International Journal of Animal Science, Husbandry and Livestock Production (IJASHLP) (2141-5191), Vol. 10(3), pp. 498-509, August, 2024. Available online at www.advancedscholarsjournals.org © Advanced Scholars Journals

Full Length Research Paper

Influence of improved and traditional stables on animal health and productions in the provinces of Ruyigi and Rutana in the Eastern part of Burundi

Nishemezwe G[1], Ntirandekura J.B[1], Nyandwi D[1], Habonimana S.[1], Farina L.[2], Santucci S[2], and Gentile A.[3]

[1]Department of Animal Health and Productions, Faculty of Agronomy and Bioengineering, University of Burundi, B.P. 2940 , Bujumbura-Burundi.
[2] IBO ITALIA - ODV-ETS, Via Boschetto 1, 44124 Ferrara (Italy)
[3]Department of Veterinary Medical Sciences. University of Bologna. Via Tolara di Sopra 50, 40064 Ozzano Emilia – Bologna (Italy)

Accepted 20th August, 2024.

Burundi is a country where more than 90% of the population lives of agriculture. Livestock farming was extensive and contributed around 4.6% of GDP. In addition, the multiplication of the number of agricultural operations on an already limited space causes the reduction of community pastures, thus making cattle animal husbandry difficult. The objective of this study is to evaluate the contribution of improved stables in the zero grazing system established since 2018. Therefore, a survey was conducted in Rutana and Ruyigi provinces of Burundi using a questionnaire containing firm and open questions and by physical observation of livestock grouped in extensive and zero grazing systems. The results showed that there was a trend of improvement in milk production, body condition, animal welfare, biosecurity, and the fight against parasitic and infectious diseases in zero grazing compared to extensive system. Policy makers should put in place legislation framework to allow the effective implementation of this new livestock system in different agro-ecological zones of Burundi.

Keywords: Animal production – biosecurity – animal health –- zero grazing- Burundi

INTRODUCTION

With a population of 10,262,865 inhabitants on an area of 27,834 km^2 including 2,700 Km^2 of lakes and 23,500 Km^2 of potentially agricultural land, Burundi is ranked 2ndamong the most densely populated countries on the African continent (Ministère de l'Environnement, de l'Agriculture et de l'Elevage,2018).It is also a country where more than 90% of the population makes a living from agriculture. According to ISTEEBU statistics from 2015, the agricultural population is estimated at 8,503,105 while it recorded 1,635,085 agricultural households (République du Burundi,2016).

The Burundian agricultural sector is the main provider of jobs (84% of the population) and 95% of the food supply. Agriculture sectorcontributesaround40.7% to GDP (Banque de la République du Burundi,2016)

Population growth inevitably leads to the reduction and overexploitation of arable land, thus leading to a reduction in soil fertility. In addition, the multiplication of the number of agricultural activities on an already limited space causes the reduction of communal grazing areas, thus making cattle animal husbandry difficult (Hatungumukama et al., 2007).

Livestock plays an important role in the Burundian

*Corresponding Author's E-mail: genishemezwe@gmail.com

agricultural farming system through its contribution to the qualitative improvement of the food ration and its contribution to the restoration and maintenance of soil fertility. Foods of animal origin are rich in protein that we need for well-being. Livestock production is widespread and contributes around 4.6% to the GDP and contributes to the fight against unemployment and becomes a very significant source of income (Keringingo et al.,2022;Keringingo et al.,2023).

The problems of livestock feeding, animal health protection, processing, conservation, marketing and export of livestock products have increasingly become elements of concern in the sector (Ministère de l'Environnement , de l'Agriculture et de l'Elevage, 2017).

Despite a lack of grazing resulting from demographic pressure in an area where the extensive system is most widespread, the number of ruminants has reached the pre-crisis level. Livestock farming as a whole is experiencing increasing progress because of the efforts of the Government and its development partners (Ministère de l'Environnement, de l'Agriculture et de l'Elevage,2018).For developping and implementing policies and strategies in livestock sector, the government took into account the following factors: i) disappearance of pastures associated to demographic pressure; ii) low productivity of local farmers; iii) high parasitic pressure on domesticated animals, iv) weaknesses in support services for animal production, v) climate change, vi) lack of innovative techniques and technologies (livestock feeding, transport, conservation and processing of animal products), vii) illiteracy of producers (Ministère de l'Environnement , de l'Agriculture et de l'Elevage ,2018).

The new zero grazing system has not yet been properly evaluated on its strengths and weaknesses in Burundian livestock farms.

According to Bareille et al (2019), grazing cows on pasture in summer provides some health benefits given its favorable effects on the two main pathological diseases of cattle: lameness and mastitis. However, compared to zero grazing, the extensive system poses a multitude of health risks to cattle. However, due to its contrasting health effects, it is difficult to assert that the practice of grazing brings economic benefits to livestock operations. An assessment of health risks should be carried out in livestock systems that are developing to adapt to climate change.

To align with the Sustainable Development Goals (SDGs) and the objectives of the National Development Plan of Burundi 2018-2027 (République du Burundi , 2018) which constitutes a strategic orientation tool on the basis of which the sectors must build their policies and action plans to contribute positively to the increase in gross domestic product (GDP), law №1/21 of October 4, 2018 was promulgated on zero grazing and the prohibition of straying of domestic animals and farmyard in Burundi. The purpose of this law is to establish the authorized animal husbandry methods and the conditions required to properly conduct the animal husbandry in zero grazing of all farmed animals (République du Burundi, 2018).

Improving livestock productivity requires improving animal health, which has the effect of reducing animal losses and therefore preserving the capital that allows poor farmers to better withstand agricultural crises and emerge of poverty (Pradère, 2014).

Biosecurity brings together all preventive measures implemented to avoid contaminating or being contaminated by a biological agent (or chemical in a broader sense) (Didier et al., 2017)

The adoption of good biosecurity practices makes it possible to reduce the risks of infectious diseases on farms, and therefore, to promote the appropriate use of antibiotics (Savadogo et al., 2022).

The development of livestock farming can play a more indirect role in the emergence of pathogens at the interface between wildlife and human populations. Particularly, the expansion of pastures and agricultural land, largely used for feeding livestock, could be associated with a higher frequency of disease emergence and a greater abundance of mammalian species that host zoonotic pathogens (Allen et al., 2017; Gibb et al., 2020).

According to the results of the national agricultural survey carried out in 2016-2017 in Burundi (République du Burundi, 2018), 27.4% of farmers own at least one cattle. According to the same source, it was estimated that 39.8% of agricultural households had at least one goat, 8.4% of agricultural households had at least one sheep, 17.9% had at least one pig. At the national level, the proportion of households which had at least one rabbit is 6.7% and those with at least one poultry represented 9.5%.

Although the new zero grazing system was adopted and was already implemented in different part of the country, it could be interesting to assess the real level of contribution in animal production context of the Burundi. On the animal health side, it is also relavant to know if the zero grazing system using the improved stables could contribute to an effective disease control and eradication.

Therefore, the present study entitled "Influence of improved and traditional stables on animal health and productions in the provinces of Ruyigi and Rutana in the Eastern part of Burundi" was carried out to evaluate the contribution of improved stables in increasing domestic animal production and safeguarding animal health in zero grazing system in the provinces of Ruyigi and Rutana.

The specific objectives are articulated in the following points:

- Evaluate the types of domestic animals raised in the study area and their level of production through the comparison of improved and traditional stables;
- Evaluate the impact of biosecurity measures Implemented in maintaining animal health;

Figure1 : Study area

Source :https://www.researchgate.net/figure/BULLET-Carte-des-provinces-et-communes-du-Burundi_figure1_299260438

- Highlight the role of different household members to look after the domestic animals;

MATERIAL AND METHODS

This study was carried out from June to December 2023, in the Rutana, Musongati and MpingaKayove communes of Rutana province and in the Butaganzwa, Ruyigi, Bweru and Butezi communes of Ruyigi Province (Figure 1).
The study was carried out in the form of a survey using a questionnaire containing firm and open questions and by physical observation of livestock in households. The animal survey and observation operation was carried out in four rounds to clearly define the variables.
The results of the survey were entered using Excel software and descriptive statistics were processed using SPSS version 21 software.

RESULTS AND DISCUSSION

This study was carried out in 16 rural households located in the provinces of Ruyigi and Rutana. In each province, 8 households were surveyed and they were divided into two categories: 4 households practicing the traditional system (extensive) and 4 households with zero grazing practice. Although domestic animal species used in the study include cattle, sheep, goats, pigs, rabbits, poultry and guinea pigs, but the report is mainly based on result obtained from cattle.

Variability of parameters among the two livestock systems during the time of observations in Provinces Rutana and Ruyigi.

Fodder crops in place in extensive and zero grazing systems

In the study area, the fodder crops put in place included Tripsacum, Pennisetum, Setaria and Leucena. As shown in Figure 2, during time zero (T0) of observation, all the farmershad planted the Tripsacum, the Pennisetum. In the two provinces, 51% of farmers have planted both types of fodder crops (Tripsacum and Pennisetum). In the other observation periods (T1, T2 and T3) the combinations offodder crops planted have no significant differences.
Improving livestock production depends not only on genetic improvement and control of animal health, but also largely on animal nutrition. Producing forage crops allows the farmers to manage the food intake of his livestock, the introduction of crops into the forage system is organized according to livestock objectives, improvement of the performance of the herd and the management of all crops (Klein et al, 2014). The results of our study showed the majority of farmers planted Tripsacumlaxum and Pennisetum spp. These results are in agreement with those of Hatungumukama et al (2007). The production of Pennisetum purpureum and Tripsacumlaxum, by using stump, should be done first because these species are already well known in rural areas and the technique would only require few financial resources. In addition, these two types of fodder crops are found in many agro-ecological zones of Burundi.

Proportion of Women taking care of animals

According to the results of figure 3 we see that there are women who took care of animals more than men. The observation in time T0 showed that the variation is not

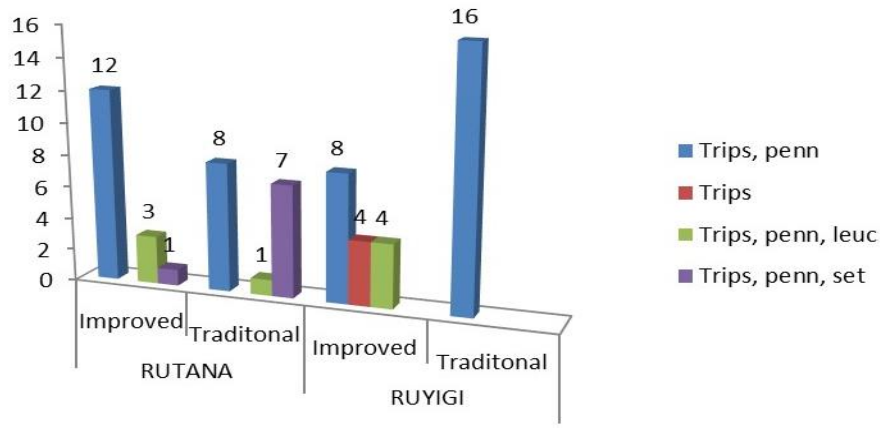

Figure 2: Distribution of fodder crops in traditional and zero grazing systems

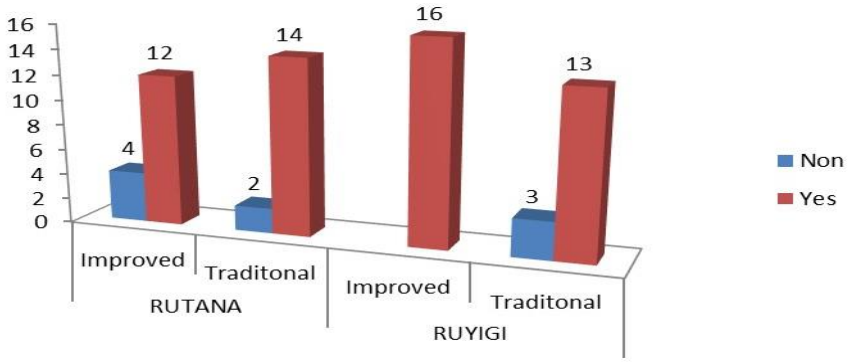

Figure 3: Position of women in taking care of animal in the traditional and zero grazing systems

significant and the situation is observed in T1, T2 and T3 in the both production systems (zero grazing and traditional).

The results of the study showed that it's women who take care of domestic animals more than men (Figure 3). These results are associated to Burundian tradition, where women and children often take care of domestic animals, while men take care of finding other financial means to support the family. Our results were confirmed by Muhammad et al (2022), who indicated that Women's participation in livestock production is accessed by estimating the number of hours spent by women and female children for different livestock species like buffalos, cow, goat/sheep, chicken, etc., and conversion of child houses to adult equivalent units in different livestock production activities feeding, watering, cleaning of the shed, milking, milk processing disease control/ caring of sick animals, marketing and others. Women's participation in livestock activities is more than men's in non-commercial activities like grazing, feeding of animals, cleaning of sheds, etc. In contrast, their role in marketing and revenue-generating activities is less.

Milk production/animal/day

The results of the study showed that milk production ranges from 0 to more than 5 liters per day per cow (Figure 4). This quantity produced was mentioned in both production systems (traditional and zero grazing) with a difference which is not significant. The majority of farmers (68.75%) have a milk production level of less than a litter per day.

Analysis of the results of the study also showed that milk production is between 0 and more than 5 liters per day per cow. These results coincide with those of Hatungumukama et al (2007) who indicated that milk production in rural areas in Burundi is between 400 -600 liters with a lactation duration of 240 days. This translates into a production of 1.6-2.5 liters per day per cow. This is because the majority of cattle raised by farmers in Burundi are cross breeds, hence milk production cannot be like that of pure breeds. Animal breeding and feeding improvement should be highlighted to promote and increase animal productivity in zero grazing system.

Body Condition for cattle in extensive and zero grazing systems

The assessment of the body condition of the animals in the study area was made by observation. The results of the observation showed that 70.31% of cattle in the provinces of Ruyigi and Rutana have a normal body

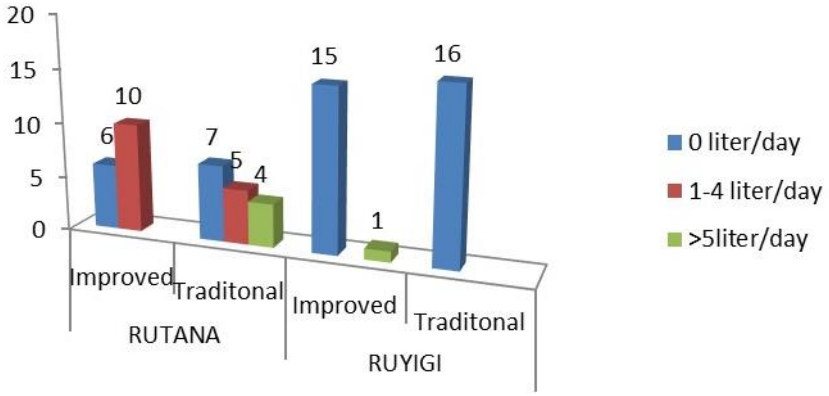

Figure 4: Milk production in traditional and zero grazing systems

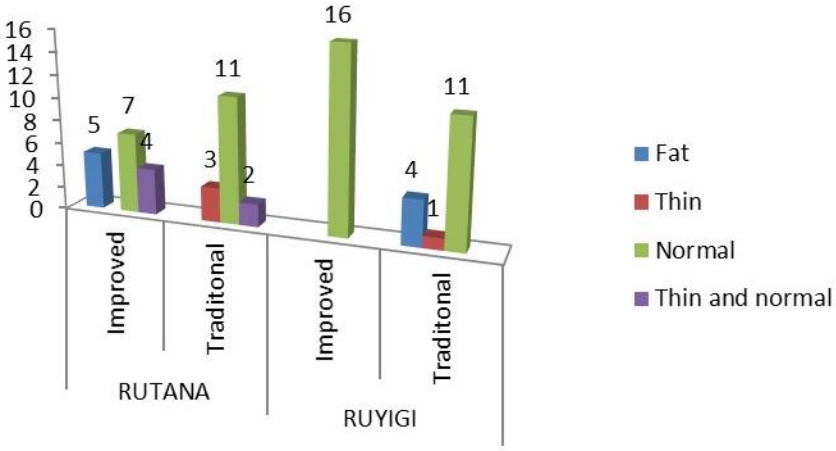

Figure 5: Body conditions of animals in traditional and zero grazing systems

condition with a tendency to be more normal in the zero grazing system. Animals that are thin have been observed in the traditional type of system of livestock. In both system, the different types of animal body condition didn't show significant differences during all observation periods (T0, T1, T2 and T3).

The results of the study showed that the animals' physical condition was 70.31% normal (Figure 5). This situation is explained by the fact that with the implementation of the zero grazing system in Burundi, all animals are fed in stables from where there is a permanent supply of fodder. The variation in the state of body condition is probably linked to climatic conditions on the one hand and on the other hand to poor management of dairy herds in terms of feeding (Ghoribi et al,2014).

Control of parasites in traditional and zero grazing systems

The results of the study showed that in both production systems, the parasites that are more controlled are gastrointestinal worms and external parasites. These two types of parasites are controlled at a rate of 84.37% in extensive and in zero grazing systems with particular emphasis in this last system (43.75%)(Figure 6).

Endoparasites (internal) and ectoparasites (external) are widespread in cattle, sheep and goats and represent an economic and animal welfare burden for the global ruminant livestock industry. Internal parasites and ectoparasites are a problem in extensive pasture and intensive livestock farming. Early detection of subclinical cases of infested animals can allow rapid treatment of certain animals to prevent the development of the disease (Temple et al, 2024). In Burundian livestock, parasite control is a tradition.

Control of infectious diseases in traditional and zero grazing systems

Infectious diseases that are controlled in the study area are: East Coast fever, Rift Valley fever, lumpy skin disease and foot and mouth disease (Figure 7). According to the analysis of the results, East Coast fever is the disease which is most controlled in both production systems. It controlled at a rate of 64.06%. This situation is explained by the fact that East Coast fever is an endemic disease in Burundi and causes more than 70% of cattle to die in Burundi. Rift Valley fever combined with

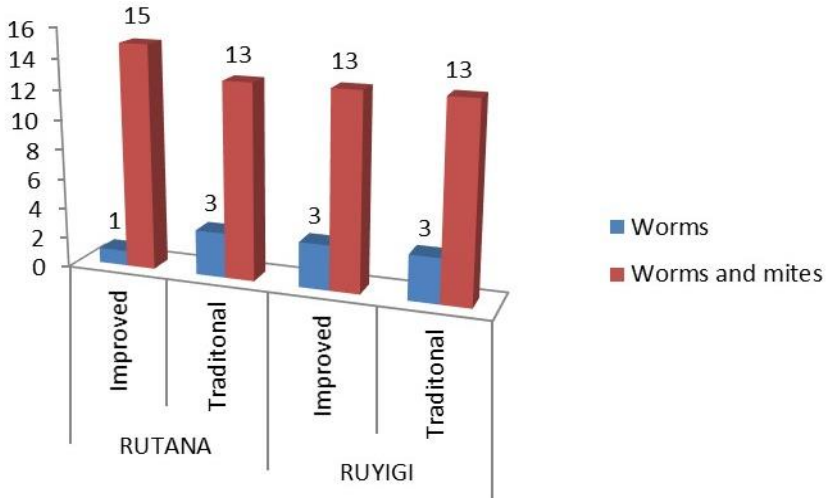

Figure 6: Control of parasites in traditional and zero grazing systems

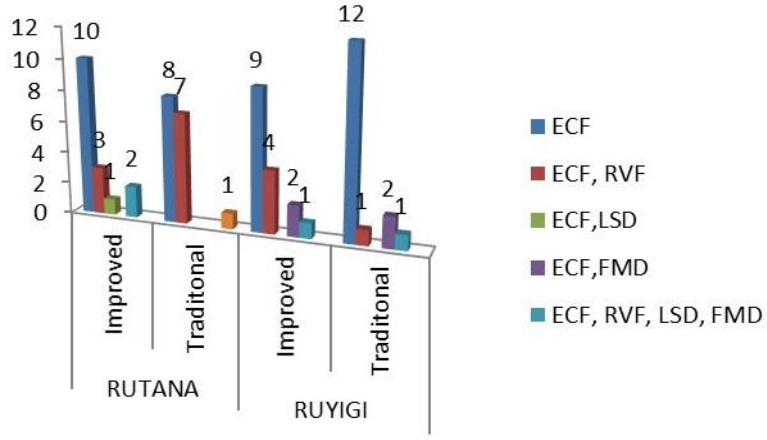

Figure 7: Control of infectious diseases in traditional and zero grazing systems

East Coast fever(20.31%) are diseases that are controlled in second place compared to other diseases. This control could be associated to the recent experience which the country had from the first outbreak of rift valley fever.

Health problems evolve over time, under the effect of environmental and socio-economic changes which lead to modifications in animal populations and animal husbandry systems, as well as the flow of animals and animal products (Lancelot et al., 2011). In the study area, the analysis of the study results showed that East Coast fever control is at 64.06% and that of the Rift Valley combined with East Coast fever is at 20.31%. This situation is explained by the fact that East Coast fever is an endemic disease in Burundi and causes more than 70% of cattle to die. This disease particularly affects animals of improved breeds or pure breeds. According to Kalume et al (2011) East Coast fever is present in more than 15 countries in central, eastern and southern Africa. It is found in particular in Tanzania, Kenya, Uganda, Rwanda, Burundi, Zambia, Zimbabwe, Mozambique and Malawi. It is also endemic to the northeast of South Africa. The prevalence of this parasitic infection is closely linked to the distribution of the vector Rhipicephalusappendiculatus, even if it does not cover all the agroecological zone of the country. This statement is therefore valid for our study area.

Treatment of animal diseases in traditional and zero grazing systems

Cattle that are injured or sick are treated immediately(Figure 8). This situation was observed throughout the study period. Only 10.93% of the respondents showed that animals are not treated immediately while 89.06% showed that animals are treated immediately. This is observed in both types of animal production systems and the difference is not significant.

Analysis of the results showed that injured or sick animals were treated quickly at a rate of 89.06%. This is explained by the fact that on each village, there is a

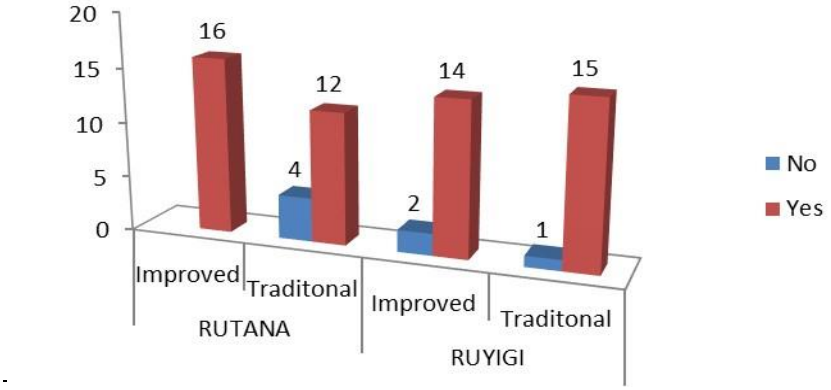

Figure 8: Treatment of animal diseases in traditional and zero grazing systems

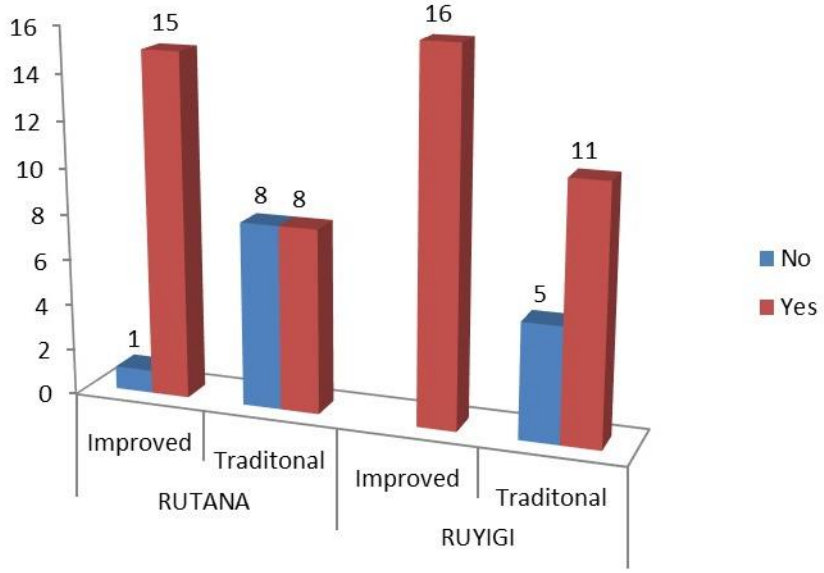

Figure 9: Biosecurity and Pest control in traditional and zero grazing systems

"Community Animal Health Agent", hence the speed of intervention in the study area.

Biosecurity and Pest control in traditional and zero grazing systems

Biosecurity is practiced to prevent parasitic diseases, insects and rodents. The results of the study showed that biosecurity measures are implemented more in zero grazing system (48.43%) than in extensive system (20.31%) (Figure 9). This is explained by the fact that in zero grazing system, farmers put more effort into protecting their animals.

Biosecurity solutions to livestock health can take a number of different forms and are generally heavily weighted towards prevention of infection rather than treatment (Daniel et al, 2017).Farm biosecurity includes all measures preventing pathogens from entering (external) and spreading within a herd (internal) and is important in facilitating the shift from cure to prevention in veterinary medicine. To assess biosecurity on farm level quantitatively an objective measurement process is required (Bert et al, 2020)

Situation of conflict between human and wildlife in traditional and zero grazing systems

Conflicts between humans and wildlife exist in Ruyigi and Rutana provinces. These conflicts include wild animals that come to devour domestic animals (examples: rapacious birds that devour chicks, jackals that devour small ruminants). Some measures are applied to mitigate conflicts between farmers and wildlife in the zero grazing system including the predator monitoring, construction of stable, the animal confinement among others. The results of the study showed that these measures are not effective at a rate of 79.68% in both livestock systems and in the two provinces. The effectiveness of these measures was observed in the two provinces at a rate of 6.25% (Figure 10).

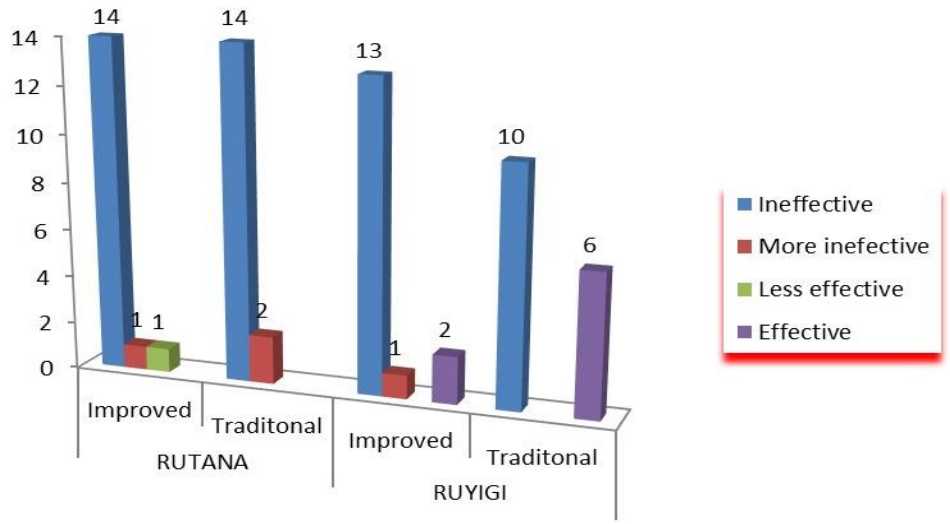

Figure 10: Situation of conflict between Human and wildlife in traditional and zero grazing systems

Human–wildlife conflict has emerged as the central vocabulary for cases requiring balance between resource demands of humans and wildlife. This situation is problematic because, given traditional definitions of conflict, it positions wildlife human antagonists (Peterson et al, 2010).

According to Philip (2016), human interactions with wildlife are a defining experience of human existence. These interactions can be positive or negative. People compete with wildlife for food and resources. Reported incidents of human-wildlife conflicts highlight three forms of conflict as the most common in all ecological zones: crop destruction, loss of domestic animals, and death or injury to humans. The factors causing these conflicts and the wildlife species involved are multiple and varied (Antoine et al , 2012).

Animal species raised by population in traditional and zero grazing systems

The domestic animals that are raised by the farmers of the provinces of Ruyigi and Rutana are cattle, sheep, goats, pigs, rabbits, chickens and guinea pigs. In households there were found more than one species (Figure 11). In traditional animal husbandry, the species that are raised together are cattle, pigs, sheep and chickens at a rate of 17.1%. In zero grazing type of livestock farming, the species that are most commonly raised together are cattle, goats, pigs, rabbits and chickens (26.5%). In both types of animal husbandry, the species raised together do not represent a significant difference.

1.Bovin
2.Bovin, ovin
3.Bovin, goat
4.Bovine, pig, ovine, chicken
5.Bovine, goat, pig, rabbit, chicken
6.Bovine, goat, sheep, pig, chicken, Guinea pig

Diversified farming systems are proposed as a major mechanism to address the many sustainability issues of today's agriculture. Multi-species livestock farming, i.e. keeping two or more animal species simultaneously on the same farm, is an option that has received little attention to date (Guillaume et al ,2020).

Even relatively wealthy farmers in densely populated regions are unlikely to keep cattle and prefer to keep smaller animals such as sheep, goats, pigs or even smaller livestock, which are less vulnerable to feed shortages and poor quality feed. Similarly, poor market access also reduces investment in cattle, which are primarily reared to be sold on the market (Desiere et al, 2015).

Multi-species livestock farming has the potential to improve the three dimensions of sustainability reviewed - economic viability for farmers, environmental soundness and social acceptability by being respectful of animals and humans - as long as locally relevant farming practices are implemented, especially an appropriate stocking rate during grazing. If relevant practices are not observed, multi-species livestock farming may produce undesirable effects, such as competition for resource acquisition during grazing, parasitic cross-infection and more intense work peaks (Guillaume et al ,2020).

Mixed grazing of small and large ruminants constitutes an agroecological approach to improve individual and per hectare growth, by promoting the dietary complementarities of animal species, while reducing the impact of gastrointestinal parasitism for small ruminants (Alexis et al, 2015). In the case of zero grazing system, the animal husbandry of mixed species also makes it possible to value the space following the limited availability of land which is observable in Burundi.

Animal movement in traditional and zero grazing systems

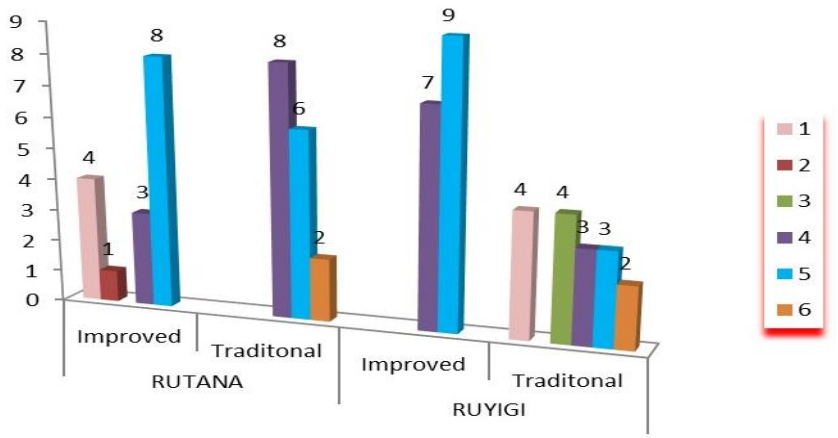

Figure 11: Animal species raised by farmers in traditional and zero grazing systems:

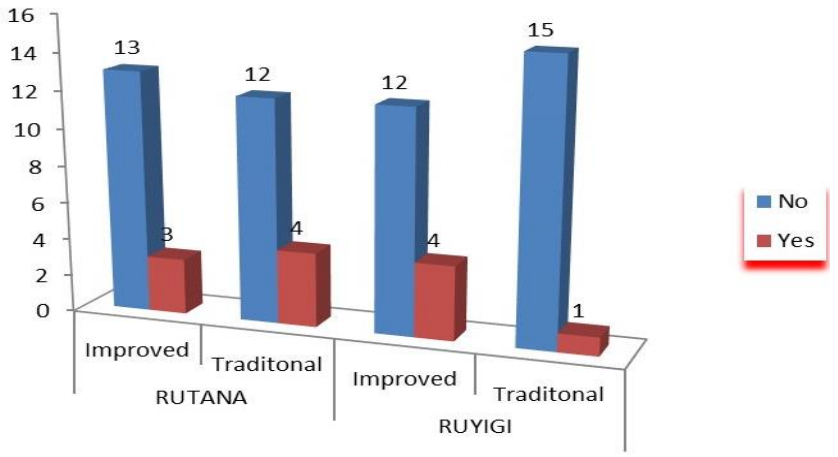

Figure 12: Animal movement in traditional and zero grazing systems

According to the results of the study, in both types of animal husbandry systems, the purchase or other movement of animals is rarely done by farmers in Ruyigi and Rutana provinces (Figure 12). This situation is observed in the traditional type of animal husbandry system in Rutana province (6.25%) and in the zero grazing system in Ruyigi province (6.25%).

Livestock plays an essential role in Burundi's agriculture because it contributes significantly to food security, farmers' income and soil fertility. This sector contributes 8% of the national GDP and between 17 and 23% of agricultural GDP (San Pedro, 2011). According to the results of the study, it was shown that farmers in the two provinces are not used to selling livestock or moving them. They use them in the production of organic manure necessary for agricultural production.

Our results differ from those found by Gebremariam et al, (2013) in Ethiopia. Domestic markets can be classified into basic/ primary “bush” markets, primary assembly markets, secondary markets for distribution and terminal markets in demand centers. Bush markets are attended by producers both as sellers and buyers and commonly intermediated by brokers, with purchase being primary for replacements and rarely for fattening.

Nutritional balance of diet in traditional and zero grazing systems

The appropriate diet must cover all needs depending on the animal category. It must also be balanced. In Burundi, the scarcity of land leads to a reduction in pastures and fodder crop fields. Faced with this situation, we observe an animal diet that is not appropriate. The results of the study showed that the diet is not appropriate at a rate of 60.93% in the study area(Figure 13). This situation is observed in both types of animal husbandry systems and throughout the study period with non-significant differences.

The high producing dairy cow requires a diet that supplies the nutrient needs for high milk production. Carbohydrates, amino acids, fatty acids, minerals, vitamins, and water are all nutrients required by the lactating dairy cow to meet the demand by the mammary gland to produce milk and milk components. However, in

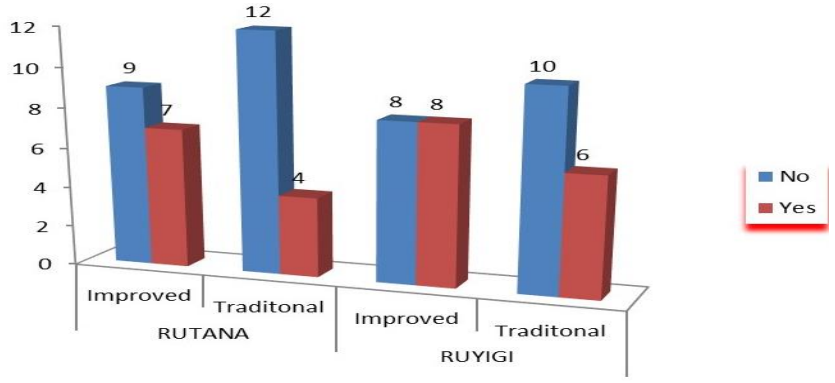

Figure 13: Nutritional balance of diet in traditional and zero grazing systems

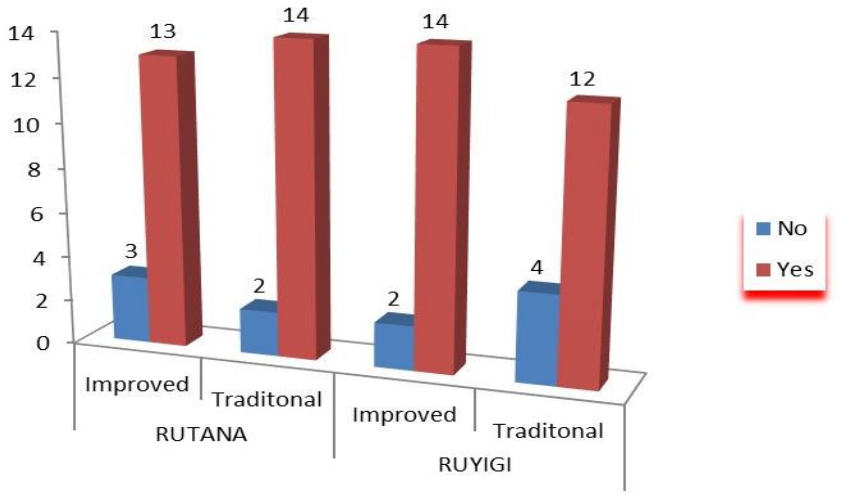

Figure 14: Accessibility to water for animals in traditional and zero grazing systems

order to develop the cow that will produce a high milk yield, it begins with the nutrition of the calf and heifer (Peter et al , 2020).

According to Peter et al., (2020),it is suggested that most cows be fed diets containing greater than 50% of the diet as forages, however, this can vary significantly depending on the inclusion of fibrous by products. However, there are instances where more forages can result in adequate production. Heifers and dry cows are fed diets with a much greater proportion of forages than lactating cows due to the lesser nutrient requirements of cattle in these life-phases. Producers need to strive for the highest quality forage as it dictates the purchase of commercial grains and supplements. Higher quality forages (lesser NDF) will result in decreasing the need for purchased feeds and enhance the farm's profits.

Accessibility towater for animals in traditional and zero grazing systems

According to the results of the study (Figure 14), cattle generally have adequate access to water supply at a rate of 82.81% in both types of livestock and throughout the study period. Some contrary cases (17.18%) to the first situation exist in the two types of animal husbandry systems but the difference is not significant.

Water is an important nutrient needed for whole life and to optimize the milk production, growth rate and reproduction in livestock. Because an animal can live longer without food but he cannot live longer without water. Enough water is required at every stage for their growth. Availability of drinking water should be all times to the animals. Water is necessary for maintaining proper ion balance and body fluids; absorbing, digesting, and metabolizing nutrients. Amongst all lactating animals needs more water because 84 to 87 % of water is also found in milk (Gaurav J.et al 2023).

The results of this study showed that livestock receive a sufficient quantity of water. Furthermore, according to Gaurav et al (2023) a quantity of 2-4 liters of water is required to digest 1 Kg of feed while lactating animals need a quantity of 3-5 liters of water to produce one liter of milk. Watering domestic animals in Burundi cannot be a problem because it is a country that has

sufficient water sources.

CONCLUSION

In conclusion, the results of the study which was carried out in Ruyigi and Rutana provinces with main objective to evaluate the contribution of improved stables in increasing animal production and safeguarding animal health in zero grazing system in the provinces of Ruyigi and Rutana, have shown that with the use of improved stables, there is a trend of improvement in animal production, animal welfare, improvement in bio-security and the fight against animal diseases compared to the use of traditional stables. These stables can be recommended in the new zero grazing system in husbandry in Burundi.The Government should put in place accompanying measures in terms of legislation allowing the effective implementation of the zero grazing production system given the interest that this system brings to farmers in terms of health, production and animal welfare.

ACKNOWLEDGEMENT

The realization of this study, we would like to express our gratitude to our financial partners who made it possible. We mention here the Italian organizations IBO Italia, LVIA, Vet for Africa, and the Emilia Romagna Region, which co-financed the projects TWITEZIMBERE _ STRENGTHENING THE RESILIENCE CAPACITY OF THE POPULATION IN EASTERN BURUNDI: INNOVATIVE BREEDING TECHNIQUES AND ENVIRONMENTAL PROTECTION, and UMUCO _ ENERGY, INNOVATION, AND ENVIRONMENTAL PROTECTION FOR THE RESILIENCE OF RURAL COMMUNITIES IN EASTERN BURUNDI, within which the researches described were conducted. We also thank the experts of the University of Bologna for their technical support and the University of Burundi which facilitated the collaboration. The participation of the farmers of Ruyigi and Rutana is also appreciated.
The production of this publication was made possible thanks to the financial support of the Emilia Romagna Region within the framework of the UMUCO project, CUP no. E41G23000120009."

REFERENCES

Alexis S, Angeon V, Arquet R, Boval M (2015). Les systèmes mixtes d'élevage de petits ruminants et de bovins : Une alternative pour améliorer les performances animales au pâturage. Innovations Agronomiques 43 (2015), 19-28.

Allen T, Kris A M, Carlos ZT, Stephen SM, Carlo R, Moreno D M, Nathan B, Kevin J O , Peter D (2017). Global hotspots and correlates of emerging zoonotic diseases. Nature Communications 8(1): 1124.

Antoine JE, Guy PD, Dominique E (2012). Tour d'horizon des conflits Homme-faune sauvage au Cameroun. Document de travail du poverty and conservation learning group no 04. p.28.

Banque de la République du Burundi (2016). Rapport annuel de la Banque de la République du Burundi.p.98

Bareille N, Haurat M, Delaby L, Michel L, Guatteo R R (2019). Quels sont les avantages et risques du pâturage vis-à-vis de la santé des bovins ? Fourrages, 238, pp.125-131

Bert D, VéroniqueR , Steven S, Anna CB , Bart P , Claude S , Jeroen D(2020) .A risk-based scoring system to quantify biosecurity in cattle production. Preventive Veterinary Medicine Volume 179, 104992.

Daniel SL, Anupma C, Andrew GDB (2017). Breaking the chain of zoonoses through biosecurity in livestock. Vaccine. Volume 35, Issue 44, 20, p. 5967-5973.

Desiere S, Niragira S, D'Haese M, Vellema W (2015). Cow or Goat? Population pressure and livestock keeping in Burundi. Research in Agricultural & applied economics. EgeconSearch. 29th ICAE. Milan Italy 2015. P.23

Didier G, Alexandre F, Bruno F (2017). La biosécurité : investissement d'avenir pour les élevages français. Bulletin de l'Académie Vétérinaire de France tome 170 n°2, 2017. pp. 112-117.

Gaurav J, Ngangkham JS, Aslam (2023). Importance and requirement of water in livestock animals. Innovations in Agriculture, Environment and Health Research for Ecological Restoration. ISBN : 978-81-923535-5-5.

Gebremariam S, Amare S, Baker D, Solomon A, Davies R (2013). Study of the Ethiopian live cattle and beef value chain. International LivestockResearch (ILRI). ISBN: 92–9146–306–X. p.48.

Gibb R, Redding DW, Chin KQ, Donnelly CA, Blackburn TM, Newbold T,JonesK E (2020). Zoonotic host diversity increases in human- dominated ecosystems. Nature 584: 398–402.

Guillaume M , Kerstin B, Marc B, Christopher B, Marie D, Bertrand D, Myriam G, Severin H, MarieA M, Marie M, Claire M, David P , Bruno R, Lisa S, Lucille S, Steffen W, Christoph W, Riccardo P (2020). Potential of multi-species livestock farming to improve the sustainability of livestock farms: A review. Agricultural Systems .Volume 181, 102821.

Ghoribi L, Hireche S, Chibat MH (2014). L'état d'embonpoint chez les bovins laitiers dans des exploitations de l'Est Algérien. Sciences &Technologie C-№ 39, pp 33-39.

Hatungumukama G, Hornick JL, Detileux J (2007). Aspects zootechniques de l'élevage bovin laitier au Burundi : Présent et futur. Annales de Médecine Vétérinaire, 151,150-165.

Kalume MK, Losson B, Saegerman C (2011). Epidémiologie et contrôle de la theiléríose bovine à Theileriaparva en Afrique : une revue de la littérature. Annales de Médecine Vétérinaire, 2011, 155, 88-104.

Keringingo T, Günlü A, Mat B (2022). Importance of livestock and dairy cattle production in Burundi's economy: Review. Research Journal of Agriculture and Forestry Sciences. Vol. 10(3), 24-29.

Keringingo T, Kayakayac Z (2023). Agricultural Land Access and Use in Burundi. East African Scholars Journal of Agriculture and Life Sciences. ISSN 2617-4472.

Klein HD, Rippstein G, Huguenin J, Toutain B, Guerin H, Louppe D (2014). Les cultures fourragères. Agricultures tropicales en poche. Editions Quae, CTA, Presses agronomiques de Gembloux, p.2642.

Lancelot R, Zundel E, Ducrot C (2011).Spécificités de la santé animale en régions chaudes : le cas des maladies infectieuses majeures en Afrique. INRA Productions Animales, 24 (1), 65-76

Ministère de l'Environnement, de l'Agriculture et de l'Elevage (2017). Politique Nationale d'Elevage au Burundi. p.20.

Ministère de l'Environnement de l'Agriculture et de l'Elevage, 2018. Stratégie Agricole Nationale. p75

Muhammad U, Abdul S, Abdul QM, Anila A (2022). Journal of Education and Social Studies. 3(2).73-83

Peterson MN, Birckhead JL, Leong K, Peterson MJ, Peterson TR (2010). Rearticulating the myth of human–wildlife conflict.Conservation Letters 3 74–82.

Peter SE, Kenneth FK (2020). Nutrition and feeding of dairy cattle. Animal Agriculture: 157–180. doi: 10.1016/B978-0-12-817052-6.00009- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7153313/ Retrieved , 02nd July, 2024.

Philip JN (2016). Human–Wildlife Conflict and Coexistence. Annual Review of Environment and Resources. 41:143–71.

Pradère JP (2014). Améliorer la santé animale et la productivité de l'élevage pour réduire la pauvreté. Organisation mondiale de la santé animale, 12 rue de Prony, 75017 Paris, France. Revue Scientifique et Technique- Office International des épizooties, 33(3). p.28.

République du Burundi (2018). Loi №1/21 du 4 Octobre 2018 portant stabulation permanente et l'interdiction de la divagation des animaux domestiques et de la basse-cour au Burundi. p.9.

République du Burundi (2018).Stratégie agricole nationale (SAN) 2018-2027. Ministère de l'agriculture et de l'élevage (2018).. p.75

République du Burundi (2016).Rapport annuel de la banque de la République du Burundi. Exercice 2016. p.98.

République du Burundi. Ministère de l'agriculture et de l'élevage. Stratégie agricole nationale 2008-2015. p.113.

République du Burundi. Ministère de l'aménagement du territoire et de l'environnement (2001). Convention cadre des Nations Unies sur les changements climatiques. p.145.

République du Burundi (2018). Enquête Nationale Agricole du Burundi (ENAB) 2016-2017. Ministère de l'Environnement, de l'Agriculture et de l'Elevage. P.131

République du Burundi (2016). Enquête Nationale Agricole du Burundi (ENAB) 2014-2015. Ministère de l'Environnement, de l'Agriculture et de l'Elevage. p.132

République du Burundi (2018). Plan National de développement du Burundi (PND) 2018-2027. p.149

San Pedro P (2011). Investir dans l'agriculture au Burundi, Rapports de Recherche d'Oxfam,p. 50

Temple D, Mainau E, Llonch P, Manteca X (2024).L'impact des parasites sur le bien-être des bovins, des ovins et des caprins. Animal welfare éducations centre.p.3.