Abstract

A cross-sectional survey was undertaken on 240 dairy cattle farms in Nyandarua District in central Kenya to determine farm characteristics, farmer’s perception of production constraints and diseases and the prevalence and control practices for ticks and helminths. Farmers were interviewed using questionnaires and 708 cattle examined.

The mean farm size was 3.2 hectares and average number of cattle per farm 20, with 66% of the farms having 3-16 animals. This indicated that dairy-cattle farming is a smallholder concern in the district. The cattle were crossbreeds mainly of Hostein-Friesian and Ayrshire kept as a source of milk for domestic consumption and sale. High proportions of the farmers considered diseases (75%), high cost of drugs (70%), high cost of supplementary feeds (70%) and inadequate pastures (60%) as the main production constraints. East Coast Fever (ECF) was ranked as the most important disease.

The majority (62%) of farmers used acaricides, which were applied at intervals of 2 to 4 weeks on 75% of the farms mostly through hand spraying. Forty percent of cattle were infested with ticks, indicating that tick borne diseases (TBDs) are a risk to cattle production. *Rhipicephalus appendiculatus* was the most abundant (81%) followed by *Boophilus decoloratus* (15%) and *Amblyomma variagatum* (4%).

Gastrointestinal tract (GIT) nematodes infections were sub-clinical but common, with *Haemonchus* being the predominant parasite, and a number of cattle were shedding *Fasciola* eggs. These data indicate that GIT nematodes and liver flukes infections are a risk to cattle production in the district. A large proportion (75%) of the farmers dewormed their cattle, but 60% used the same type of drug for more than three years and the dosage was estimated using eye measure on all the farms. These practices are considered as risk factors for the development of anthelmintic resistance.

There is a need to improve access to quality extension and veterinary services and seek solutions to constraints facing the farmers in the district in order to improve dairy cattle productivity.

**Key words:** assessment of prevalence, cattle production, constraints, control practices, farm characteristics, helminths, smallholder dairy, ticks

Introduction

In Kenya, the livestock sector contributes 10% of the agricultural production and the dairy industry is the most advanced of the livestock sub-sectors. The dairy industry is dominated by smallholder farmers, who account for over 80% of the total output (Gitau et al 1997). The dairy sub-sector utilises exotic breeds mainly Hostein-Friesian and
Ayrshire and their crosses with local breeds, the highest concentration of these animals being found in the Central and Rift Valley provinces of the country. The smallholder systems may be intensive or semi-intensive with small herd sizes of animals, which are kept on small holdings of between 1 and 2.8 hectares, depending on the part of the country (Ngungu 2005).

Nyandarua District is one of the six administrative district of Central Province, located in the north-western part of the province and west of the Aberdare (Nyandarua) Ranges. The district covers an area of 3,304 km². In 2007 the district had a cattle population of 288,000 which accounted for 34% of all the cattle in Central Province. The cattle population consisted of 260,000 dairy cattle and 28,000 beef cattle (Ministry of Livestock Development 2007). In Central Province dairy farming is an important enterprise, with the sale of milk providing a more reliable source of income than that derived from many other farming enterprises (Gitau et al 1997).

Despite the central role of the smallholder farms in the dairy industry in Kenya, production levels are lower than their potential (Walshe et al 1991; Omore et al 1994) and continue to decline (Omore et al 1999). A number of constraints hamper increased production in these systems, which include diseases, poor management, inadequate nutrition and lack of farm inputs (Omore et al 1999). Among the diseases, tick-borne diseases (TBDs) are considered to be the most important and East Coast Fever (ECF) caused by *Theileria parva* and transmitted by the tick *Rhipicephalus appendiculatus* is the most important. Other less-important TBDs in cattle are benign theileriosis caused by *Theileria mutans*, babesiosis caused by *Babesia bigemina*, anaplasmosis caused by *Anaplasma marginale* and cowdriosis caused by *Cowdria ruminatum* (Gitau et al 1997). An important component affecting the efficiency of transmission of TBDs is the population dynamics of tick vectors.

Knowledge of the species and number of ticks on cattle provides useful information on tick population dynamics, dynamics of disease transmission and estimates of resistance of the different hosts (Norval et al 1992). There are no published reports on tick species, tick control practices and factors influencing tick counts in dairy cattle in Nyandarua District.

In addition to TBDs, helminths parasites are considered to be prevalent and a major limitation to cattle production in cattle in Kenya. A previous study in Nyandarua District (Maingi and Gichigi 1992) revealed that *Haemonchus* was the predominant parasite among the gastrointestinal (GIT) nematodes, accounting for over 40% of the parasite population, followed by *Trichostrongylus*. The study by Maingi and Gichigi (1992) was limited in scope, covering only 4 farms in small sections of the district.

**Materials and methods**

**Study area**
Nyandarua District is an administrative district in the central highlands of Kenya. The district is divided into six administrative divisions, namely North and South Kinangop, Kipipiri, Ol Kalau, Ol-Joro-Orok and Ndaragwa. It was split into two in 2007: Nyandarua North District and Nyandarua South District. The information in this paper refers to prior 2007.

The district lies within an altitude belt of between 1500 and 4000 meters above sea level. The district is of high to medium potential in terms of agricultural production, with a mean annual rainfall of between 1000 mm and 2000 mm, occurring in two seasons. The long rainy season occurs between March and June and short rains season between October and December. The mean monthly minimum air temperature varies from 6 to 10 and the maximum from 22 to 26°C. The area consists of open woodland with natural pastures consisting of a variety of grass types, the dominant type being Kikuyu grass (*Pennisetum clandestinum*).

In 2007, the livestock population in the district comprised of 288,000 cattle, 324,100 sheep and 87,900 goats (Ministry of Livestock Development 2007).

**Description of the survey**

Sensitization was achieved through meetings with farmers and field veterinary officers in all six divisions of the district. The objectives of the project were then discussed with them and 240 farmers (40 from each division) selected randomly during the meetings, to participate in the project.

**Questionnaires data collection**

Questionnaires that had been pretested were used, to collect detailed information on farm characteristics, farmers’ perception on production constraints and important diseases, ticks and helminths control practices, types of acaricides and anthelmintics used methods of application and the interval between treatments. The questionnaires were closed ended to ease precision of responses and analysis and were administered to respondents at the farm level through face to face interviews.

**Sample collection and analysis**

A total of 708 cattle were sampled from all six divisions of the district. For farms with 3 to 16 animals which constituted 66% of the farms, 2 animals randomly selected on the farm were sampled per farm. For the other farms, 10% of the total number of animals on each farm was sampled.

The cattle were categorised into the three age groups <1 year (young stock), 1- 2 years (immature) and over 2 years (adults) according to dentition. During the survey, ticks (immature and adults) encountered on the study animals were collected, counted and identified by genera using the descriptions of Soulsby (1982). Faecal samples were also collected in labelled plastic containers and stored in cool boxes for transportation to the
laboratory. The faecal samples were analysed for GIT nematode egg counts using the modified McMaster Technique and for fluke eggs using a sedimentation technique (MAFF 1986). Pooled faecal samples from each farm were also cultured and larvae harvested identified according to MAFF (1986). The study was conducted during a period of four months from March to June 2009.

Data management and statistical analysis

Data were first entered into Ms Excel program (Microsoft Corporation, USA) and screened for errors that might have occurred during the entry. Any error detected was corrected by rechecking against the original data forms. Data analyses were performed using the Statview® for Windows Version 5.0.1 (SAS Institute Inc 1995–1998, Cary, NC) and Ms Excel (Microsoft Corporation, USA).

Results

Farm characteristics

Thirty five percent of the respondents were male heads of household, 50% wives, 10% workers and 5% siblings. The average age of the household head was 43 years (range: 35-65). The level of education for household heads was categorized as none (5%), primary school (20%), secondary (55%), and tertiary (20%). Livestock and subsistence crop farming was undertaken by all of the households. Other activities undertaken by household heads included business (58%) and full time employment (42%).

Cattle had been kept on the study farms for periods of 1 to 5 years (15%), 6 to 10 years (50%) and more than 10 years (30%). The farmers owned a total of 6,005 cattle. In descending order the categories of cattle according to age were young stock <1 year (40%), immature 1- 2 years (20%) and adults over 2 years (40%). Fifty six percent of the farmers owned 0.4 – 2 hectares of land, 17% owned 2.4 – 4 hectares, 24% owned 4.4 – 8 hectares and only 3% owned 8.4 – 20 hectares. The average farm size was 3.2 hectares while the mean number of cattle per farm was 20, with 66% of farms having 3-16 animals. The cattle were crossbreeds mainly of Hostein-Friesian, Ayrshire and local breeds.

The cattle were managed by women on a large proportion of farms (56%), mostly the wives. The male household heads were directly involved in cattle husbandry on 15% of the farms. On 72% of the farms, cattle were grazed; the majority (77%) on permanent pastures owned by the farmers and 23% on communal land. Twenty eight percent of the animals were semi-zero grazed. In addition to grazing, the cattle were fed variety of feeds including napier grass, vegetables, carrots and maize stovers from the farms. Sheep were the most common livestock species grazed with cattle and were found on 125 (52%) farms. Other animals found on the farms included dogs (30%), donkeys (11%) and goats (14%). All the farmers in this study also kept chicken in variable numbers.
The farmers obtained most of the advice on cattle husbandry from other farmers (37%), with only 20% being advised by government extension officers, while the others did not receive advice at all.

Production constraints and disease perception

The production constraints associated with cattle farming in this study are presented in Table 1.

<table>
<thead>
<tr>
<th>Production constraint</th>
<th>Number of farmers</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diseases</td>
<td>180</td>
<td>75</td>
</tr>
<tr>
<td>High cost of drugs</td>
<td>168</td>
<td>70</td>
</tr>
<tr>
<td>High cost of supplementary feed</td>
<td>168</td>
<td>70</td>
</tr>
<tr>
<td>Inadequate pastures</td>
<td>144</td>
<td>60</td>
</tr>
<tr>
<td>Lack of extension services</td>
<td>132</td>
<td>55</td>
</tr>
<tr>
<td>Lack of credit</td>
<td>72</td>
<td>30</td>
</tr>
</tbody>
</table>

The main production constraints as perceived by farmers included diseases (75%), high cost of drugs (70%), high cost of supplementary feeds (70%), inadequate pastures (60%) and inadequate extension services (55%). Forty-five percent of farmers used bulls instead of artificial insemination. Of the main diseases, ECF was ranked first followed by anaplasmosis and babesiosis. Others were respiratory problems, worms and eye infections in that order of importance.

Ticks infestations and control practices

Table 2 shows the genus and species of ticks isolated from cattle in the six divisions, the percentage occurrence of each tick and tick burdens.

<table>
<thead>
<tr>
<th>Genus of tick</th>
<th>Division</th>
<th>S. Kinango</th>
<th>N. Kinangop</th>
<th>Kipipi</th>
<th>Ndaragwa</th>
<th>Ol-Joro-Orok</th>
<th>Ol-Kalau</th>
<th>Total</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of cattle examined (N)</td>
<td></td>
<td>90</td>
<td>116</td>
<td>127</td>
<td>138</td>
<td>126</td>
<td>111</td>
<td>708</td>
<td></td>
</tr>
<tr>
<td>No. and (%) of cattle infected with ticks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Rhipicephalus appendiculatus</td>
<td></td>
<td>20 (22%)</td>
<td>30 (26%)</td>
<td>88 (69%)</td>
<td>80 (58%)</td>
<td>40 (32%)</td>
<td>25 (23%)</td>
<td>283</td>
<td>40</td>
</tr>
<tr>
<td>2. Boophilus decoloratus</td>
<td></td>
<td>5 (6%)</td>
<td>10 (9%)</td>
<td>20 (16%)</td>
<td>15 (11%)</td>
<td>9 (7%)</td>
<td>11 (10%)</td>
<td>70</td>
<td>10</td>
</tr>
<tr>
<td>3. Amblyomma variagatum</td>
<td></td>
<td>0</td>
<td>0</td>
<td>10 (11%)</td>
<td>15 (19%)</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>4.0</td>
</tr>
</tbody>
</table>

No. of ticks isolated

<table>
<thead>
<tr>
<th>Genus of tick</th>
<th></th>
<th>S. Kinango</th>
<th>N. Kinangop</th>
<th>Kipipi</th>
<th>Ndaragwa</th>
<th>Ol-Joro-Orok</th>
<th>Ol-Kalau</th>
<th>Total</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rhipicephalus appendiculatus</td>
<td></td>
<td>85</td>
<td>61</td>
<td>184</td>
<td>197</td>
<td>95</td>
<td>61</td>
<td>680</td>
<td>81</td>
</tr>
</tbody>
</table>
Tick infestation was estimated to be 40% and overall mean tick density was 1.2 ticks/cattle. A total of 840 ticks were isolated from the cattle, the majority of which were *Rhipicephalus appendiculatus* (81%), followed by *Boophilus decoloratus* (15%) and *Amblyomma variagatum* (4%). The highest proportion of cattle infested with *Rhipicephalus appendiculatus* was in Kipipiri (68%) and Ndaragwa (58%) divisions. The proportions of cattle infested with the tick in the other divisions ranged from 22% to 32%. The proportions of cattle in the six divisions, which were infested with *Boophilus decoloratus* ranged between 15% and 16%, while *Amblyomma variagatum* was only found in 11% and 19% of cattle examined in Kipipiri and Ndaragwa divisions, respectively. The mean tick burdens for *Rhipicephalus appendiculatus* and *Boophilus decoloratus* did not differ significantly between the divisions ranging from 0.55 – 1.4 and 0.13 – 0.23 ticks/cattle respectively. The mean tick burdens for *Amblyomma variagatum* in Kipipiri and Ndaragwa divisions were 0.11 and 0.14 ticks/cattle, respectively. This difference in mean tick burden was not statistically significant.

Fifty-five percent of farmers indicated that ticks were of great significance, and the majority (82%) used acaricides for tick control. The acaricides were applied at intervals of one week (20%), two weeks (19%) and more than two weeks (61%) and the most common method of application was hand spraying. The acaricides used by majority of the farmers (67%) over the last five years were Amitraz (12.5% w/v) preparations such as Triatix®, Coopers, Kenya Ltd., Tixfix®, Twiga Chemical Industries, Nairobi and Almatix®, Unga Farm Care, Nairobi).

**Helminths infections and control practices**

The mean GIT nematode faecal egg counts (FEC) for cattle in the six administrative divisions of Nyandarua District are presented in Table 3.

<table>
<thead>
<tr>
<th>Division</th>
<th>Mean faecal egg count</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Kinangop</td>
<td>740</td>
</tr>
<tr>
<td>North Kinangop</td>
<td>630</td>
</tr>
<tr>
<td>Kipipiri</td>
<td>560</td>
</tr>
<tr>
<td>Ndaragwa</td>
<td>510</td>
</tr>
<tr>
<td>Ol-Kalau</td>
<td>800</td>
</tr>
<tr>
<td>Ol-Joro-Orok</td>
<td>780</td>
</tr>
</tbody>
</table>

The mean FEC did not differ significantly between the divisions. Fifty eight percent of the cattle were infected with GIT nematodes. Overall FEC were highest in cattle less than 1 year of age (mean FEC 868) and lowest in adult cattle over two years old (mean FEC 345).
*Haemonchus* was the most predominant genus of GIT nematodes in the six divisions based on larvae identified from faecal cultures and it accounted for 42 to 51% of the larvae. Other genera were *Trichostrongulus* spp. (30 – 40%) and *Cooperia* spp. (8-20%), *Oesophagostomum* spp. (4 – 10%) and *Strongyloides* spp. (2 – 5%).

The percentage of cattle found to be shedding *Fasciola* eggs in the six divisions were 34% in South Kinangop, 20% in North Kinangop, 15% in Kipipiri, 10% in Ndaragwa, 18% in Ol Kalau and 30% in Ol-Joro-Orok. This percentage was highest in animals aged over 2 year (38%) and lowest in young stock less than 1 year of age (5%).

Farmers had moderate to high levels of knowledge on worm infestation and diagnosis. Seventy-five percent of the respondents indicated that they dewormed their cattle, mostly (60%) after every three months. Farmers mainly diagnosed worm infection by observing unthriftness (71%), and distended abdomen (48%), coughing (10%) and poor appetite (10%). Expert veterinary advice on drugs was minimal (26%) and farmers relied mainly on over the counter salesmen (51%) for advice on drug usage. Other considerations included previous experience of the drug effectiveness (34%), the low price of the drug (12%), ease of administration (18%), advice from animal health personnel (26%), advice from other farmer (9%) and seminars (5%).

The main dewormers used by the farmers included levamisole plus oxyclosanide® combination e.g. Nilzan®, Coopers Ltd, Kenya (53%), levamisole e.g. Wormicid®, Cosmos Ltd, Kenya (23%), albendazole e.g. Valbazen®, Kenya Swiss Chemical Co. Ltd (15%), and others (5%). Those who could not remember the name of the dewormer used were 4%. Sixty percent of the farmers had been using the same type of drug for more than 3 years, and the dosage was estimated using eye measures on all the farms.

**Discussion**

Dairy cattle, sheep and crop farming are the main activities in the district (Ministry of Livestock and Fisheries Development 2007). The majority of farms in this study had low to medium hectare, which in some instances could support both livestock and crop farming. The majority of farmers however had problems obtaining enough grazing pastures because of the mixed farming. Twenty-three percent of the farmers therefore relied on communal land for grazing. Communal grazing is likely to be associated with inadequate nutrition for the cattle especially during the dry seasons, if no supplementary feeds are provided. The control of livestock diseases is also difficult under this system (Maingi et al 2001) unless a common routine of deworming, vaccinating and acaricides application is adopted. In order to enhance productivity of the dairy cattle in the district, expert advice on nutrition and disease control is needed on the farms. On the majority of farms, women who were in most cases the wives of household heads managed the cattle, with the household heads only undertaking a lesser role. These results are consistent with those of results of Kagira et al (2010) on pig farming in Busia District, Kenya. In any
projects involving technology transfer such as improvement of animal husbandry and disease control in Nyandarua District, consideration of gender would be important.

In the current study, the level of education amongst the cattle farmers was medium, which is in agreement with literacy rates reported for the district (Ministry of Finance and National Planning 2002). Eighty-five percent of the farmers had kept cattle for periods of more than five years, showing a sustained interest in cattle rearing. All the farmers kept cattle purely for generation of income and domestic consumption of milk. The level of education and sustained interest in cattle farming for economic gain is likely to positively influence implementation of improved technology and knowledge on livestock and crop management, transferred to farmers in the district.

The majority of the farmers kept exotic or improved breeds of cattle which yield higher cash revenue due to higher production than indigenous breeds. The cross bred cattle with indigenous genetics are also more resistant to diseases. A major constraint observed in this study is the use of bulls rather than AI to serve the animals on a number of farms. This is not only an avenue for transmission of reproductive diseases, but a hindrance to improvement of productivity of the cattle through introduction of superior genetics. It is also noteworthy that expert veterinary advice was minimal and a large proportion of farmers (55%) perceived lack of extension services as a constraint to improved dairy cattle production. The limited government extension services have been linked to poor funding and privatization of veterinary services (Chema and Gathuma 2004). This has led to a scenario where farmers lack proper animal management and disease control skills as observed by Kagira et al (2010).

Majority of the farms were small (average farm size of 3.2 hectares) with 73% of the farmers owning 0.4 – 4 hectares. The mean number of cattle per farm was also small (20 animals) with majority of the farms (66%) having 3-16 animals. These observations indicate that dairy cattle farming in the district is a smallholder concern. This is similar to observations on dairy farms in Kiambu District in the Central Province (Gitau et al 1994) and in Vihiga District in Western Province (Ongadi et al 2007). Smallholder dairy farming in developing countries in Africa has been described as a catalyst for agricultural development with the potential for increasing income generation and employment, with subsequent enhancement of food security and improvement of livelihoods (Winrock International 1992). Efforts to improve productivity of the dairy industry in these countries should therefore focus on the smallholder farmers.

Eighty-two percent of the farmers used acaricides for tick control and the most common method of application was hand spraying. Furthermore, 67% of the farmers used amitraz (12.5% w/v) preparations over the last five years. In a study carried out on cattle farms in Ngorongoro, Tanzania (Swai et al 2005) 65% of farmers using hand spraying were found to be using less than the recommended concentrations of acaricides. Improper use of acaricides (under dosing) exposes ticks to sub-lethal strengths of acaricides leading to the possible development of resistance (Kagaruki 1991). Development of resistance is also hastened by the use of the same acaricide over a prolonged period of time as was the case
on a large proportion (67%) of the study farmers. The efficacy of the commonly used acaricides in the district needs to be regularly monitored.

The most abundant tick was *Rhipicephalus appendiculatus* followed by *Boophilus decoloratus* and *Amblyomma variagatum*. The abundance of *Rhipicephalus appendiculatus* as observed in this study is in agreement with findings from previous studies on cattle in pastoral communities in Ssembabule District, Uganda (Otim et al 2004) and Ngorongoro, Tanzania (Swai et al 2005). This has been attributed to the fact that cattle are the primary hosts of the tick and their resistance is reduced under field conditions (Kaiser et al 1982). It is noteworthy that ticks were abundant on cattle (40% of the cattle had ticks) despite the high proportion of farmers (82%) using acaricides. These data confirmed the concern by a large proportion of the farmers (75%) that diseases particularly TBDs form a risk to cattle production in the district. The treatment for ECF the disease a majority of farmers considered most important is expensive. This could explain the high proportion (70%) of farmers who considered high cost of drugs as a major constraint. The high abundance of ticks may be attributed to several factors including the high proportion of farmers (61%) applying acaricides at intervals of more than 2 weeks. These factors need to be investigated and information on the proper use of acaricides to control the most important species of ticks in the region conveyed to the farmers.

The high proportion of cattle shedding GIT nematode eggs confirms previous observations that the infections are common in cattle in the district although they are usually sub-clinical (Maingi and Gichigi 1992). Sub-clinical GIT nematode infections are the most important (Soulsby 1982), particularly when the most pathogenic nematode *Haemonchus* is predominant as was the case in this study. The percentage of cattle shedding *Fasciola* eggs in the six divisions also indicated that the infections are common. These data indicate that GIT nematodes and liver fluke infections are a risk to cattle production in the district. It is therefore noteworthy that farmers had moderate to high levels of knowledge on worm infestation and diagnosis and a large proportion (75%) dewormed their cattle. Veterinary advice on drugs was however minimal (26%) and farmers relied mainly on the counter salesmen (51%) for advice on drug usage. Majority (60%) of the farmers had however been using the same type of drug for more than 3 years and the dosage was estimated using eye measures on all the farms. These practices are considered as risk factors for the development of anthelmintic resistance. The efficacy of anthelmintics in cattle in the district needs to be examined and appropriate action taken.

**Conclusions**

- This study identified the most important constraints to smallholder dairy production in Nyandarua District, characterised the farms and established the prevalence, levels of infestation/infection and control practices for ticks, GIT nematodes and liver flukes.
• The factors responsible for the high abundance of ticks despite the high proportion of farmers using acaricides need to be investigated and appropriate remedial measures put in place.

• The extension service is inadequate. Therefore there is a need to improve access to quality extension and veterinary services and seek solutions to constraints facing the farmers in the district in order to improve dairy cattle productivity.

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