Analysis of the dairy production system in the Ruzizi plain and the Kalehe territory.

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Key words: Feeding system, diary production, cattle, Kalehe, Ruzizi Plain

Submitted 08/08/2023, Published online on 31/10/2023 in the *Journal of Animal and Plant Sciences (J. Anim. Plant Sci.) ISSN 2071 – 7024*

1 SUMMARY

In order to characterize dairy cow production systems in the Ruzizi Plain and Kalehe territory, this study was conducted on 110 farms with 2596 suckling females, spread over the Ruzizi Plain and the Kalehe highlands. The characterization of production systems and the determination of milk production were carried out by means of a survey questionnaire. The main results show that the feeding of dairy cows in the study areas is mainly based on grazing (100%). The pastures are communal in the Ruzizi plain (100%) while in Kalehe, the pastures are private (100%) with salt intake. On both sides, salt is used as a feed additive but its use shows a negative interaction with milk production ($p = 0.03$) as does the number of lactating females which shows a negative correlation with milk production ($p < 0.001$). In addition, milk production estimated in litres/cow/day remains very low in the Ruzizi plain and in Kalehe. It is 1.4±0.91 and 2.27±1.31 litres/cow/day in the rainy season in the Ruzizi plain and Kalehe respectively. In conclusion, the results of this work cite a cattle diet based on less tended pastures with some salt supplementation in the drinking water, which leads to low milk production. Thus, an improvement of the pastures and a diagnosis of the genetic types of the animals raised would be necessary to improve the milk production.

2 INTRODUCTION.

The Democratic Republic of Congo has 80 million hectares of arable land (although only 9-10% used) in which there is potential to support 40 million head of livestock. In addition, there is potential to increase fodder production given the high availability of water in the country (MCPME, 2010). Moreover, it is estimated that the DRC can feed up to 3 billion people, but it cannot even feed its population of around 8 tens of millions (Jerome, 2015). According to these figures, 9-10% of the cultivated land alone should be able to feed over 80 million people. However, despite its cattle population, the DRC continues to import meat and dairy products on a daily basis (PNIA-RDC, 2013). This suggests that the low production is not due to a problem of land availability but rather to poor control of the factors of variation in the milk production chain. In the animal production chain, it has been shown that health and hygiene management, the animal feeding system, the management of the animal microclimate by the building and humans as managers but also as beneficiaries of production are the main production factors (Théwis *et al.*, 2005). Of all these factors, feed is the most important in milk production as it provides most of the variable factors (Kibwana, 2016). Thus, milk production is influenced by the quality of the forage(s) present on the pasture (Legarto *et al.*, 2014) but also by the climate (space and time) which, at the level of the tropics, shows its influence generally in the adaptation of animals to the temperature and in the way it influences the state of pastures in agroecological zones (Berbigier, 1998). Thus, given that pasture is the main source of feed for dairy cows in the Ruzizi Plain and Kalehe Territory (two of the best areas for dairy cattle production in South Kivu), the estimation of the carrying capacity and the characterization of dairy cattle production systems requires in-depth studies for a good orientation of policies for the improvement of the dairy value chain. In this context, the overall aim of this study is to contribute to the increase of milk production in South Kivu. More specifically, it was discussed to identify the production systems of the dairy cow in the region and to determine the milk production in the study area.

3 METHODOLOGY

3.1 Environments: Figure 1 shows the two study areas. Kalehe and the Ruzizi plain respectively from left to right (Figure 1).

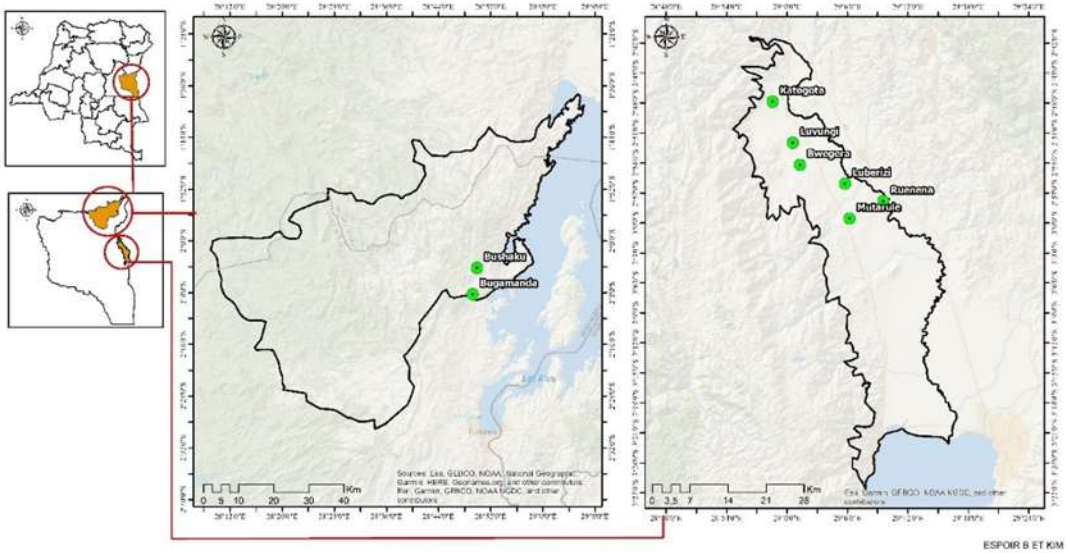

Figure 1: Maps of the study areas.

3.1.1 The Ruzizi plain: The Ruzizi plain straddles three countries: the Democratic Republic of Congo, Rwanda and Burundi. The Congolese part has an area of about 126,669 ha. The average annual temperature is around 23-24°C, with average temperature differences of around 14-15°C, and average annual rainfall of 800-1000 mm for 130-150 days of rain. It is occupied by Vertisols or tropical black clays, Solonetzic soils and various alluvial deposits which dominate in extension of Entisols on dune sands and rare rocky points. The livestock observed in these farms is dominated by the "Tutsi" cow (Figure 1). It is the result of a cross between a long-horned bullock and a zebu with a cervico-thoracic hump. It is dominated by Ankole blood. The weight of the animal is 300 kg for the cow, 360 kg for the ox and 400 kg for the bull. The grassy savannah vegetation is the most diverse and best represented (Byavu *et al.*, 2014). The Katogota, Luvungi, Bwegera, Luberizi, Mutarule and Runingu clusters were considered for this study on the basis of the cattle herd raised there and the accessibility according to the means committed to the study.

Figure 1 : Tutsi cows .

3.1.2 The territory of Kalehe: The territory of Kalehe, in its mountainous part in transition to the province of North Kivu, is an important region for cattle breeding. The climate of Kalehe is said to be warm temperate. The average temperature is 16.8 °C with a variation of 1.1 °C. The average rainfall is 1637 mm with a difference of 188 mm between the wettest and driest month (Climate-data.org, 2019). In Kalehe, the localities of Bushaku and Bugamanda were studied on the basis of the orientations of the local herders.

4 MATERIALS AND METHODS.

4.1 The sample size of the farms: The sample size used was 110 farms, 66 of which were in the Ruzizi plain (1996 lactating females out of 5208 breeding females) and 44 farms in Kalehe (600 lactating females out of 1382 breeding females). The estimated number of cattle per region, according to the information collected from the herders' committees, was around 18,043 in the Ruzizi plain, in the groups concerned by the study (around 1,375 in Katogota, 3,906 in Luvungi, 3,330 in Bwegera, 5097 in Luberizi and 4,335 in Mutarule), and more than 5040 in Kalehe (around 1,440 in Bugamanda and 3,600 in Bushaku).

4.2 Evaluation of dairy cow production systems: The production system was assessed on the basis of a survey questionnaire administered directly to cattle farmers in the areas concerned.

4.3 Quantification of milk production: In the survey method, the amount of milk that the animals give per day on the farm at the time of the study (in March 2020) is a question asked to the farmer that allows to know the amount of milk that was produced on the farm for all lactating females. Thus, the total amount on the farm was divided by the number of lactating females to get an average of the productivity per female.

4.4 Statistical analysis: Data entry was done with Excel 2013 and statistical analyses including descriptive and inferential analysis and graphical representations were done with R 4.0.3 in its extension Rstudio 1.2.1335.

5 RESULTS

5.1 Dairy production system in the Ruzizi Plain and Kalehe: Table 1 presents the main characteristics of the cattle milk production systems in Kalehe and the Ruzizi Plain.

Table 1 Cattle dairy production systems in Kalehe and the Ruzizi Plain.

Parameter	Modality or unit	Ruzizi Plain (%)	Kalehe (%)
General information on the farming system			
Breeding system	Extensive	100	100
	Intensive	0	0
Farmers by herd size	From 1-10	1.56	49.30
	From 11-25	14.06	28.26
	From 26-50	37.5	39.13
	>50	46.87	2.17
Farmers by number of suckling females	From 1-10	35.94	80.53
	From 11-25	48.44	17.39
	From 26-50	15.63	2.17
	>50	0	0
Power supply system			
Power mode	Grazing only	85.34	2.17
	Grazing and supplementation likely.	14.66	97.83
Grazing system	Rotary	0	47.83
	Continuous	100	52.17
Supplement used	Salt	14.66	97.83
Average amount of salt	Kg/cow/month	0.37 ± 0.11	0.73 ± 0.33
Frequency of distribution	Number of times per month	0.81 ± 0.21	1.8 ± 0.71
Estimated grazing time	Time	8	8
Grazing category	Private	0	100
	Public	100	0
Land subdivision	Single plot of land	---	91
	Land subdivided into paddocks	---	9
Herds by grazing area per cow (in ha/cow).	From 0 to 1	---	71.74
	From 1 to 2	---	21.74
	From 2 to 3	---	4.35
	From 7 to 8	---	2.17

Range improvement practices (Defending, introducing new species, weeding)	Yes	0	30.43
	No	100	67.39
Fertilization	Yes	0	0
	No	100	100

The results presented in Table 1 show that the extensive system is the only one practised in cattle rearing in both study areas (100% in the plain and in Kalehe). The distribution of farms according to animal numbers shows that there are more animals per farmer in the Ruzizi plain than in Kalehe. Indeed, the proportion of farms with more than 50 animals is higher in the plain (46.87%) than in Kalehe where 49.30% of farms have between 1 and 10 animals per farm. In Kalehe, 80.53% of farms have between 1 and 10 females, while in the Ruzizi plain there is a high proportion of farms with 11 to 25 suckling females per farm. Table 1 also illustrates that the feeding system is essentially based on pasture in both study areas. In Kalehe, on the other hand, there is more use of Sodium chloride as a supplement in cattle watering than in the Ruzizi Plain (respectively 0.73 ± 0.33 kg vs. 0.37 ± 0.11 kg of salt/cow/month with a distribution frequency of 1.8 ± 0.71 vs. 0.81 ± 0.21 times per month). Salt is used by 97.83% of the farmers in Kalehe, while in the plain, it is used by only 14.66%. In addition, the rotational system is only used in Kalehe at 47.83%, where the pastures are privately owned (100%), subdivided or not into paddocks. Most of the herds (71.74%) graze on pastures that provide less than 1 ha per year. Only 30.43% of the farmers undertake improvement work on the pastures, but none of them fertilise them. On the other hand, in the Ruzizi plain, pastures are shared (100%) without any range improvement work (100%).

5.2 Quantification of milk production in both areas:

Characterisation of milk production: Table 2 presents the results of the characterisation of milk production in the sites.

Table 2 Milk production at the sites.

Parameter	Modality	Ruzizi Plain (%)	Kalehe (%)
Milking system	Manual	100	100
	Mechanical	0	0
Product used for washing.	Water only	10.94	6.52
	Soap	89.06	89.13
	Other products (cypress leaves, ash)	0	4.34
Herds by milk production band.	From 0 to 0.5	22.65	6.52
	From 0.5 to 1	36.72	18.48
	From 1 to 2	32.81	38.04
	> 2	7.8	36.96
Milk production in March 2020	Litres On average per cow per day.	1.4±0.91	2.27±1.31

Table 2 illustrates the characteristics of milk production in the Ruzizi plain and in Kalehe. Milking is 100% manual, with washing of implements before milking (98.44% in Ruzizi and 100% in Kalehe), with soap being used in the majority (89.06% in Ruzizi and 89.13% in Kalehe). Most farmers have an average production of less than 2 litres/day/cow in the Ruzizi plain (more than 90%) while those with a production of more than 2 litres/day/cow represent 36.96% of farmers in Kalehe.

5.3 Effect of the number of females and the amount of salt consumed in the drink on milk production: The linear regression between

the number of lactating females and milk production shows a significantly significant ($p < 0.001$) low incidence and negative correlation with a reduction of 0.03 litre of milk per cow per day for each lactating female that increases. The amount of salt used as a supplement has a pronounced negative effect on milk production ($p = 0.03$). As the salt dose increases, the average amount of milk produced per cow decreases by 1.227 litres per cow per day in the wet season.

6 DISCUSSION.

The results of this work show that the livestock system is essentially extensive in the Ruzizi Plain and the Kalehe territory. This could be explained by the low capacity of the herders to commit too many resources regardless of their financial means (Roukayath, 2016). This would justify the design of the number of animals per farm in the Ruzizi Plain as a knock-on effect. Indeed, in the Ruzizi Plain, farmers tend to accumulate a lot of animals per farm. These same remarks are made in North Kivu by Bucyalimwe (2001). This could also be explained by the fact that the pastures are in common and therefore the herders do not fear for the source of fodder. In addition, since the daily amount of milk per farm depends on the number of lactating females, this would push them to accumulate cows. On the other hand, when considering the milk production per cow per day for the average calculated for the whole farm, it is a decreasing function of the number of lactating females. This could be justified by the fact that milkers would tend to get tired if the number of females to be milked is large as explained by Robitaille (2012). Salt (sodium chloride) is involved in two main ways in animal biochemical metabolism. It contributes to ensuring osmotic balance but also acts as an electrolyte (Jaster *et al.,* 1978). Thus, an excess of salt in drinking water is negatively correlated with milk production because of the decrease in the availability of water through salt in the animal body (Jaster *et al.,* 1978; Zamiri *et al.,* 2010). However, if this is added to the drink, exceeding the 1.2% threshold is not good. Moreover, if this concentration reaches 6%, it leads to a decrease in food intake. Below this 1.2% threshold, it has no effect (Amaral *et al.*, 1985). If salt is applied as a fertiliser to pasture, it has a positive and significant effect on feed intake, leading to an increase in milk production (Chiy *et al.*, 1991). In this study, the average amount of salt consumed in drinking water in Kalehe is 0.73 ± 0.30 kg/cow/month distributed 1.8 ± 0.71 times. So, on average, his cows consume 0.94 ± 0.39 kg of Sodium chloride on the day of supplementation. If we consider that an adult cow consumes on average 43 litres of water per day as specified by Massabie *et al* (2013), then these cows consume approximately 0.55-1.33% salt in their drinking water on the day of supplementation.

7 CONCLUSION AND RECOMMENDATIONS

This work focused on the characterization of dairy production systems in the Ruzizi Plain and in the Kalehe territory. The results presented illustrate an extensive livestock farming system that is dominant in both areas with a feeding system based on common pastures in the Ruzizi Plain and private pastures in the Kalehe highlands with salt supplementation in the drink, the concentration of which even leads to a decrease in milk production in the area. But also, milk production remains very low, i.e., below two litres of milk per cow per day in the different ecological zones despite a small difference between the two zones. This work suggests that it would be appropriate to consider programmes to improve pastures in South Kivu province and to apply good pasture management practices such as fertilisation of grazing areas, the introduction of new species adapted to the different agro-ecological zones, the use of rotation systems in pastures and their management. This work has some weaknesses. Indeed, in this work, no account was taken of stall farms and the integration of all the diversity of milk production factors in a longitudinal study, especially with regard to the study of pastures in

these study areas. Thus, it is recommended that the next research project should look at pastures with a longitudinal study that would compare pasture conditions, production systems and milk production to better isolate the factor that decreases milk production in the study areas.

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