Farmer practices that influence risk factors, prevalence and control strategies of rabbit coccidiosis in Central Kenya

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Abstract

Rabbit production is a fast growing industry in Kenya. Despite the growth, an assessment of farmer's knowledge, attitude, and practices that influence the occurrence of rabbit coccidiosis is not documented. This study was conducted in Central Kenya to assess farmers' practices that influence risk factors, prevalence, and control strategies of rabbit coccidiosis. Questionnaires were used to collect data from 97 rabbit farmers and 27 agro-veterinary outlets. Prevalence and intensity of coccidia infection were also determined.

Results revealed that rabbit production is majorly carried out by smallholder (53.6%) farmers who on average keep less than 10 rabbits. The overall prevalence of coccidiosis in the two counties was 49% with infection intensity ranging from 100 to 12.0 x 10^4 oocysts per gram. Poor housing structures (10.5%), inefficient and irregular cleaning methods (74.2%) were the major risk factors for coccidiosis. The majority of farmers reported treating coccidiosis using Sulpha-chloropyrazine (22%) and Trimethoprim/Sulphamethoxazole combination (15%). Non-chemotherapeutic methods used in the management of coccidiosis included the ethnoveterinary use of *Aloe vera* and and liquid paraffin. The study recommends that strategic farmers' training on best practices in rabbit production and health should be carried out and that a controlled laboratory

and field study be conducted to determine the efficacy of the commonly used treatment and control strategies for rabbit coccidiosis amongst the available methods.

Keywords: *anticoccidials, feeding, housing, prevention, treatment*

Introduction

Rabbit production is a fast growing industry in Kenya, (Borter and Mwanza 2010) especially amongst smallholder farmers (Hungu et al 2013; Serem et al 2013). Previous studies have associated this growth to the decreasing individual landholdings and commercialization of rabbit production as a source of food and income generation (Serem et al 2013; Mailu et al 2014).

Despite increasing interest in rabbit production, diseases are still a major challenge to the industry in Kenya (Borter and Mwanza 2010). According to Okumu et al (2015), endoparasites of rabbits especially coccidiosis are a major cause of losses in rabbit production. Coccidiosis is a ubiquitous apicomplexan protozoan infection of animals that seriously impair their growth and utilization of feed (Soulsby 2005). Eleven *Eimeria* spp. have been shown to affect rabbits with varied pathogenicity (Gardiner et al 1998). The species have been shown to be highly tissue, organ and host specific (Georgi and Georgi 1990).

Even though good farm hygiene is suggested as sufficient control method to coccidiosis in a rabbitry, use of anticoccidial drugs for treatment and prevention is still common. In Kenya, there are no registered anticoccidial drugs for rabbits and those in use are adopted from the poultry industry. The objective of this study was to carry out a baseline survey on the farmer practices that influence the prevalence of coccidiosis in rabbits and the associated risk factors. The study also determined the options available to smallholder farmers in Kenya, for control of rabbit coccidiosis.

Materials and methods

Study area

A cross-sectional study was conducted in Kiambu and Nyeri counties of the former Central Province of Kenya. Kiambu has 12 sub-counties while Nyeri has 8 sub-counties. The two counties have established rabbit value chain in smallholder rabbit production systems keeping less than 100 rabbits per household (Hungu et al 2013; Serem et al 2013; Okumu et al 2014). The two counties keep a variety of rabbit breeds including New Zealand white, California white, Chinchilla, Flemish giant, Angora, French ear lop, Dutch, Cross breeds among others (Serem et al 2013).

Study design

Focused group discussions supplemented with rapid rural appraisal (RRA) meetings were conducted to develop a semi-structured questionnaire. The scope of the questions covered farm demographics, rabbit breeds kept and breeding practices, numbers, housing type and housing structures, feeding practices, risk factors, and the various coccidia control strategies used by the farmers to determine the factors contributing to coccidiosis and the control methods available to the farmers.

Farm selection

Study farms and agro-veterinary outlets were randomly selected from the list of 124 total rabbit farmers and 42 agro-veterinary outlets kept by the Livestock Production Offices in the two counties (**Figure 1**). Using a total population of N=124, 5% margin of error, 95% confidence interval and assumed sample proportion of 0.02 (Martin et al 1987), a total of 97 farms were selected for questionnaire administration in the two counties. Based on the rule of a minimum 30 respondents per county (strata) (Cohen 1988), more than the recommended 30 questionnaires were administered per county due to the vastness of the counties and to more accurately represent the characteristics of the population sampled (Marcoulides 1993). A shorter questionnaire designed for agro-veterinary outlets was administered to supplement the main questionnaire by gathering information on the drugs farmers bought for treatment and prevention of coccidiosis.

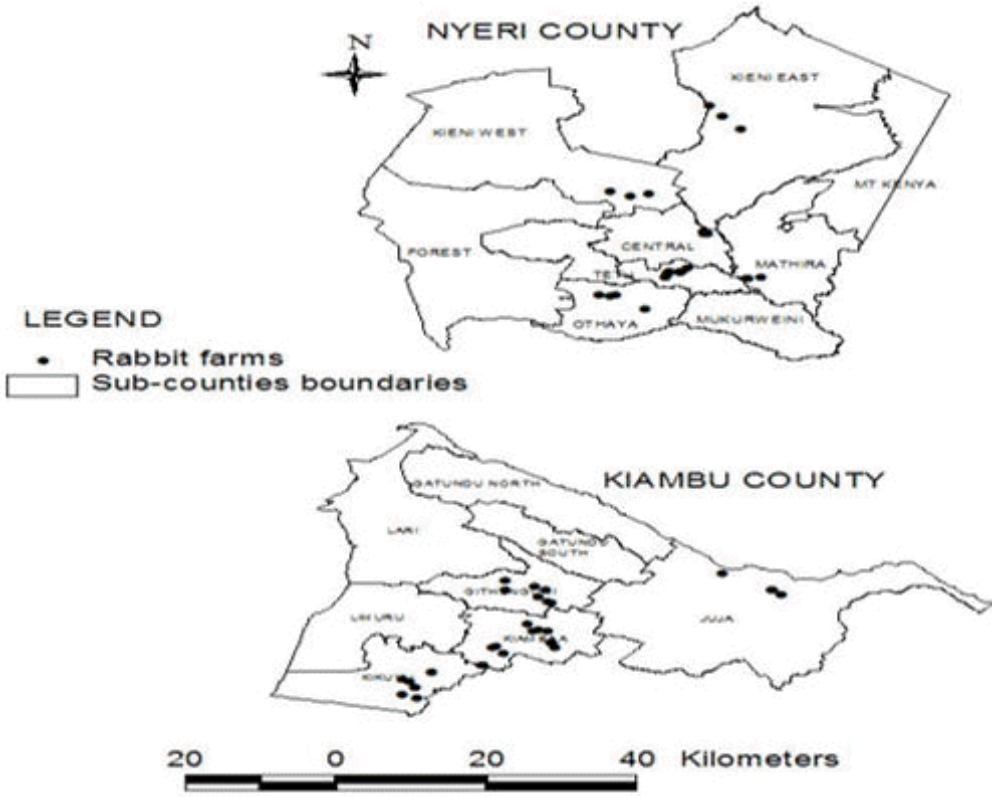

Figure 1. A map showing study area with GPS points of farms visited in Kiambu and Nyeri

Questionnaire administration

On each visit, a semi-structured questionnaire complemented with observation data sheet was administered via personal interviews to randomly selected rabbit farmers and agro-veterinary outlets. The questionnaires were administered by the researchers assisted by four trained enumerators who had also participated in the pre-testing stage. The questionnaires were administered in three languages: English, Kiswahili, and Kikuyu the local language of the area for the farmers who could not speak in either English or Kiswahili. This was used to identify the production practices, risk factors and coccidia control options and strategies used by farmers.

Sampling and processing of fecal samples

At least 5 fecal samples were collected from each farm visited for determination of coccidia prevalence and infection intensity. The fecal samples were collected purposively from the cages of rabbits between 3 weeks and 4 months of ages since this is the age group mostly affected by coccidiosis. McMaster flotation technique was used to morphologically identify the unsporulated oocysts based on the presence of outer and inner oocyst wall and z-zygotes as described by You, (2014) and to determine oocysts per gram of feces (o.p.g) (MAFF 1986). Any fecal sample with at least 1 o.p.g was considered positive for coccidia oocyst. Oocysts were recovered from pooled positive samples and sporulated in a petri-dish containing 2.5% $K_2Cr_2O_7$(to a depth of 3-5mm) at 26^{o}c for 4-7 days. This was followed by centrifugation at 3000 rpm for 10 minutes and isolation carried out according to Soulsby (2005). Identification of coccidian species was based on morphological features (shapes, sizes, presence and absence of micropyle, micropyle cap, oocyst residuum, sporocyst residuum, sporozoite and its nucleus, oocyst wall and sporocyst wall, polar granules and their descriptions) according to Eckert et al (1995). Fecal samples were also examined for helminth eggs and those that were positives were also pooled and cultured for 4 days and the L_3 larvae of strongyle eggs identified (Soulsby 2005).

Data analysis

Data was entered into MS EXCEL (2013), processed and exported to IBM SPSS Statistics Version 20 for analysis. Descriptive statistics was used to summarize the data. Factor analysis and ANOVA were used to rank the risk factors and to determine the significance levels respectively.

Result and discussion

Demographics of farmers and general farm details

A total of 97 farmers and 27 agro-veterinary outlets completed the questionnaires. Out of the 97 farmers, 75 were males, 18 females while the entries for four questionnaires were missing. The majority of the farmers (71.3%) were more than 50 years old followed by those between 40-50 years at 20.2% (Table 1). This shows that mostly the elderly currently participate in rabbit production as was also established by Hungu et al (2013) as opposed to earlier years when rabbit keeping was mainly done by young boys as a hobby.

Table 1. Age stratification of the rabbit farmers

Number	Frequency (n)	Percentage (%)
21 to 30	1	1.1
31 to 40	7	7.4
41 to 50	19	20.2
>50	67	71.3
Total	94	100

The majority of rabbit farmers owned between 1-2 acres (41.5%) and less than 1 acre (39.4%) as previously reported by Hungu et al (2013) and Serem et al (2013). Still, 6.4% and 12.8% owned 2-3 acres and more than 3 acres, respectively.

Rabbit farmers who owned stone houses and timber houses were 52.6% and 24.7%, respectively. This indicates that rabbit farming has well been adopted by the middle class and is no longer a domain of the low in social class. The majority of the respondents had kept rabbits for 2-5 years (30.9%) and more than 5 years (30.9%). Kiambu county had a higher proportion of new farmers (< 6 months in the industry) venturing in rabbit production compared to Nyeri. Main reasons for keeping rabbits were as a business and source of food at 72.2% and 15.5%, respectively and this was in concurrence with earlier studies by Hungu et al, (2013) and Serem et al (2013). This shows the importance of rabbit production in supporting livelihood in the region. Other livestock kept by the rabbit farmers were mostly chicken (25.2%), cattle (18.7%), sheep and goats (17.7%).

Number of rabbits and breeds kept

The majority of farmers (53.6%) had less than 10 rabbits and 11 to 20 rabbits (18.6%) (Table 2). Findings by Hungu et al (2013) and Serem et al (2013) from Kenya and (Lukefahr 2007; Oseni et al 2008) from West Africa also showed that rabbit production is predominantly practiced on a small scale basis in developing countries.

Table 2. Number of rabbits kept by farmers

Number	Frequency (n)	Percentage (%)
1 to 10	52	53.6
11 to 20	18	18.6
21 to 30	13	13.4
31 to 40	6	6.2
>40	8	8.2
Total	97	100

New Zealand white (25.4%), cross breeds (24.2%) and California white (12.9%) were the most kept rabbit breeds (Figure 2). This was in agreement with earlier studies by Serem et al (2013) and Mailu et al (2014) but differed slightly from Hungu et al (2013) from Kenya and (Lukefahr et al 1995 and Oseni et al 2008) from Nigeria who showed that there were more California whites than crosses. However, it is important to note the number of cross breeds might have increased over the years due to haphazard breeding practices by farmers (Mutisya 2014).

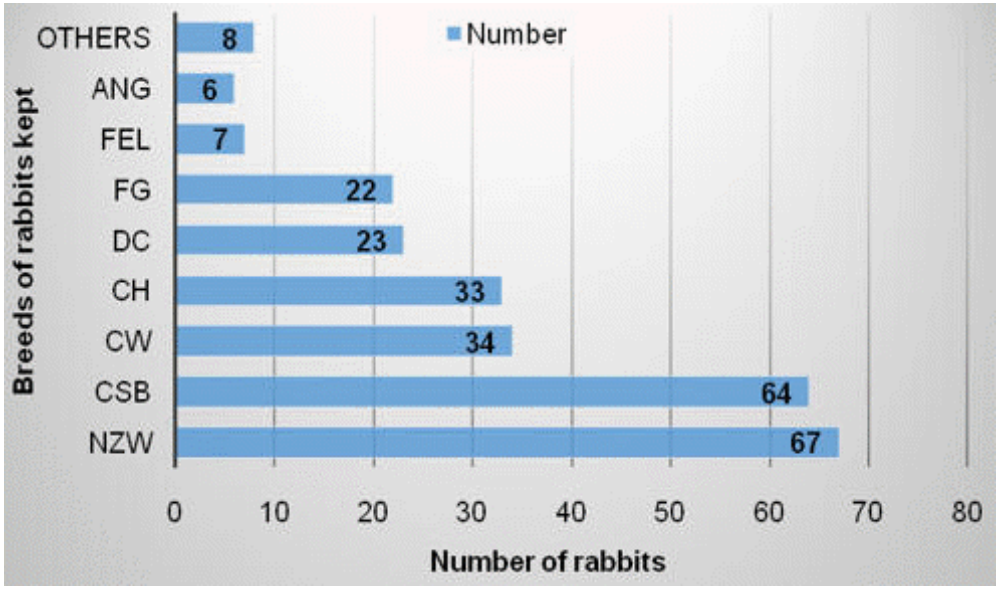

Figure 2. Breeds of rabbit kept by smallholder farmers in Central Kenya. CH (Chinchilla), ANG (Angora), CW (California white), CSB (Crossbreed), DC (Dutch), FG (Flemish giant), FEL (French ear lop) and NZW (New Zealand white)

Source of start-up stock and Breeding practices

The bulk of the farmers sourced their start-up stock of rabbits from other farmers (59.4%) and government breeding centers (14.2%) (Figure 3). On the other hand, only 0.9% of the farmers sourced their rabbits from research institutions including those owned by the government. The same scenario was seen in replacement of breeding stock where 43.8% and 41.6% of the farmers replaced from other farmers and own stock respectively. Similar findings were also reported by Oseni et al (2008) who noted that this coupled with poor record keeping encourages inbreeding and dilution of the genetic resource. This practice may contribute to spread of coccidiosis and other diseases by carriers to disease-negative farms. A greater number of the respondents replaced breeding bucks and does after 1 and 2 years, respectively.

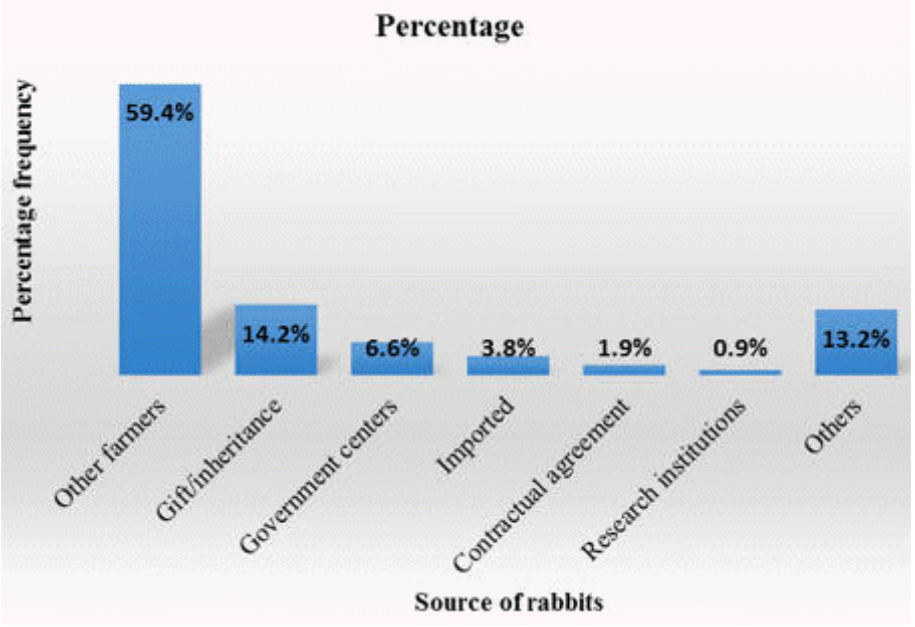

Figure 3. Source of rabbit start-up stock in central Kenya

Hygiene and cleaning practices

Figure 4.shows different cleaning methods used by farmers. The majority (74.2%) cleaned hutches by changing beddings only. Since many of the hutches had wooden floor (62%), this method is not efficient and it may be contributing to the high prevalence of coccidiosis in the study area. Few farmers (10.5%) cleaned the hutches with water and disinfectants. Frequencies of cleaning ranged from once per week (28.9%), daily (27.4%) after 2 weeks, once a month, when visually dirty and some had never cleaned. These findings suggest that most farmers had insufficient knowledge on the role of hygiene in prevention of coccidiosis.

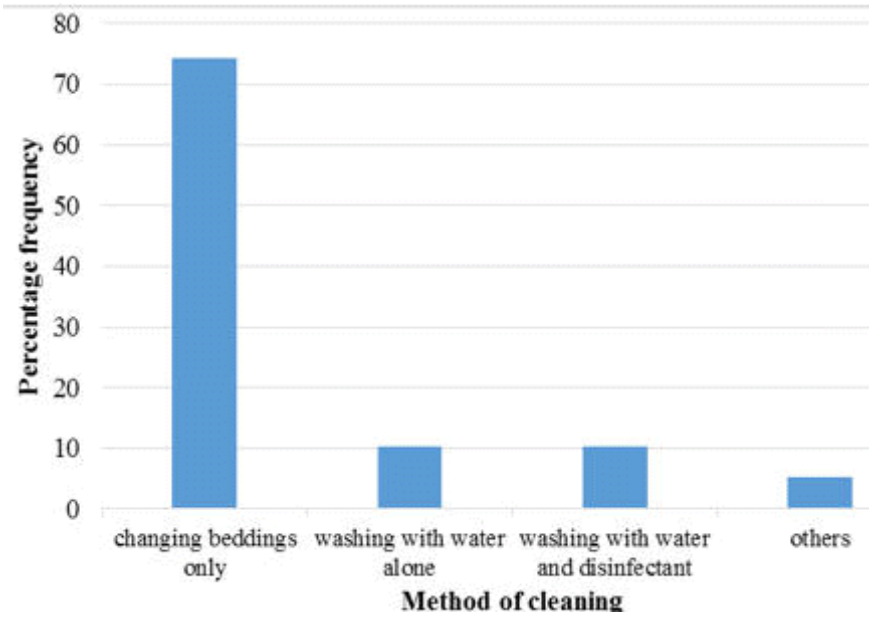

Figure 4. Methods of cleaning used by smallholder rabbit farmers in central Kenya

Most of the rabbit hutches had floors made from wood (62%) and wire mesh (33%). Wood is commonly used to build hutches in these areas because it is readily available and relatively cheap compared to the recommended wire mesh. The same findings were reported by Lukefahr et al (2000) in Cameroon; Oseni et al (2008) in Nigeria and Serem et al (2013) in Kenya. Generally, there was poor keeping of hygiene in most of the farms. This was characterized by the presence of fecal contents on cage floor (29.9%), off-hutch odor (6.2%), feed on cage floor (36.1%), water on cage floor (9.3%) and soiled rabbits (5.2%) as shown in Figure 5.

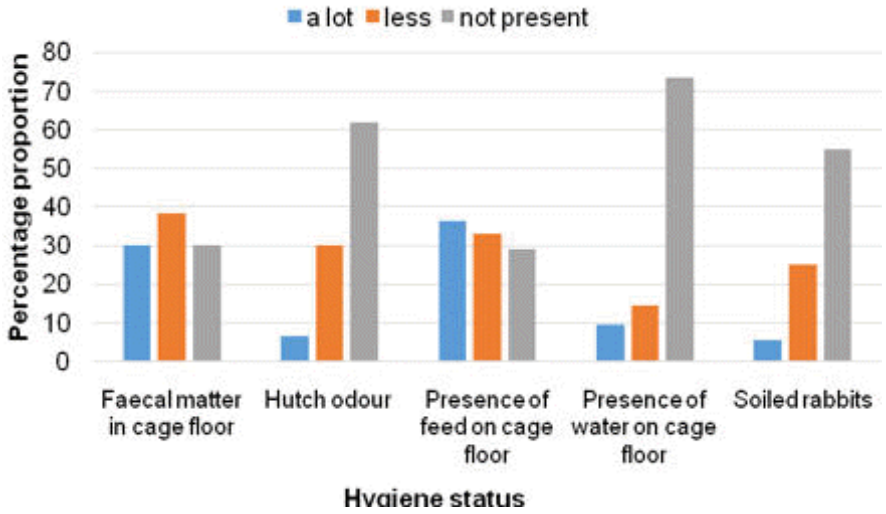

Figure 5. Clustered hygiene status of rabbit farms in central Kenya

Housing structures

The most common outdoor houses were the no tier (28.2%) and single tier (21.4%) types (Figure 6). In most of the houses, rabbits were either caged individually (23.3%) or grouped by age (18%). Additionally, 17.3% of the farms had outdoor hutches while 12.7% had indoor hutches with rabbits grouped by sex; and a few farmers did not group their rabbits in any particular way. Previous studies by Serem et al (2013) in Kenya and Oseni et al (2008) in Nigeria had attributed the high number of low-level tiered hutches to the small scale nature of rabbit production in the developing countries.

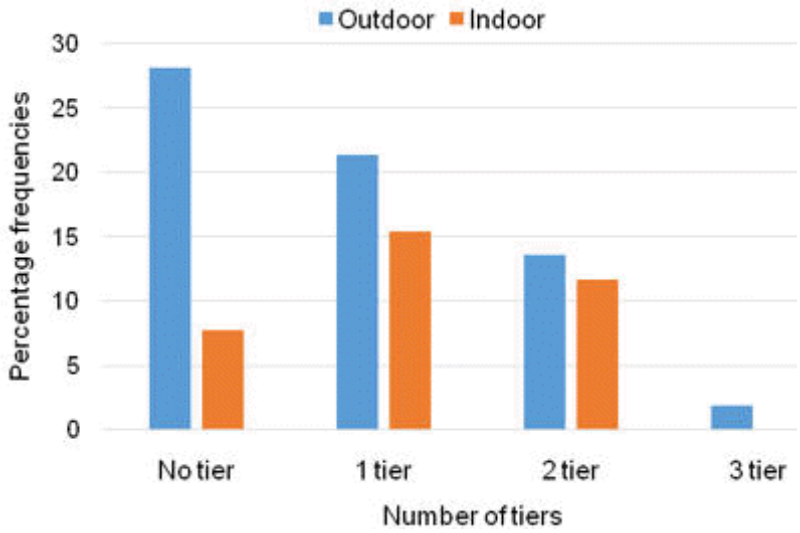

Figure 6. Type of rabbit housing structure in Central Kenya

Feed and feeding practices

The majority of the farmers (49%) reported to use forage as the only source of feed for rabbits; 42% used both forage and commercial or commercial feed only (9%). Farmers using commercial feeds only were from Kiambu probably attributed to its proximity to the city where most feed manufacturers and suppliers are located compared to Nyeri where most farmers relied on forage. Use of commercial feeds and a combination of commercial feeds and forages increased steadily with the level of education as depicted in Figure 7. This indicates that management is improved with good education as was also portrayed by Serem et al (2013) and Mailafia et al (2010) who showed a strong correlation between the two parameters. The finding underscores the need for progressive farmer education on best practices in rabbit production.

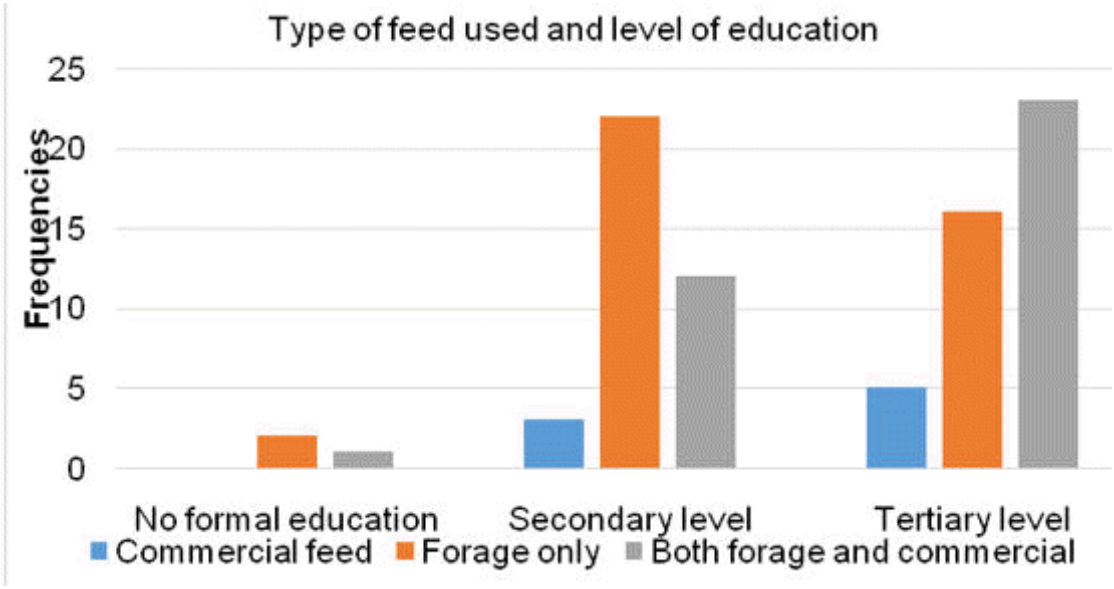

Figure 7. Type of rabbit feed used in relation to the level of education of farmers in central Kenya

Farmers associated poor quality feed such as the use of cattle maize bran with bloating (27.9%), diarrhea (20.9%) and loss of appetite (11.6%) (Table 3). Also, rabbit farmers associated sudden changes in rabbit feed with clinical signs of diarrhea (29.2%), bloating (22.9%) and sudden death (22.9%).

Table 3. Farmer perspective of Clinical signs (%) manifested by rabbits in relation to feeding practices

Clinical signs	Sudden change of diet	Overfeeding	Poor quality feed	Fresh (un-wilted) forages
Diarrhoea	29.2	0	20.9	30.9
Bloating	22.9	57.1	27.9	32.4
Sudden death	22.9	14.3	20.9	26.5
Mucus in feces	4.2	0	9.3	4.4
Lack of appetite	16.7	14.3	11.6	2.9
Stunting	2.1	0	7	2.9
Other signs	2.1	14.3	2.3	0

Most farmers fed their rabbits on fresh forages once they remove the surface dew including weeds (20%), kales (16%), cabbages, sweet potato vines both at (13%), hay (13%), grass (13%) and less frequently carrots and corn stalks (n=413). Feeding of fresh forages with dew was associated with bloating (32.4%), diarrhea (30.9%) and sudden death (26.5%) in rabbits.

Three commonly used commercial feeds were A (64.3%), B (5.4%), C (3.6%) and D (3.6%) (Trade names of the feeds have been masked to ensure good practice). The majority of the farmers associated excessive feeding of the commercial pellets with bloating (57.1%), sudden death (14.3%) and loss of appetite (14.3%) as presented in table 4. Out of the 27 agro-veterinary outlets interviewed, two associated use of commercial feed A with diarrhea/mucoid feces and one associated another commercial feed D with diarrhea. This may reflect poor formulation and especially low crude fiber levels in the feeds (De Blas et al 1999).

Table 4. Percentage of clinical signs that farmers associated with use of commercial feeds in various age groups of rabbits

Age groups	Clinical signs					
	Diarrhoea	Bloating	Sudden death	Lack of appetite	Stunting	Mucoid feces
Kits	15.2	18.8	13.6	17.9	14.3	0
Weaners	48.5	42.5	49.2	25.6	50	37.5
Growers	18.2	17.5	23.7	25.6	21.4	25
pregnant doe	7.6	10	6.8	12.8	7.1	12.5
lactating doe	7.6	8.8	6.8	15.4	7.1	25
other ages	3	2.5	0	2.6	0	0

Farmer knowledge on clinical signs associated with coccidiosis

Diarrhea, distended abdomen, inappetence and sudden death were the most common clinical signs that farmers associated with coccidiosis (Figure 8). Diarrhea was frequently reported in crossbreeds (29.9%), New Zealand whites (28.9%) and California whites (23.7%). This may be attributed to the high occurrence of these breeds in the study area. Similar scenario was depicted for manifestation of distended abdomen (New Zealand white, 25.6%; crossbreeds,22.2% and California white, 18.8%), lack of appetite (New Zealand white, 21.5%; Cross breeds, 17.7% and Chinchilla 15.0%) and for sudden death (New Zealand white, 26.9%; cross breeds, 21.7% and California white, 14.9%).

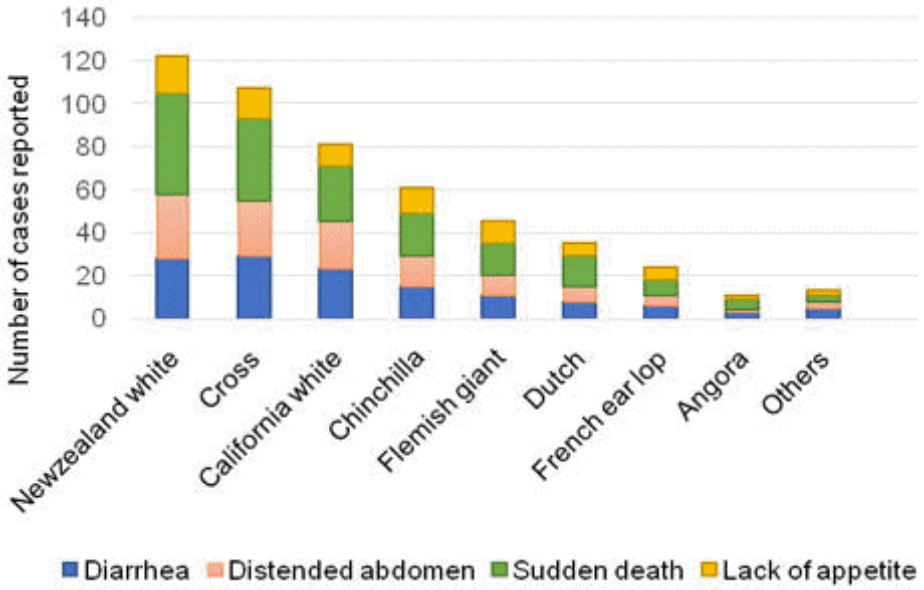

Figure 8. Clinical signs that farmers associated with coccidiosis in different rabbit breeds

Clinical signs reported in different age groups of rabbits

Diarrhea (43.2%), distended abdomen (44.3%) and sudden death (39.7%) were frequently reported clinical signs in weaned rabbits compared with other age groups (Figure 9).

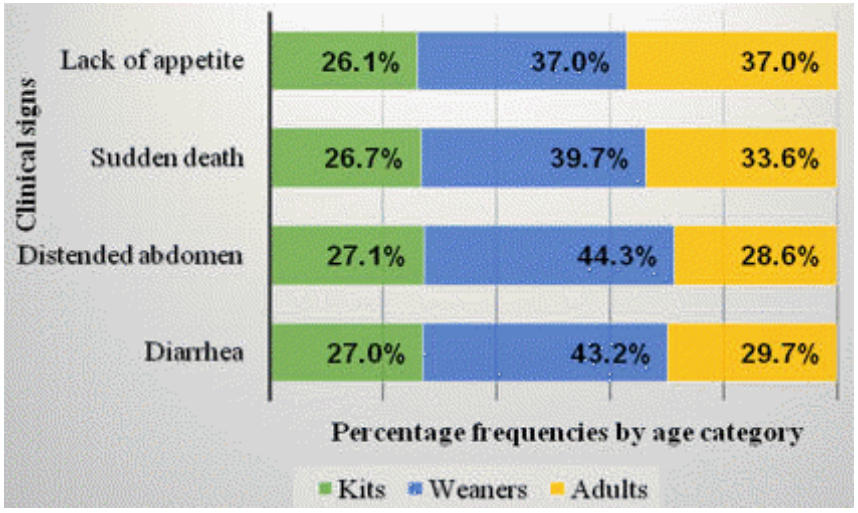

Figure 9. Clinical signs of coccidiosis reported in different age groups of rabbits in central Kenya

Action taken when rabbits are sick

When rabbits are sick, the majority of farmers (42%) independently treated their rabbits, 33.6% called a veterinarian or animal health assistants and 9.2% sought advice from other farmers. Those who self-treat mostly get information on drug usage from other farmers (17.5%) while 10.3% rely on their own experience. This indiscriminate use of drugs with limited or no pharmacological knowledge may contribute to the development of resistance to the available anticoccidials (Chapman 1997). Interestingly, 13.7% of the respondents reported that they do nothing and let the disease take its course. Most farmers in this group stated that they were not aware that rabbits are supposed to be treated when sick. As was also shown by Hungu et al (2013), technical information on management and control of rabbit diseases is still deficient. Farmers are keen to access technical information as shown in an earlier study done in a different county that 80.1% of farmers had attended training on commercial rabbit production (Mutistya 2014). There is a need for continuous strategic training of rabbit farmers because, with time, experienced farmers abandon the enterprise as new ones come in (MOLD 2012).

Commonly used treatment and prevention strategies against coccidiosis

Sulphonamide based antibiotics sulpha-chloropyrazine (22%), trimethoprim/sulphamethoxazole (15%) and amprolium (7%) were the most commonly used anticoccidials to treat clinical signs associated with coccidiosis in rabbits. Aminoglycosides (neomycin), sulphadimidine, tylosin and penicillins are less frequently used (Table 5). This varied with the situation in Europe where Pakandl (2009) listed robenidine, salinomycin, diclazuril and lerbek as the commonly used anticoccidials. As opposed to Europe where prophylactic measures are emphasized, in Kenya, most farmers only apply treatment once the clinical signs appear, which, as Pakandl (2009) noted, is rarely successful. For prevention of coccidiosis, the

majority of the farmers used sulpha-chloropyrazine (41%), sulphadimidine (31%), trimethoprim/sulphamethoxazole combination (18%) and neomycin (18%). Amprolium is used less frequently. All these drugs are mainly registered for use in poultry but not rabbits in Kenya. Fourteen farms (14) reported they had not treated their rabbits for coccidiosis.

Table 5. Percentage frequencies of drugs used by farmers to treat clinical signs associated with rabbit coccidiosis in central Kenya

Treatment regime	Clinical signs					
	Diarrhoea	Distended abdomen	Lack of appetite	Sudden death	Frequencies (n)	Percentages (%)
Sulpha-chloropyrazine	11	3	2	2	18	22
Trimethoprim/sulphamethoxazole	10	2	1	0	13	15
Amprolium	4	1	0	1	6	7
Neomycin	4	1	0	0	5	6
Sulphadimidine	4	1	0	0	5	6
Tylosin	3	0	0	1	4	5
Penicillins	1	0	0	0	1	1
Multivitamin	3	1	11	6	21	25
Liquid paraffin	3	3	0	0	6	7
Herbs (*Aloe vera*)	2	1	0	1	4	5
Total	45	13	14	11	83	100

Trade names of the drugs have been masked to avoid influence on marketing

Some farmers also use non-conventional treatments such as liquid paraffin (14%) and herbs like *Aloe vera* (9%) to relieve distended abdomen and diarrhea. 85% of these farmers felt liquid paraffin and herbs are effective in the treatment of diarrhea and distended abdomen while 6% reported that they do not work. Few farmers reported that liquid paraffin is effective in the prevention of diarrhea and bloat. The use of herbal extracts (Youn and Noh 2001) and other natural alternatives such as fungal extracts and probiotics (Chapman et al 2013) against *Eimeria* parasites have been done in poultry.

Prevalence of coccidiosis and other endoparasites

Out of 526 fecal samples collected in the two study sites, 258 (49%) tested positive for coccidia parasites with oocyst per gram of feces ranging between 1 x 10^2 to over 12.0x10^4. Prevalence of coccidiosis was 79.4 % based on farms surveyed. Prevalence per county were 50.4% (119 out of 236) and 47.9% (139 out of 290) for Nyeri and Kiambu, respectively (P=0.570). The farm based prevalence of 79.8% is slightly lower when compared with the 85.1% reported in an earlier study by Okumu et al (2014). Poor hygiene due to the high number of wooden floors coupled with poor cleaning methods may be responsible for the high coccidiosis prevalence recorded in this study. The observed presence of feces in the cages may have facilitated the rapid spread of the disease in grouped rabbits. It is recommended that the hutches be cleaned more frequently with water and disinfectant to minimize reinfection. Housing rabbits of different age groups in the same cage also contribute to the spreading of coccidiosis. Use of rabbit cages that prevent fecal contamination and facilitate effective cleaning and disinfection is recommended.

*Eimeria*species identified were *E. magna* (16%), *E. irresidua* (12%), *E. intestinalis, E. perforans* (8%), *E. flavescens* (24%) and *E. coecicola* (28%). Of these, *E. magna, E. irresidua* and *E. perforans* are the most pathogenic in intestinal coccidiosis. In a previous study, Okumu et al (2014) showed that rabbits in Kenya are mostly affected by mixed infection of *E. perforans, E. magna, E. piriformis, E. intestinalis, E. flavescens,* and *E. coecicola.* Studies in India and Iran have also reported high prevalence of mixed infections of rabbits with different *Eimeria* species (Bhat and Jithendran 1996; Hamidinejat et al 2010).A study of intestinal coccidiosis in Italy established that *E. perforans, E. exigua* and *E. magna* were the most common species causing intestinal coccidiosis (Papeschi et al 2013).

Twenty-five (4.8%) and 13 (2.5%) fecal samples were positive for strongyle and Strongyloides eggs, respectively with egg counts ranging from 100 to1900 eggs per gram of feces. This was in agreement with Okumu et al (2014) who found very low nematode egg counts in rabbits. Two samples (0.4%) and one sample (0.2%) were positive for *Giardia lamblia* cysts and tapeworm eggs of *Taenia pisiformis*, respectively. *Passalurus ambiguous* larvae were identified from cultured fecal samples.

Conclusions and recommendations

- Prevalence of coccidiosis (79.8%) in the study area was considered high. Poor housing structures, inefficient and irregular cleaning methods, and lack of technical knowledge on rabbit production are the major risk factors facilitating the spread of coccidiosis in the study areas.
- The high cost of commercial feeds and building materials hinders adoption of rabbit production in large scale and county governments should find ways to subsidize these. The commonly used treatment options of coccidiosis in rabbits are Sulphachloropyrazine (22%) and sulphamethoxazole/trimethoprim combination (15%) which the farmers use without consulting the veterinarians, implying that in the process of treatment, prudent use of the drugs cannot be assured, a practice that may predispose to drug resistance.
- To avoid development of resistance to these drugs, regulation of their usage should be enforced (drugs to be sold only to veterinarians and animal health assistants). Strategic and progressive farmer education on good practices in rabbit production will mitigate the identified risks factors for coccidiosis.

The study recommends a controlled laboratory and field study to determine the most effective drug for rabbit Coccidiosis among the above-mentioned options currently in use.

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Competing interests

The authors have no competing interests

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