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Impact of Diverse Production Environment on Prevalence of Cattle Diseases and External Parasites in Smallholder Dairy Farms in Kenya

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Abstract

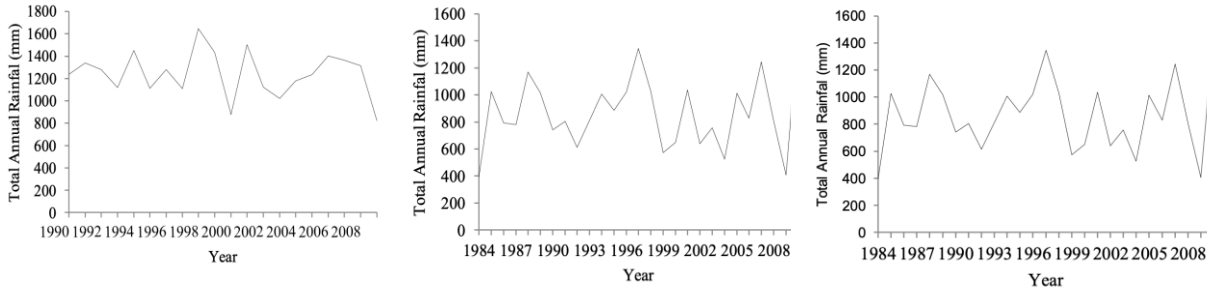
The study analyzed the impacts of diverse production environments (PEDs) on the prevalence of cattle diseases and external parasites in smallholder dairy farms in Kenya. The PEDs were sampled from three counties; Rongai sub-county in Nakuru County, Kipkelion sub-county in Kericho County and Nandi South sub-county from Nandi County. In each sub-county, one location with the highest dairy cattle populations was sampled. A participatory survey and interviews were conducted among the smallholder dairy farmers. The most prevalent diseases in all the PEDs included east coast fever (ECF), mastitis, dermatitis, black quarter, brucellosis, anaplasmosis, anthrax, milk fever, foot rot, lumpy skin (LSD), foot and mouth (FMD). Disease prevalence level ranged from 2.00 (rare) to 4.00 (ever-present). Ticks, mosquitoes, tsetse flies, fleas, ants, crabs, mites, flies and lice were the most common external parasites. In all the PEDs, farmers observed an increase in crabs, frogs, flies and ticks which is attributed to increase in temperature and decline in amount of rainfall. Findings from this study provide resourceful information for developing diseases and parasites mitigating strategies in the specific production environment.

Keywords*:* climate change, parasites, diseases, production environments

Introduction

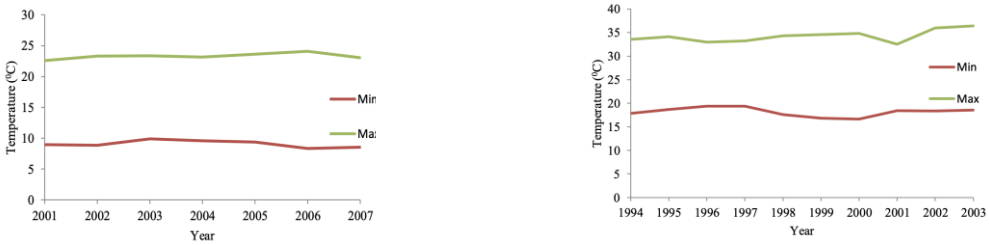
Rainfall (Figure 1) and temperature (Figure 2) patterns in Nakuru, Kericho and Nandi Counties is declining and increasing trends respectively due to climate change (Ngeno *et al*., 2013). Rainfall trend in Nandi south, Rongai and Kipkelion sub-counties in the past 19, 26 and 27 years respectively has reduced and highly variable. Total annual rainfall ranged from 821.1mm to 1647.7mm,

407.0mm to 1407.5mm and 685.2mm to 1458.8mm in Nandi South, Rongai and Kipkelion sub-counties respectively. Temperature trend from 2001 to 2007 in the Nandi south and from 1994 to 2003 in Rongai is ranging between 8.34^{0}C and 24.01^{0}C and 16.66^{0}C to 36.40^{0}C respectively. Kipkelion sub-county temperature range from 17 to 25^{0}C (Ngeno *et al*., 2013).



Nandi Rongai Kipkelion

Figure 1. Rainfall trend in Nandi South, Rongai and Kipkelion sub-counties.
(Source: Ngeno *et al*., 2013)



Nandi South Rongai

Figure 2. Temperature trend in Nandi South and Rongai sub-counties.
(Source: Ngeno *et al*., 2013)

The temperature and rainfall variations in these counties impacts directly and indirectly on the cattle production. Changes in rainfall and temperature patterns directly affects the spreading and richness of disease and parasite vectors and their predators, predator competitors and parasites of vectors themselves. The effects include the change in pathogens and vectors molecular biology resulting in the emersion of new diseases and disease patterns, due to exposing of hosts to pathogens and vectors that are new and/or

mixed. Consequently resulting in diseases and parasites spreading into new regions or an increase in their frequencies, and, in turn, lowers productivity and increases livestock deaths (Patz*et al.*, 2000). Increasing temperatures and declining precipitation within the diverse production environments (PEDs) in sub-counties may stimulate the spread of diseases; promote the survivability or abundance of the disease agents or their intermediary host. Such effects in PEDs could lead to prominence of diseases initially thought as "exotic" to become more important at the same time the existing diseases becoming more widespread and accompanied with increased risks of immunity development (Skuce *et al.*, 2013). Other factors influenced by rainfall and temperature change in PEDs which could alter bovine diseases include the farm routine and land use practices, pathogens' and vectors' molecular biology, environment and zoological aspects and the creation of new climates environments at micro-level (Gale *et al.*, 2009). The potential influence of changes in climatic variability (CVC) in PEDs on the prevalence, abundance and distribution of cattle external parasites and diseases has not been assessed. This study analysed the prevalence of cattle external parasites and diseases in the smallholder dairy farms under diverse production environments of Rongai sub-county in Nakuru County, Kipkelion sub-county in Kericho County and Nandi South sub-county in Nandi County.

Methodology

Study areas

Rongai sub-county in Nakuru County, Kipkelion sub-county in Kericho County and Nandi South sub-county in Nandi County were sampled. Selected sites represent the varying degree of rainfall and temperatures (variables to measure climate change) and were used to mimic the potential impacts of climate change.

Sampling method

In each sub-county, one sub-county, one location was selected in conjunction with the Ministry of Livestock, Department of Livestock Development, community-based organization (CBO) and the county administration (chiefs and their assistants) officers. Three sub-locations per location with the highest dairy cattle populations were sampled. The selected sub-locations were Mogotio, Boito and Lengenet in Rongai sub-county, Mosombor, Kimolwo, and Toretmoi in Nandi South sub-county and Kipsirichet, Chakoror and Kedowa in Kipkelion sub-county. Two main landmarks in each sub-location were selected and transecting lines

were drawn. The 5th households were randomly sampled and interviewed.

Data Collection and analysis

The environmental stressors considered based on farming perception which was common across the studied regions were disease epidemic and vector prevalence. Data collection were done following guidelines by Food and Agriculture Organization of the United Nations (FAO/WAAP, 2008). Techniques used included ranking, scoring, trend and seasonal analysis. Information was collected using a structured and pretested questionnaire. Enumerators from each locality were recruited and trained on data collection procedure. Enumerators with good personal interaction skills, basic form four education, fluent in local language, conversant with the study area and available to work full-time during data collection were recruited. These eased communication and acceptability in the community. Disease symptoms described by farmers were recorded. Clinical signs obtained from the farmers were interpreted by a veterinarian to identify the specific disease. A relative ranking of the impacts of CVC on disease and parasite prevalence in the PEDs based on farmers perception and farming experience were done on a five-scale ranking order; 1 = Eradicated, 2 = Rare/ Occasional, 3 = Frequent, 4 = Ever present and 5 = Emerging. Statistical Package for Social Sciences (SPSS, Version 20) was used in the analysis.

Results and discussion

Type of diseases in the PEDs and their prevalence levels are presented in Table 1. East coast fever (ECF), mastitis, dermatitis, black quarter, brucellosis, anaplasmosis, anthrax, milk fever, foot and mouth disease (FMD), foot rot and lumpy skin disease (LSD) diseases were the most common diseases. The mean prevalence levels ranged from 2.00 (rare) to 3.00 (frequent). Frequently diseases included: ECF, mastitis, Nagana and dermatitis in Nandi south sub-county; anaplasmosis, FMD, and LSD in Rongai sub-county.

Table 1. Type of diseases in the diverse production environments (PEDs) and their prevalence levels

Sub-county	ECF	Mastitis	Dermatitis	Black quarter	Brucellosis	Anaplasmosis	Anthrax	Milk fever	FMD	Foot rot	LSD
Nandi south	3.39	3.21	3.00	2.11	-	2.44	2.20	2.25	3.20	3.00	2.07
Kipkelion	3.37	3.17	-	2.20	2.00	2.42	2.27	2.11	3.12	2.80	2.50
Rongai	3.25	3.00	2.00	2.00	2.60	2.50	2.00	2.67	3.04	-	3.63

Scale: 1 = Eradicated, 2 = Rare/ Occasional, 3 = Frequent, 4 = Ever present, 5 = Emerging; ECF-East Coast Fever; LSD- Lumpy Skin Disease; FMD-Foot and Mouth Disease

Table 2 presents the type of ecto-parasites and their prevalence levels in the studied PEDs. Ticks, mosquitoes, tsetse flies, fleas, ants, crabs, mites, flies and lice were indicated as the most common external parasites. Among the parasites, ticks were shown to be ever-present in all the studied areas. Tsetse flies, fleas, ants and mites were also frequent. Mosquitoes and lice were reported to be rare. In all the PEDs, farmers observed an upward trend in the population of ticks, crabs, flies and frogs.

Table 2. Type of ecto-parasites and their prevalence levels across the study area

Sub-county	Ticks	Mosquitoes	Tsetse flies	Fleas	Ants	Crabs	Mites	Flies	Lice
Nandi-south	3.72	2.20	2.86	2.51	2.85	-	2.66	-	-
Kipkelion	3.71	2.14	2.89	2.48	2.86	-	2.59	-	-
Rongai	3.60	-	3.00	-	-	3.26	2.42	3.05	2.14

Scale: 1 = Eradicated, 2 = Rare/ Occasional, 3 = Frequent, 4 = Ever present, 5 = Emerging

The effects of CVC are accompanied not only by the change in prevalence levels of diseases. The observed increase in the frequency of the diseases in the study area indicates the possible effects of climate change which has resulted in declining precipitation and increasing temperatures that favours the survival and multiplication of pathogens and vectors causing cattle diseases. Increase in the frequency of ECF, mastitis and dermatitis in Nandi south sub-county, anaplasmosis, FMD and LSD in Rongai sub-county may also be attributed to microbes developing new strains and change in pathogen pathways and infectivity in new host species or populations. This is in agreement with studies conducted on the effects of climate change on the occurrence and prevalence of livestock diseases and the ecology of emerging neurotropic viruses (Olival & Daszak, 2005; Gale *et al.*, 2009). Patz *et al.,* (1996) indicated that climate

change may affect the transmission of diseases by either shortening the incubation time of the pathogens and/or increasing their reproductive and biting rates (Patz *et al*., 1996). Frequency of disease in the PEDS could also be promoted by the change in the zoological factors and environmental conditions (development of new micro-environments and micro-climates) (Gale *et al*., 2009). Rising temperature in the PEDs in the studied regions is likely to have contributed to the expansion and the distribution of cattle vector-borne diseases. Other factors influenced by change in temperature and rainfall which could have affected the frequency of cattle diseases in the PEDs include the dynamics of production systems due to shifting to more intensification systems like zero-and semi-zero grazing (animals' frequency of contacts are increased leading to the higher spread of diseases) and change in land use. The risks arising due to climatic variations under the PEDs may have also altered both the quality and quantity of foraging resources and consequently, cattle might end up eating soil, thus exposing them to soil pathogens.

Arthropod vectors such as biting flies are the main vector-borne diseases transmitters (Atkinson *et al*., 2009). Climate change have impact on the frequency and the type of ecto-parasites and other insects. For example, in Mexico, the population of mosquito species which feeds on mammals has increased and replaced Culextaeniopus, which had been the principal mosquito vector due to loss of plants which eliminated the habitats of Culextaeniopus (Gale *et al*., 2009). Dairy cattle in the PEDs face a great challenge of diseases since invertebrate vectors that are on increase are the main transmitters of livestock diseases. The observed increase in flies, ticks, crabs and frogs could be due to an increasing trans-boundary movement of people, livestock and the changing ecological conditions. Soft (Argasid) ticks, *Ornithodorossonrai* and borreliosis have widened their array into regions of Sub-saharan Africa due to increasing drought (Trape *et al.*, 1996). In the studied regions, rise in the frequency of ticks can be associated with declining amount of rainfall. Temperature determines the prevalence of a parasite; for instance, Van den Bosscheand Coetzer (2008) indicated that an increase of 1^0C in temperature resulted in about a 10% increase in parasites prevalence. At higher temperatures, many arthropods' vectors increase their feeding rate. This, therefore, enhances the contact of livestock to pathogens, and hence increasing the spread of diseases. Warmer night-time temperatures

are the main effect of CVC on mean temperature. This is imperative for nocturnal insect vectors like mosquitos (Harvell*et al*., 2002; Benisto*net al*., 2004; Gale *et al*., 2009). A study on birds found in regions with prodigious temperatures indicated superfluous parasite incidences compared to those inhabiting highland areas where temperatures are low (Zamora-Vilchis *et al*., 2012). Mosquito flight activity can enhance their abundance in the presence of precipitation, consequently, speeding the mosquitos' reproductive cycle. As a result, activities such as mating, looking for a host, and blood-feeding flights will be needed (Shaman & Day, 2005; Gatton *et al*., 2013). In Kenya, where temperature, rainfall variability and dry seasons have been foreseen to rise, parasite occurrence is most likely to rise. A similar trend is likely to occur in PEDs, where cattle kept in the warmer regions of Rongai sub-county experiencing more parasite prevalence compared to Nandi and Kipkelion sub-county. The expected higher parasite rate in Rongai sub-county could be associated with two factors; one, the fact that plenty of vectors are associated to temperatures positively, and secondly, the transmission of vector-borne diseases may be increased by prodigious ambient temperatures (Lindsay*et al*., 1996; Zamora-Vilchis *et al*., 2012).

Conclusion

The prevalence of cattle diseases and ecto-parasites in Rongai, Kipkelion and Nandi South sub-counties is linked to the effects associated with the changing climate; which is reduction in precipitation and increase in temperatures. To control and/or minimize cattle diseases and ecto-parasites, it is paramount to enforce climatic restrictions on vectors, environmental habitats and disease-causing agents.

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Conflict of interest

The authors declares that there is no conflict of interest.

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