Milk production of Ankole crossbreds and Holstein Friesian cattle in different production environments of Rwanda

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Abstract

The aim of the study was to assess the productive performance of dairy cattle in three different agroecological zones of Rwanda: Congo-Nile/Western, Central plateau/Central, and Eastern plateau/East agroecological zones. A single-visit multi-subject survey was conducted to obtain information on the dairy cattle performance from 51 farms. The breed groups were classified as Ankole x Holstein Friesian (AF), other Ankole crossbreds (AX) and pure Holstein Friesian (F). F had higher milk yield than AF in all zones and AF had higher milk yield than AX, except in the Western zone. Across all zones, F produced 10 L more than AX and 6 L more than AF per day. Cows in the Eastern zone had the highest milk yield, which was contrary to our expectation, because the Western zone receives more annual rainfall, and hence should have a better pasture level. The large difference in performance of Holstein Friesians and its crossbreds in different agroecological zones indicates that considerable improvement could be achieved by improving the production environment.

Introduction

Livelihoods of many resource-poor farmers in low income countries depend on livestock (Delgado et al., 1999) and this is also true in Rwanda. In addition to 10% contribution to national GDP, the cattle production provides milk, meat, fertilizer, fuel, draft power and also as a means of economic uplift from the sale of milk and milk products. The cattle population is estimated at about 1.3 million heads of which 45% are local Ankole longhorn, 33% crosses and 22% exotic breeds (NIRS, 2015). As in other tropical countries, these animals are reared essentially under the traditional low input husbandry management system, which is often subjected to poor nutrition and disease control leading to low productivity (Abeygunawardena and Dematawewa, 2004). Rwanda's projected increasing trends for human population and urbanization coupled with rising household incomes, like other countries in Sub-Saharan Africa, will lead to a substantial increase in the demand for livestock products, particularly milk and meat (FAO, 2009). In an effort to improve production, particularly milk production, the Government of Rwanda (GoR) embarked on genetic improvement programs through importation of dairy cattle and upgrading local breeds using subsidized imported and locally produced dairy cattle semen. Also, the GoR has been distributing improved cows to poor families through the GIRINKA program. Currently, many smallholder farms and some larger farms exists across the country, but the cattle breeding and on-farm performance data collection is either lacking or limited. Therefore, a single-visit multi-subject formal survey technique was undertaken to investigate the productive performances of purebred and crossbred dairy cattle in different agroecological zones of the country.

Material And Methods

Site description

The study was conducted in three agroecological zones: Congo-Nile/Western Agroecological Zone (**WAZ**), Central plateau/Central Agroecological Zone (**CAZ**), and Eastern plateau/East Agroecological Zone (**EAZ**)

(Fig. 1). In WAZ, Karongi, Nyabihu and Rubavu districts were involved in the study. The zone is characterized by high altitude (1800–3000 m) and high annual rainfall (1200–1600 mm). The average annual temperature ranges between 15 and 17°C. Livestock is dominated by crossbreds and exotic cattle and production system is mainly extensive in Nyabihu while in Karongi and Rubavu is predominantly zero grazing. Districts selected from CAZ were Huye and Kamonyi. The altitude ranges from 1100 to 1700 m, the annual rainfall varies from 1000 to 1500 mm and the annual average temperature ranges from 18 to 20°C. Livestock is dominated by cattle, goats and pigs in a predominantly zero grazing practice. In EAZ, the study was conducted in the districts of Kayonza, Rwamagana and Gasabo. In this zone, cattle and goats are the dominating livestock. Both exotic and local cattle are found in the area. The farming is characterized by mixture of zero and free grazing. The pasture is fenced by euphorbia spp. In zero grazing, the cows are mainly feed on napier planted along the road, on contour hedge rows bordering planting for soil erosion control and around the marshland. In this land use system, there is variation of altitude with gentle slopes between 1200 to 1500 m above sea level. The rainfall varies between 800 and 1000 mm annually and the temperature ranges between 20 and 22 ^{o}C.

The cows were managed differently depending on feed availability under both intensive and semi-intensive management system. The feed included natural pasture (cut-and-carry), hay, milling by-products, concentrate mix and non-conventional feeds. Cows were hand-milked twice per day. Animals were watered from piped water and mineral licks were provided ad libitum. Natural mating and artificial insemination were used for breeding cows. There was regular vaccination against notifiable diseases such as anthrax, black leg, lumpy skin disease and foot and mouth disease. Spraying or dipping against ticks was regular and farmers called veterinarians to treat their animals whenever diseases occurred.

Data recording and statistical analysis

This study focused on specific dairy cattle farms within different agroecological zones of Rwanda. Within these zones, the survey was conducted in districts known to have a large dairy cattle population. Ease of access and size of the farm were among the factors considered in purposely selecting farm and the list of farmers was acquired in collaboration with district and sector veterinary officers. The survey was conducted by University of Rwanda students as interviews in the year 2013. The respondents were either owners or managers of each dairy farm. The survey technique was of single-visit multi-subject type (ILRI, 1990). The information collected covered several production parameters including breed of the cow, dam weight, age and puberty weight, age at first calving, current age, calving interval, milk yield, lactation length and longevity, but for this study only milk yield per day (in L) was considered. Milk produced at the farms was recorded for both morning and afternoon for that particular day and summed to daily milk yield. Breed groups were classified as Ankole x Holstein Friesian (AF), other Ankole crossbreds (AX, mainly Jersey, Sahiwal and Brown Swiss) and pure Holstein Friesian (F). Combining several crosses into AX became necessary because each of these crossbreds occurred with low frequencies. Unfortunately, purebred Ankole were found almost only in CAZ and were thus not included in the analysis.

The data were entered and organized in Excel spreadsheets and statistical analyses were carried out using SAS software (SAS, 2012). The linear model included fixed effects of age of cow (in years, 2–8^{+}), breed group (AF, AX, or F), agroecological zone (WAZ, CAZ, or EAZ), and the interaction between breed group and agroecological zone. Differences between Least Squares Means (LSM) were considered to be significant at the level $p < 0.05$.

Results And Discussion

All factors in the statistical model were highly significant ($p < 0.0001$) and R^2 of the model was 60.6%. In total, there were 5,806 cows with milk yield records and information on factors in the model. The dominant cattle breed group was pure Holstein Friesian followed by its cross with Ankole cattle (Table 1).

Table 1
Number of animals and least squares means (LSM) for daily milk yield (L) for three breed groups in three agroecological zones (AEZ)[1]

	Number of animals				**LSM[2]**			
	AEZ				AEZ			
Breed group[3]	WAZ	CAZ	EAZ	Total	WAZ	CAZ	EAZ	Main effect
AX	37	506	11	554	7.8^{c}	4.3^{a}	3.4^{ab}	5.1
AF	363	55	870	1288	7.9^{c}	5.9^{b}	13.3	9.0
F	1056	660	2248	3964	11.8	12.3	21.7	15.3
Main effect	-	-	-	-	9.1	7.5	12.8	

[1] Congo-Nile/Western Agroecological Zone (WAZ), Central plateau/Central Agroecological Zone (CAZ), and Eastern plateau/East Agroecological Zone (EAZ). [2] LSM with same superscript are not significantly different from each other (p-value > 0.05). [3]AF=Ankole x Holstein Friesian, AX = Other crossbreds with Ankole, F = Pure Holstein Friesian.

Eastern plateau (EAZ) had the highest average milk yield (Table 1). This was contrary to our expectation, because WAZ receives more annual rainfall, and hence should have a better pasture level compared to EAZ. This indicates that there are other management factors, such as supplemental feeding, that differ between the zones.

The average milk yield varied between breed group by zone combination from 3.4 to 21.7 L (Table 1). F had higher milk yield than AF in all agroecological zones and AF had higher milk yield than AX, except in WAZ. The difference between breed groups was highest in EAZ.

Across all zones, F had about 6 L higher milk yield than AF and 10 L higher than AX. The almost 10 L difference between F in EAZ and F in the other two zones indicates that the level of nutrition in WAZ and CAZ were below that needed for Holstein Friesian cows to express their genetic potential. Compared to results from cows in same agroecological zone (CAZ) during the years 1999–2010 and 2013–2017, Manzi et al. (2020) reported lower average milk yield (4.6 L) for AF, most likely due to lack of supplementation of lactating animals. Similarly, Nigusu and Mekasha (2016) in Ethiopia reported significant difference in the performance of Holstein Friesian and its crosses with Zebu cows in urban and secondary town dairy production systems, where a higher daily milk yield was found in the urban production systems (15.5 ± 5.2 L) and for high-grade Holstein cows (15.3 ± 4.1 L) and lower in secondary town production systems (13.7 ± 3.9 L) and for crossbred cows (11.2 ± 3.6 L). Unlike our findings, in a study analysing livestock farming systems in Kenya it was observed that the average daily milk production was highest in central highlands comparable to WAZ (11.8 L) followed by mid-altitude eastern region comparable to CAZ (10.4 L) and lowest in coastal lowlands comparable to EAZ (7.0 L). The reason given for increased milk production in highlands was that farmers invested in commercial concentrates for their dairy cattle (Njarui et al. 2016).

Concluding remarks

Contrary to our expectation, because WAZ receives more annual rainfall, and hence should have a better pasture level compared to EAZ, cows in EAZ had higher milk yield. The large difference in performance of Holstein Friesians and its crossbreds in different agroecological zones indicates that considerable improvement could be achieved by improving the production environment, especially the nutrition.

Declarations

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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Conflict of interest

The authors declare that they have no conflict of interest

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Figures

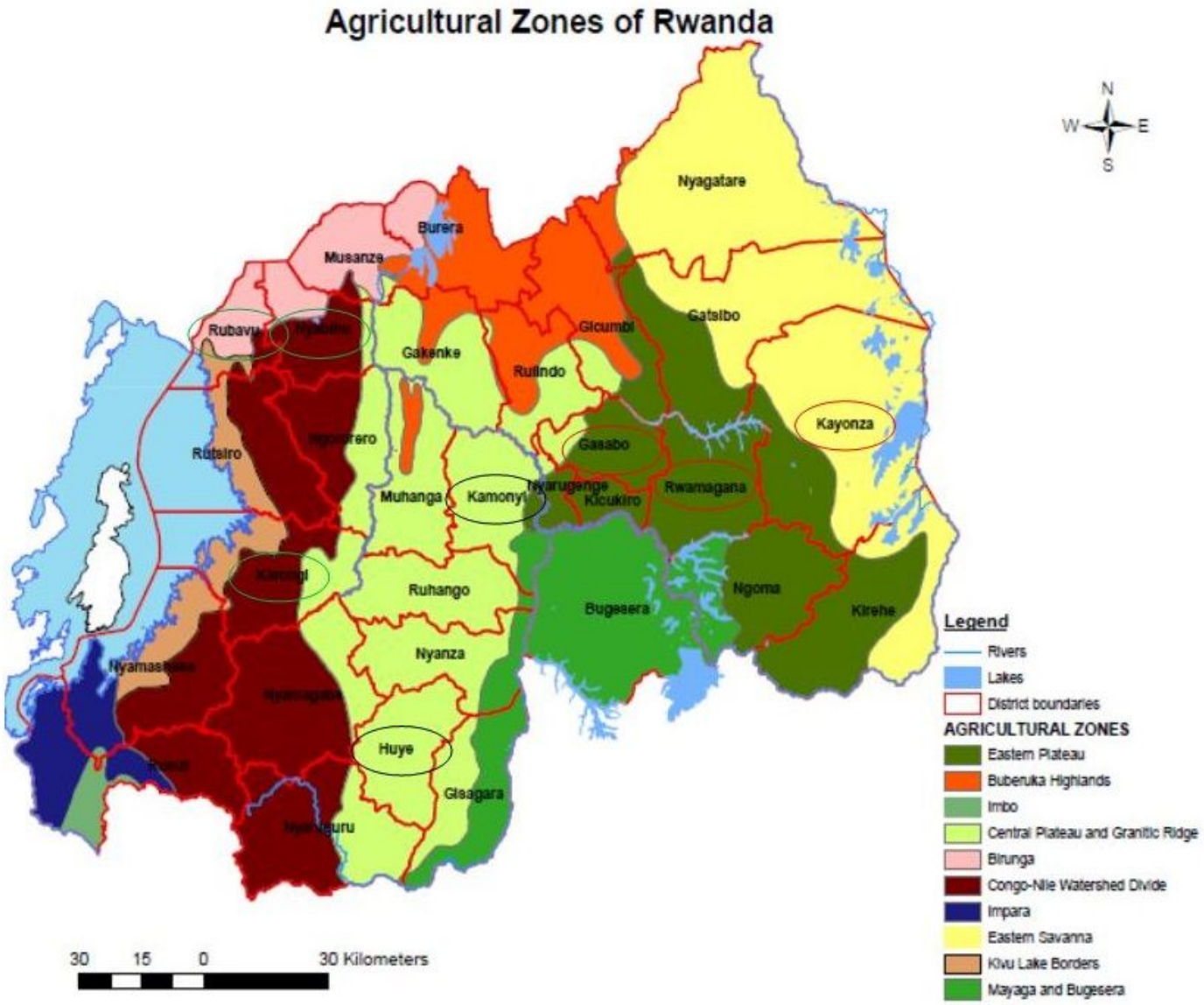

Figure 1

Agroecological zones in Rwanda (from Delepierre, G. 1975). Congo-Nile/Western agroecological zone (WAZ, green circles), Central plateau/Central agroecological zone (CAZ, black circles), and Eastern plateau/East agroecological zone (EAZ, red circles).