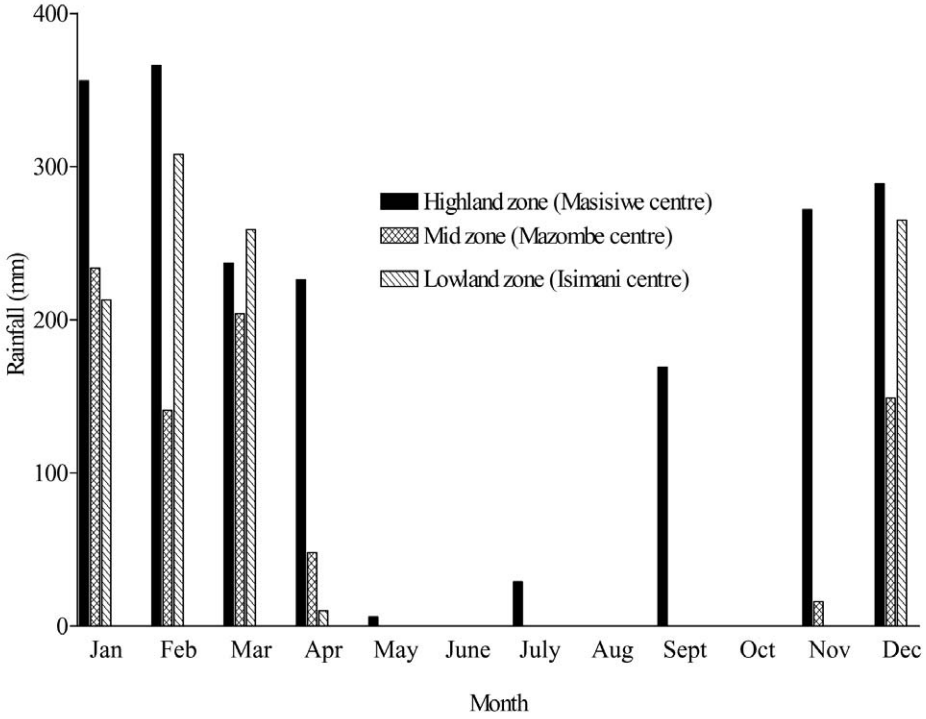
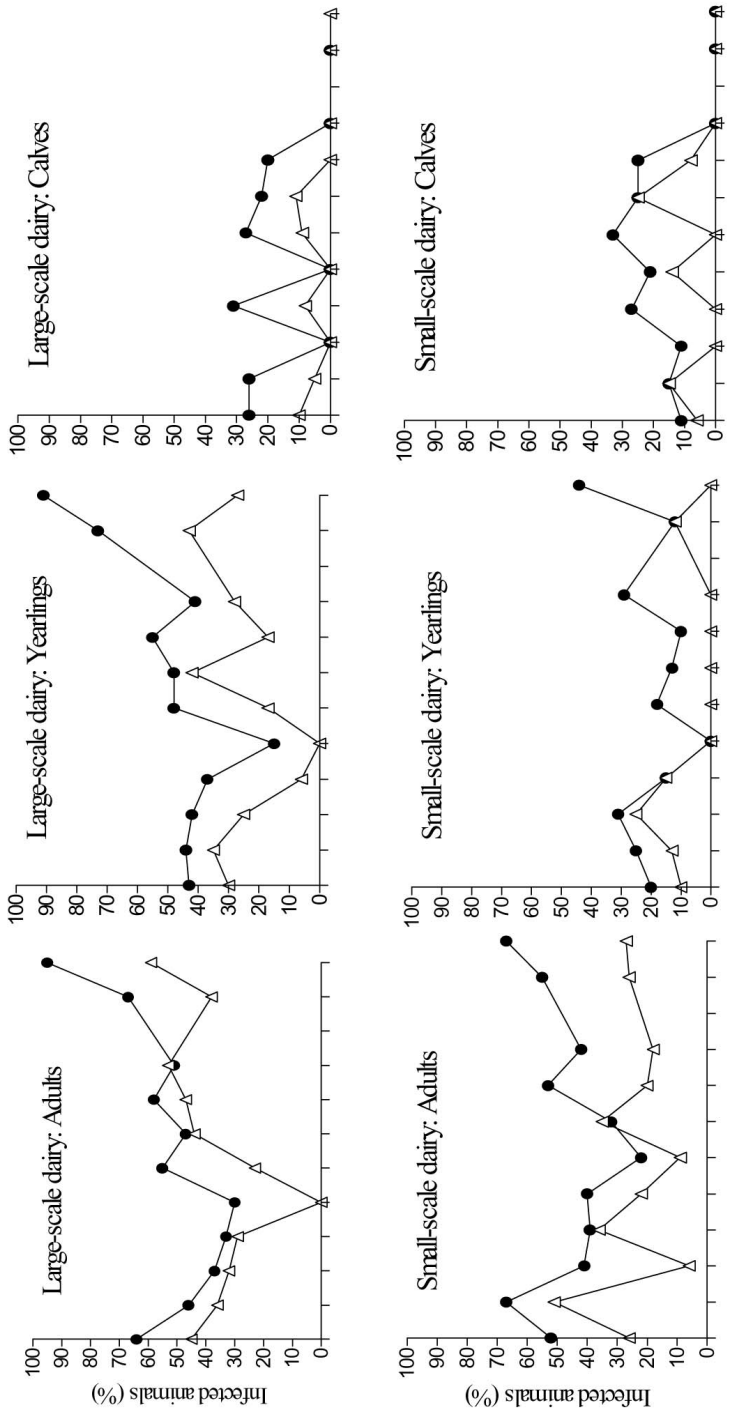


Figure 1. Monthly rainfall at three meteorological centres located in each ecological zone of Iringa district from January to December 2002

traditional system (44.9%), moderate in the large-scale dairy system (30.2%) and lowest in the small-scale dairy system (17.8%). There was a significant association between prevalence and the age of animal (χ^2 = 72, df = 2, p = 0.001). In all management systems, adults had the highest prevalence (40.4%); weaners/yearlings were intermediate (27.8%); and calves had the lowest prevalence (13.6%). The prevalence was higher in the highland zone than in the mid zone (44.9 vs 24%). The prevalence varied greatly among large-scale dairy farms and villages.

Epidemiology of amphistomes

The proportion of animals excreting amphistome eggs over time within and between age groups and management systems is shown in Figure 2. The proportion of egg-positive animals was high in the traditional system in all age groups throughout the year. Only adults and yearlings on large-scale dairy farms had a high prevalence most of the year. Except for adults, which had a moderate burden, low numbers of animals were found passing amphistome eggs in small-scale dairy cattle throughout the year.


Large-scale dairy: Adults
Large-scale dairy: Yearlings
Large-scale dairy: Calves
Small-scale dairy: Adults
Small-scale dairy: Yearlings
Small-scale dairy: Calves
Infected animals (%)
Infected animals (%)
0
10
20
30
40
50
60
70
80
90
100

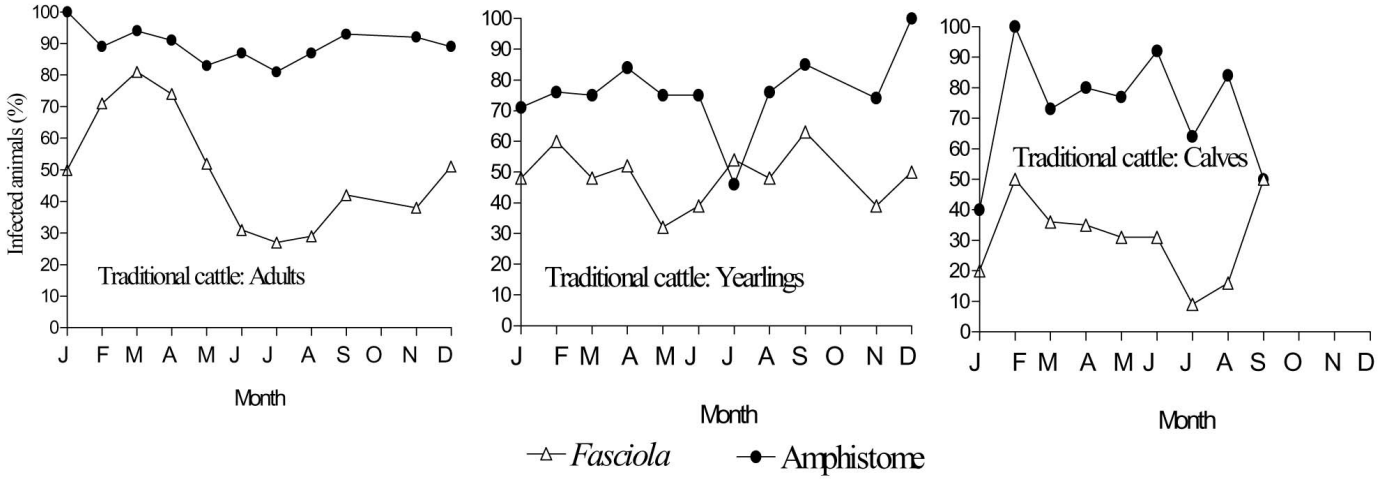


Figure 2. Proportion of cattle (%) excreting *Fasciola* and amphistome eggs within and between age groups and management systems in Iringa district during a period of 12 months (Jan–Dec 2002)

There was a difference in the proportion of egg-positive animals among management systems and this was associated with the type of management ($\chi^2 = 388$, df = 2, $p = 0.001$). The traditional management system had the highest annual prevalence (82.7%); the large-scale dairy system was intermediate (47.4%); and the small-scale dairy system had the lowest annual prevalence (35.9%). The prevalence of amphistomes was significantly associated with the age of animal ($\chi^2 = 80.9$, df = 2, $p = 0.001$). In all management systems, adults had the highest annual prevalence (65.4%); weaners/yearlings had a moderate prevalence (52%); and calves had the lowest prevalence (40%). The annual prevalence in the mid zone (66.5%) was higher than in the highland zone (52%). The prevalence of amphistomes also varied greatly among farms and villages; Mshughulika had the highest annual prevalence (91.3%) among farms, while Ifunda had the highest annual prevalence (78.5%) among villages. The proportion of animals excreting amphistome eggs was always higher than that of animals excreting *Fasciola* eggs in all zones, villages, management systems, farms, sex and age groups.

DISCUSSION

The study has shown a significant influence of the type of management and season on the prevalence of fluke infections in cattle. The annual prevalence of *Fasciola* compares with previous reports in the southern highlands of Tanzania (Mahlau; 1970; Ecimovic and Mahlau; 1973), and is lower than that of a cross-sectional study by Keyyu and colleagues (2004), probably because in the present study farmers continued with their routine anthelmintic treatment programmes. The study has clearly indicated a seasonal pattern of *Fasciola* infection, despite the fact that the proportion of animals excreting fluke eggs was affected by anthelmintic treatment on dairy farms and probably by self-cure in traditional cattle. The proportion of animals excreting fluke eggs increased gradually from the early dry season and peaked towards the end of the dry/early rainy season. The pattern appeared to overlap the snail biology in the area as described by Kassuku and colleagues (1986) and Makundi (2001), which indicated a high proportion of infected snails from the end of the rainy season into the dry season. The high proportion of traditional cattle excreting *Fasciola* eggs during the rainy season concurs with studies in other tropical countries (Schillhorn van Veen *et al.*, 1980; Roberts and Suhardono, 1996; Vassilev, 1999) and, considering the 3-month prepatent period of fluke infections, it suggests that most animals were infected towards the end of the dry season. The low proportion of egg-positive animals during the rainy season on dairy farms might be due to more effective treatments with drugs against nematodes and flukes during this period. The overall high proportion of animals excreting fluke eggs towards the end of the dry season concurs with findings of Mahlau (1970) and might be related to the grazing practice during the dry season, whereby cattle were grazed in marshy areas, valleys and flood plains, thus exposing them to contaminated pastures. It might also be due to a decrease in the number of anthelmintic treatments on most farms during the dry season.

Small-scale dairy farms had a consistently low proportion of animals passing fluke eggs year-round. The higher proportion of egg-positive animals on traditional farms compared to other management systems concurs with studies on traditional migratory cattle in Mali (Tembely *et al.*, 1988) and on communal cattle in Ethiopia (Lemma *et al.*, 1985). The high prevalence might be due to heavy contamination of snail habitats and ingestion of metacercariae as a result of high stocking density and local overcrowding around watering points. In contrast to a number of studies (Asanji, 1989; Rolfe *et al.*, 1991; Szmidt-Adjidé *et al.*, 2000), the present study showed no seasonal pattern of amphistome. This lack of seasonal pattern might be due to a high proportion of infected animals throughout the year. The high prevalence might be due to lack of specific drugs against amphistomes (Mage *et al.*, 2002). Most drugs that were used in the district were specific for nematodes and/or *Fasciola*, and the dosage has to be increased in order to attain activity against amphistomes. Therefore, the proportion of egg-positive animals was constantly high throughout the year, especially on traditional farms, and it was rare to find non-infected animals. Amphistomosis is a neglected disease with unknown effects in most areas despite regular recovery of the flukes in slaughtered cattle. The higher prevalence in adults than in young animals concurs with other studies (Silangwa, 1973; Holland *et al.*, 2000). The high prevalence in adults might be due to a long exposure time as well as management practices, whereby adults were trekked long distances to graze in valleys, flood plains and swampy areas.

This study has indicated a high prevalence of *Fasciola* in grazing animals despite the fact that farmers continued with routine anthelmintic treatments. The reason could be inappropriate timing of treatments, use of inappropriate drugs or under-dosing, or flukes may have developed resistance to the commonly used anthelmintics. Based on the local climatic conditions and management systems, routine treatments against *Fasciola* and amphistomes might be not necessary for zero-grazed, small-scale dairy cattle or for calves/weanlings in large-scale dairy farms, but it should be based on clinical disease. Strategic treatments are especially important in all age groups of traditional cattle and also in adults and yearlings on large-scale dairy farms.

In conclusion, this study has indicated that *Fasciola* and amphistomes are endemic and widespread in Iringa and that the prevalence is influenced greatly by management systems. On the basis of these results, two strategic treatments are recommended in traditional and large-scale dairy cattle instead of the previous strategy of treating the whole herd at least four times a year. The first treatment should be administered at the beginning of the dry season (May/June) in order to control outbreaks of acute fasciolosis, and the second treatment should be given at the end of the dry season (November) in order to prevent clinical fasciolosis and to interrupt the parasites' life cycle in the snail host during the rainy season. In small-scale dairy farms, only one treatment of adults might be necessary at the end of the dry season.

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Épidémiologie de *Fasciola gigantica* et des amphistomes chez le bétail de fermes d'élevage de vaches laitières traditionnelles, sur une petite échelle et sur une grande échelle, dans les régions montagneuses du Sud de la Tanzanie

Résumé – Une étude descriptive longitudinale a été conduite pour déterminer la prévalence et la distribution des douves du foie (*Fasciola gigantica* et d'amphistomes) dans des fermes d'élevage de vaches laitières traditionnelles, sur une petite échelle et sur une grande échelle, dans le district d'Iringa, dans les régions montagneuses du Sud de la Tanzanie. Des examens coprologiques de différentes cohortes destinés à déterminer la présence d'ufs de douves du foie ont été enregistrés chaque mois. Les résultats ont indiqué que le type de gestion de l'élevage avait une influence significative sur la prévalence à la fois de *Fasciola* et des amphistomes. La prévalence des douves du foie a été la plus élevée dans le système traditionnel, modérée dans le système d'élevage sur une grande échelle et la plus basse dans le système d'élevage sur une petite échelle durant la majeure partie de l'année. Les adultes et les animaux âgés d'un an avaient la prévalence la plus élevée de douves du foie de tous les systèmes d'élevage et ce, tout le long de l'année. La proportion d'animaux excrétant des oeufs d'amphistomes a toujours été plus élevée que celles d'animaux excrétant des oeufs de *Fasciola* dans toutes les zones, villages, systèmes d'élevage, fermes et groupes d'âge. La proportion d'animaux excrétant des oeufs de douves du foie a augmenté progressivement à partir du début de la saison sèche et a été à son apogée à la fin de la saison sèche et au début de la saison des pluies. Des traitements stratégiques contre la douve du foie ne sont recommandés chez les adultes et les animaux âgés d'un an que dans les fermes traditionnelles et d'élevage sur une grande échelle. Des traitements systématiques des veaux/des animaux sevrés pourraient être superflus dans les fermes d'élevage sur une grande échelle et traditionnelles et dans les fermes d'élevage sur une petite échelle de vaches laitières non mises au pré. Des traitements stratégiques au début de la saison sèche (juin) et à la fin de la saison sèche/saison des pluies (novembre/décembre) sont recommandés pour la mise en place d'un programme antihelminthique rentable.

Epidemiología de *Fasciola gigantica* y Amphistomes en el ganado de granjas lecheras tradicionales, granjas de producción a pequeña escala y granjas de producción a gran escala en las tierras altas sureñas de Tanzania.

Resumen – Se llevó a cabo un estudio longitudinal descriptivo para determinar la incidencia y distribución de duelas (*Fasciola gigantica* y amphistome) en granjas lecheras tradicionales, de producción a gran escala, y de producción a pequeña escala en el distrito de Iringa, zonas altas sureñas de Tanzania. Se fueron anotando mensualmente los exámenes coprológicos de diferentes cohortes para constatar la presencia de huevos de duelas. Los resultados indicaron que el tipo de gestión tenía una influencia significativa sobre la prevalencia de ambas, Fasciolas y anfistomas. La incidencia de duelas fue más alta en el sistema tradicional, fue moderada en el sistema lechero a gran escala y más baja en el sistema lechero a pequeña

escala durante la mayor parte del año. Los animales adultos y los comprendidos entre 1 y 2 años de edad poseían la prevalencia más alta de duelas en todos los sistemas de gestión a lo largo del año. La proporción de animales que excretaban huevos de anfistoma era siempre más alta que la de los animales que excretaban huevos de Fasciola en todas las zonas, pueblos, sistemas de gestión, granjas y grupos de edad. La proporción de animales que excretaban huevos de duelas aumentaba gradualmente a partir de principios de la estación seca y alcanzaba su máximo al final de la estación seca y primera parte de la estación lluviosa. Se recomiendan tratamientos estratégicos contra duelas en animales adultos y de 1 a 2 años de edad sólo en granjas lecheras tradicionales y aquellas con producción a gran escala. Los tratamientos rutinarios de becerros/y animales recién destetados en granjas tradicionales, de producción a gran escala, y de producción a pequeña escala pero sin pastos podrían ser innecesarios. Para un programa de control helmíntico rentable en la zona, se recomiendan tratamientos estratégicos a principios de la estación seca (Junio) y al final de la estación seca/principios de la estación lluviosa (Noviembre/Diciembre).