THE CONTRIBUTIONS OF RUMEN8-FORMULATED BALANCED RATIONS ON THE PERFORMANCE OF LACTATING CROSSBREED COWS IN RUKUNGIRI DISTRICT, SOUTH WESTERN UGANDA

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Declaration

I Joan Atukunda, hereby declare that this dissertation titled "**Assessing the contributions of rumen8 software-formulated balanced rations on the performance of lactating crossbreed cows in Rukungiri district, South Western Uganda**" is my original work and has never been submitted to any institution before for any award.

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Approval

This dissertation titled "**Assessing the contributions of rumen8 software-formulated balanced rations on the performance of lactating crossbreed cows in Rukungiri district, South Western Uganda**" has been submitted to the university with my approval as the Supervisor for examination.

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Dedication

This dissertation is dedicated to the family members who supported me financially for going back for further studies. May God bless them.

Acknowledgement

Firstly, my sincere gratitude and appreciation goes to the Almighty God for all the inspiration, love, wisdom and strength, he granted me.

I would like to express my special gratitude to my supervisors Mr. Bahame B. David (PhD Research Fellow) and Rev. Nuwemuhwezi Gershom (PhD Research Fellow) for their special support throughout the research and dissertation writing.

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List of acronyms/Abbreviations

MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
REC	Research Ethics Committee
SNV	Stichting Nederlandse Vrijwilligers
UNFFE	Uganda National Farmers Federation

Abstract

This study investigated the contributions of Rumen8 software-formulated balanced rations on the performance of lactating crossbreed cows in Rukungiri District, Southwestern Uganda. The study aimed at assessing the level of awareness and utilization of Rumen8 software among dairy farmers for formulating balanced rations, evaluating the perceived benefits and challenges of implementing Rumen8-formulated rations, and identifying the factors influencing the adoption or rejection of the software. A cross-sectional survey design was employed, and data was collected from 124 respondents using structured questionnaires and key informant interviews. Descriptive and inferential statistics, including chi-square tests, were used to analyze the data. The results showed that the level of awareness of Rumen8 software among dairy farmers was moderate, with 58.1% of respondents aware of the software. However, only 42.7% of farmers actively utilized it to formulate balanced rations, indicating limited adoption. The perceived benefits of using Rumen8 were significant, with 77.4% of respondents reporting increased milk yield, 67.7% observing improved cow health, 55.6% noting better reproductive performance, and 54.8% perceiving more consistent feed quality. Furthermore, 50.0% of respondents reported a reduction in feeding-related diseases, while 22.6% indicated cost savings on feed. Results established the key challenges to utilization of Rumen8 software as resistance to change from traditional feeding practices (p=0.000), technical difficulties with the software (p=0.021), difficulty in understanding ration recommendations (p=0.044), and limited access to necessary technology such as computers and smartphones (p=0.036). Additionally, lack of technical support (p=0.007) emerged as a significant barrier, while the high cost of recommended ingredients (p=0.124) was the least significant challenge. Results established the most significant factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers as access to extension services (P=0.000), peer influence (p=0.001), education levels and availability of trainings (p=0.008), Income levels (p=0.006), access to information (p=0.000), understanding software benefits (p=0.000) and the least significant factor as farm size (p=0.648). while Rumen8 software offers substantial benefits in improving milk yield, cow health, and overall dairy farm productivity, its adoption is constrained by both technological and behavioral challenges. The study recommends enhancing farmer access to extension services, improving technical support, and conducting comprehensive training programs to boost the adoption and utilization of Rumen8 among dairy farmers in Rukungiri District. These efforts would contribute to the sustainable improvement of dairy production and livelihoods in the region.

CHAPTER ONE

1.1 Introduction

Lactating cows require a balanced ration to meet their nutritional needs for optimal milk production. In Uganda, crossbreed cows are commonly used for milk production due to their high milk yield potential. However, there is limited information on the effects of feeding a balanced ration on the performance of crossbreed lactating cows in Southwestern Uganda. This study assessed the contributions of rumen8 software-formulated balanced rations on the performance of lactating crossbreed cows in Rukungiri district, South Western Uganda.

1.2 Background of the study

Livestock production plays a vital role in the agricultural sector of Uganda, providing a source of income, food, and employment for many rural communities (MAAIF, 2021). However, productivity levels have been low due to poor feeding practices, inadequate nutrition, and diseases (MAAIF, 2021). One of the major constraints has been poor rumen health, leading to reduced feed utilization and poor growth rates.

Mungube *et al.* (2013) demonstrated the importance of feeding a balanced ration to lactating cows for optimal milk production. According to Kirui *et al.,* (2019), feeding a balanced ration to lactating cows results in higher milk yield and improved milk quality. Similarly, Mungube *et al.* (2013) found that feeding a balanced ration to dairy cows increased milk production and improved the overall health and condition of the cows.

Rumen8 is a computerized feed formulation software that has been introduced in Uganda to improve dairy production. The software was introduced by SNV, a Netherlands-based

development organization, in collaboration with the Ugandan Ministry of Agriculture, Animal Industry, and Fisheries (MAAIF) in 2015 (SNV,2015). The introduction of Rumen8 was part of a larger project aimed at improving dairy production and livelihoods of smallholder farmers in Uganda.

The use of Rumen8 in Uganda has been successful in improving milk production and quality. A study by Kiconco *et al.* (2019) found that using Rumen8 to formulate dairy cow diets led to improvements in milk yield, milk fat content, and milk protein content. The study also found that using Rumen8 led to a reduction in feed costs for smallholder farmers.

Rumen8 is a computerized system that formulates balanced rations based on the nutrient requirements of the animal. It takes into account factors such as breed, weight, age, and milk yield to ensure that the animal receives a balanced diet. According to Galindo *et al.* (2019), feeding a balanced ration formulated by Rumen8 to lactating cows resulted in higher milk yield and improved body condition compared to cows fed a conventional ration.

1.3 Statement of the problem

Uganda has a large livestock population, with approximately 14 million cattle, 4 million goats, and 4 million sheep (MAAIF, 2019). However, the productivity levels have been low due to poor feeding practices, inadequate nutrition, and diseases. Rumen health has been identified as a significant constraint to productivity, and interventions such as Rumen 8 have been introduced to address this challenge (UNFE,2020).

Lactating crossbreed cows in Rukungiri district, South Western Uganda, are often fed with rations that may lack precision and optimal nutrient balance. This can lead to low performance in terms of milk production, reproductive efficiency, and overall health. Current feeding practices may not

effectively meet the specific nutritional needs of these cows, resulting in under performance and reduced profitability for farmers. lactating crossbreed cows in Rukungiri district would be provided with precisely formulated, balanced rations using Rumen8 software. This software utilizes advanced algorithms to create customized feeding plans tailored to the specific requirements of individual cows thus optimizing nutrient intake and enhancing overall performance. If properly fed, cows would experience improved milk yield, better reproductive outcomes, and enhanced health and vitality. The current feeding practices in Rukungiri district do not adequately address the individualized nutritional requirements of lactating crossbreed cows. The lack of precision in ration formulation and the absence of tailored feeding plans derived from software like Rumen8 contribute to inefficiencies in nutrient utilization and subpar performance. This results in missed opportunities for maximizing milk production, reproductive success, and overall profitability for farmers. It is from this basis that research was conducted to assess contributions of rumen8 software-formulated balanced rations on the performance of lactating crossbreed cows in Rukungiri district, South Western Uganda.

1.3 Objectives of the study

1.3.1 General objective

To assess the contributions of rumen8 software-formulated balanced rations on the performance of lactating crossbreed cows in Rukungiri district, South Western Uganda.

1.3.2 Specific objectives

(i)To examine the level of awareness and utilization of Rumen8 software among dairy farmers in Rukungiri District for formulating balanced rations.

(ii)To evaluate the perceived benefits and challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers in Rukungiri District.

(iii) To identify factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers in Rukungiri District.

1.4 Research questions

(i) What is the level of awareness and utilization of Rumen8 software among dairy farmers in Rukungiri District for formulating balanced rations?

(ii) What are the perceived benefits and challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers in Rukungiri District?

(iii) What are factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers in Rukungiri District?

1.5 Scope of the study.

The scope of the study focused on geographical, content and time scope as listed below.

1.5.1 Geographical scope

The study was conducted in Rukungiri District is located in South Western Uganda bordering the Districts of Ntungamo in the East, Kabale in the South, Mitooma in the North and Kanungu to the West. It lies at an approximate altitudinal range of about 615 m to 1864 m above sea level; Latitude 000 47’ 21”S and Longitude 290 56’ 30” E. The administrative Headquarters of the district is situated in Rukungiri Town Council about 380 km from Kampala, the Capital City of Uganda.

Rukungiri district is made up of two counties and one municipality. Rukungiri district Local Government covers an area of 1,524.28 sq km2. According to Census 2024, Rukungiri has a population of 314,694 of which females are164, 678 (52.3%) and males 150,016 (47.7%) with an urban population of 43,606 (13.9%). There is an increasing rate of population growth from 1.3% (275,162) to 1.5% (314,694). It is now projected to be 360,127 at a rate of 1.7 per annum.

1.5.2 Content scope

The study focused on assess the contributions of rumen8 software-formulated balanced rations on the performance of lactating crossbreed cows in Rukungiri district, South Western Uganda. It was limited to; assessing the awareness and utilization of Rumen8 software among dairy farmers in Rukungiri District for formulating balanced rations, the perceived benefits and challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers and identifying factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers in Rukungiri District.

1.5.3 Time scope

The study was based on ten-year time frame (2014-2024). This is the time when different organisations like SNV and Pearl dairies have been advocating and encouraging dairy farmers to adopt rumen8 software in formulating feed rations to enable them increase on their milk production.

1.6 Significance of the study

Farmers. Understanding the impact of Rumen8-formulated balanced rations on dairy cow performance can directly benefit farmers by potentially improving milk yield, reproductive efficiency, and calf growth rates. This knowledge empowers farmers to make informed decisions

regarding their feeding practices, ultimately enhancing the productivity and profitability of their dairy operations.

Livestock extension officers. Extension officers play a crucial role in disseminating information and providing technical assistance to farmers. The findings of this study would serve as valuable evidence-based guidance for extension officers when advising farmers on optimizing their feeding strategies to maximize the performance of lactating crossbreed cows.

Policy makers. Policy makers in the agricultural sector would utilize the results of this study to inform policies and programs aimed at promoting sustainable dairy production practices. Insights into the efficacy of Rumen8-formulated balanced rations would contribute to the development of policies supporting the adoption of innovative technologies and practices to improve dairy farming outcomes in Uganda.

Researchers and academia. The study would add to the existing body of knowledge on dairy nutrition and management practices, particularly in the context of smallholder dairy farming in Uganda. Researchers and academia would build upon these findings to conduct further research, develop new technologies, and refine feeding recommendations for dairy farmers in similar settings.

Agricultural service providers. Companies or organizations involved in providing agricultural inputs and services, such as feed manufacturers or distributors, would benefit from understanding the demand for Rumen8-formulated balanced rations among dairy farmers. This knowledge would inform their product development, marketing strategies, and extension efforts tailored to meet the needs of their target market.

1.7 Justification of the study

In Rukungiri District, Southwestern Uganda, dairy farming plays a significant role in the livelihoods of many smallholder farmers (Rukungiri District Production Report 2022). However, despite the importance of dairy production, many farmers face challenges related to low milk yields, poor reproductive performance, and inadequate calf growth. These challenges are attributed, in part, to suboptimal feeding practices and limited access to nutritional expertise and resources.

There is a lack of comprehensive data on the effectiveness of feeding strategies, particularly regarding the use of software like Rumen8 for formulating balanced rations tailored to local conditions. Ideally, dairy farmers in Rukungiri District would have access to scientifically formulated balanced rations tailored to the specific nutritional needs of lactating crossbreed cows (Rukungiri District Production Report 2022). By utilizing tools like Rumen8, farmers would optimize feed formulations based on local feed availability, cow requirements, and production goals. In this ideal scenario, dairy farmers would experience improved milk yields, enhanced reproductive performance, and healthier calf growth, leading to increased income and livelihood security for farming households.

There is still a gap between the current feeding practices of dairy farmers in Rukungiri District and the potential benefits of implementing Rumen8-formulated balanced rations. Many farmers lack the knowledge, resources, or access to appropriate technologies to optimize their feeding programs effectively (Rukungiri District Production Report 2022). As a result, dairy cow performance is still low, leading to reduced productivity, income instability, and overall inefficiencies in the dairy value chain. Addressing this problem requires empirical evidence on the effectiveness of Rumen8-formulated balanced rations in improving dairy cow performance under local conditions, as well

as identifying barriers to adoption and implementation. It is from this background that this research was conducted to assess the contributions of rumen8-formulated balanced rations on the performance of lactating crossbreed cows in Rukungiri district, South Western Uganda.

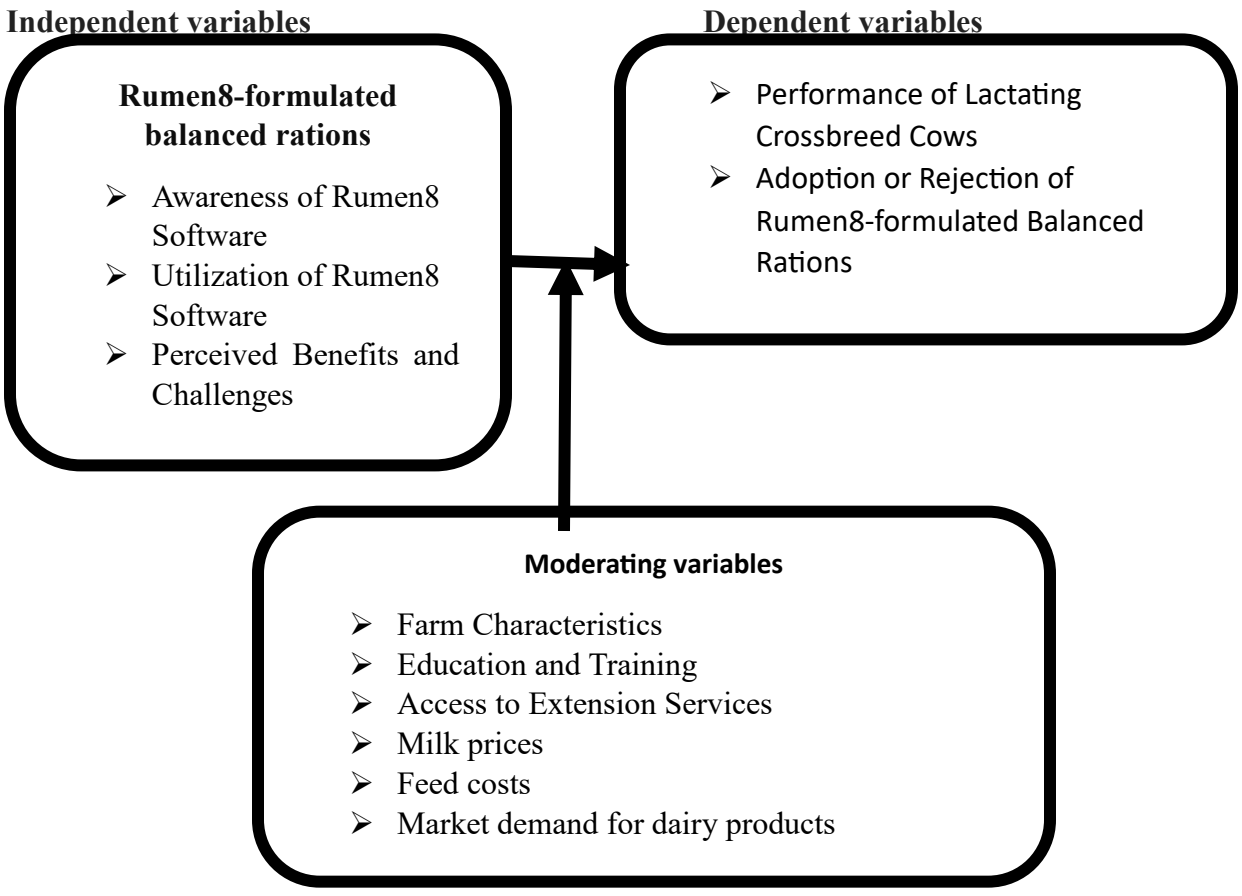
1.8 **Theoretical framework**

The study adopted Rumen Functionality and Nutrition. This theory focuses on the role of the rumen in digesting feed and extracting nutrients, emphasizing the importance of balanced rations for optimal rumen function (Mupangwa *et al.,* 2023). It is based on concepts from ruminant nutrition and physiology to explain how specific dietary formulations (such as Rumen8) influences the performance of lactating cows. The efficiency of rumen fermentation determines the availability of nutrients for absorption in the small intestine. Balanced rations that provide adequate levels of energy, protein, vitamins, and minerals are essential for supporting optimal rumen function and ensuring that the animal's nutrient requirements are met for maintenance, growth, reproduction, and lactation.

Ruminants have the unique ability to convert fibrous plant materials, such as grasses and crop residues, into high-quality protein and energy sources for human consumption. The efficiency of this conversion process depends on the quality and digestibility of the feed, as well as the capacity of the rumen to ferment and extract nutrients from the diet (Mupangwa *et al.,* 2023).

1.9 Conceptual framework of the study

The conceptual framework below is based on fact that the use of Rumen8 software to formulate a balanced ration for feeding lactating crossbreed cows has the potential to improve milk production, feed efficiency, and cow health. However, the success of this intervention depends on several mediating factors, including feed availability, farmer knowledge, and environmental factors. Therefore, interventions that address these mediating factors are essential for the successful adoption of Rumen8 software and the promotion of sustainable dairy production in Southwestern Uganda.



Source: Researcher 2024

The performance of lactating crossbreed cows is directly influenced by the composition and quality of formulated balanced rations. Farmers who are aware of and use Rumen8 software are more likely to formulate balanced rations that meet their cows' specific nutritional requirements, leading to improved performance outcomes. Farmers' perceptions of the benefits and challenges associated with implementing Rumen8-formulated balanced rations can influence their management decisions and the effectiveness of the feeding program. Those who are familiar with the software and have successfully used it in the past may be more inclined to adopt the rations.

Larger farms with more resources may be better positioned to adopt the software. Farmers with higher education and access to training programs are more likely to use the software effectively. Market factors like milk prices and demand may also influence farmers' decisions.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter presents literature and it was reviewed basing on the following themes; the awareness and utilization of Rumen8 software among dairy farmers for formulating balanced rations, the perceived benefits and challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers and factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers.

2.1 The level of awareness and utilization of Rumen8 software among dairy farmers for formulating balanced rations.

Rumen8 software is a valuable tool designed to assist dairy farmers in formulating balanced rations for their livestock. Attributes of Rumen 8 software verse traditional feed mixing methods. The awareness and utilization of this software among dairy farmers play a crucial role in optimizing feed efficiency, animal health, and overall farm productivity. Research by Kaur *et al.,* (2023) highlighted that awareness of digital tools like Rumen8 among European dairy farmers is increasing but remains relatively low compared to traditional methods of ration formulation.

The study found that only 30% of surveyed farmers were aware of the software's existence, indicating a need for greater promotion and education within the industry. Lack of awareness can be attributed to limited promotion efforts or inadequate training programs provided to farmers. In a study conducted by Ndambi *et al.,* (2020), it was observed that while awareness levels are improving, the actual utilization of Rumen8 software among European dairy farmers is still

limited. Barriers such as cost, technical complexity, and resistance to change were identified as key factors hindering widespread adoption.

According to MAAIF (2021) awareness levels regarding Rumen8 software among dairy farmers in Uganda vary. Some farmers are well-informed about the benefits of using Rumen8 for ration formulation, while others lack knowledge about its existence or functionalities. Factors influencing awareness include access to information, training programs, and extension services provided by agricultural organizations. The actual utilization of Rumen8 software among dairy farmers in Uganda is relatively low compared to the level of awareness (Trendov *et al.,* 2019). Challenges such as limited access to technology, inadequate training on software usage, and preference for traditional methods of ration formulation hinder widespread adoption (Canton, 2021). However, farmers who have incorporated Rumen8 into their practices have reported improvements in livestock health, milk production, and cost-effectiveness (Canton, 2021). To enhance the awareness and utilization of Rumen8 software among dairy farmers in Uganda, it is essential to focus on capacity building through training programs, workshops, and demonstrations. Collaboration between government agencies, agricultural institutions, and technology providers can facilitate the dissemination of information and resources needed for successful implementation. Additionally, promoting the benefits of using Rumen8 through success stories and case studies can inspire more farmers to adopt this innovative tool (Marinchenko, 2021).

2.2 The perceived benefits and challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers

In Uganda Research conducted by Nakalembe *et al.,* (2020) found that the use of Rumen 8 in dairy cows resulted in increased milk yield and improved feed efficiency. Similarly, a study by Kugonza *et al.*, (2021) reported increased weight gain and improved feed conversion efficiency in beef cattle fed with Rumen 8. However, the adoption of Rumen 8 in Uganda is still in its early stages, and more research is needed to determine its efficacy in different livestock production systems and regions. Nevertheless, the product's potential to improve rumen health and enhance nutrient utilization makes it a promising intervention in addressing the productivity challenges faced by smallholder farmers in Uganda.

According to MAAIF (2021), several organizations have played a significant role in promoting the adoption of Rumen 8 in Uganda. For instance, the Uganda National Farmers' Federation (UNFF) has partnered with several companies to provide training on the use of Rumen 8 and facilitate its distribution to smallholder farmers. Additionally, the Ministry of Agriculture, Animal Industry, and Fisheries (MAAIF) has supported the adoption of Rumen 8 through its Livestock Development Program, which aims to improve livestock productivity and enhance food security.

A study by Prodanović *et al.,* (2021), evaluated the effectiveness of Rumen 8 software in formulating feed rations for lactating cows. The study found that the software was effective in optimizing the nutrient content of feed rations, resulting in improved milk yield and milk composition. A study by Chowdhury *et al.,* (2020) also reported that the use of Rumen 8 software improved milk yield and milk quality in lactating cows. However, some studies have reported limitations in the use of Rumen 8 software for feed formulation. A study by Kim *et al.*, (2020) found that the software did not always provide accurate predictions of feed intake, which affected

the accuracy of the feed formulation. Additionally, the study reported that the software did not consider the effects of the environment and management practices on feed intake, which could lead to suboptimal feed formulations.

Another limitation of Rumen 8 software is the paucity of data on the composition and availability feed ingredients. A study by Ahmed *et al*., (2021) reported that the accuracy of the feed formulation using Rumen 8 software was affected by the availability and quality of data on feed ingredients. The study recommended the use of locally available feed ingredients and regular updates of the software's database to improve the accuracy of the feed formulations. Moreover, the use of Rumen 8 software requires technical skills and knowledge on feed formulation. A study by Kawas *et al.,* (2020) reported that the software's effectiveness was limited by the lack of technical skills among farmers and extension agents, which affected the adoption and use of the software.

A study by Ngowi *et al.,* (2020), evaluated the effectiveness of Rumen 8 software in formulating feed rations for lactating cows in Tanzania. The study found that the software was effective in optimizing the nutrient content of feed rations, resulting in improved milk yield and milk composition. The study recommended the use of locally available feed ingredients and regular updates of the software's database to improve the accuracy of the feed formulations. However, there are still research gaps in the effectiveness of Rumen 8 software on feed formulation for lactating cows in Tanzania. For instance, there is a need to evaluate the software's performance in different production systems and regions in Tanzania. Additionally, there is a need to investigate the software's limitations in accurately predicting feed intake and the effects of environmental and management factors on feed intake in Tanzania's production systems.

Several studies have demonstrated the effectiveness of Rumen8 software in optimizing feed formulation for lactating cows in Kenya. In a study by Karuri *et al.,* (2018), the authors found that

Rumen8 software significantly improved the nutritional value of dairy cow feed, resulting in increased milk production and profitability. Similarly, Kebun *et al.,* (2020) observed a significant improvement in milk production and profitability following the use of Rumen8 software in feed formulation for lactating cows. Despite the significant benefits of Rumen8 software in feed formulation for lactating cows, there are still research gaps that need to be addressed. One of the gaps is the limited studies on the use of Rumen8 software in smallholder dairy farms in Kenya. Most of the studies have been conducted on large-scale farms, yet smallholder farms constitute a significant proportion of dairy farms in Kenya.

In another study by Gitau *et al.,* (2021), the authors compared the performance of lactating cows fed on diets formulated using Rumen8 software with those fed on diets formulated manually. The study found that cows fed on diets formulated using Rumen8 had significantly higher milk production and feed efficiency compared to those fed on manually formulated diets. However, is the limited studies on the long-term effects of Rumen8 software on milk production and cow health. Most studies have only examined the short-term effects of Rumen8 software, yet it is essential to assess the long-term effects of the software on cow health and milk production

Rumen8 is a feed formulation software that is specifically designed for ruminants. It has been used in South Africa for formulating diets for lactating cows. Several studies have evaluated the effectiveness of Rumen8 software in formulating diets for lactating cows in South Africa. In a study by Brouckaert *et al.*, (2016), Rumen8 was used to formulate diets for Holstein cows in South Africa. The study found that Rumen8 was effective in formulating diets that met the nutrient requirements of the cows and improved milk production. However, there is a need for studies comparing Rumen8 to other feed formulation software in terms of their effectiveness in formulating diets for lactating cows in South Africa.

Another study by Du Plessis *et al.,* (2018) evaluated the effect of Rumen8 on the performance of Jersey cows in South Africa. The study found that cows fed diets formulated using Rumen8 had higher milk production compared to those fed diets formulated using traditional methods. However, there is limited research on the effect of Rumen8 on the quality of milk produced by lactating cows in South Africa.

Several studies have investigated the effectiveness of Rumen8 software on feed formulation for lactating cows in Nigeria. Adewumi *et al.*, (2018) evaluated the performance of lactating cows fed with diets formulated using Rumen8 software. The study found that cows fed with diets formulated using the software had higher milk yield and better feed conversion ratio compared to those fed with conventional diets. Similarly, Ogunade *et al.,* (2019) reported that lactating cows fed with diets formulated using Rumen8 had higher milk yield, milk protein, and milk fat compared to those fed with conventional diets. Moreover, there is a need for more studies to investigate the impact of the software on animal health, particularly on the incidence of metabolic disorders such as ruminal acidosis.

Moreover, Adeyemi *et al.,* (2020) investigated the economic benefits of using Rumen8 software for feed formulation for lactating cows. The study found that farmers who used the software saved up to 15% of the total cost of feed formulation while achieving optimal nutrient balance for their animals. Similarly, Ogunade *et al.,* (2019) reported that the use of Rumen8 software resulted in a 10% increase in milk yield, 20% reduction in feed cost, and 25% increase in net income for dairy farmers in Nigeria. However, there is a need for studies to investigate the challenges and limitations of using the software in feed formulation, particularly in terms of the availability and affordability of feed ingredients in Nigeria.

Several studies have investigated the effect of using a combination of forages and concentrate in feed formulations using Rumen8 software in Kenya. A study by Gitari *et al.,* (2020) evaluated the economic benefits of using Rumen8 software to formulate dairy cattle feed in Kenya. The study found that using Rumen8 software to formulate feed resulted in a 24% increase in milk production and a 25% increase in profits

Despite challenges, research by Kaur *et al.,* (2023) demonstrated the significant benefits of incorporating Rumen8 software into dairy farm management practices. The software's ability to optimize feed efficiency, reduce costs, and improve animal health outcomes were cited as compelling reasons for farmers to consider its adoption. Further investigation by Kaur *et al.*, (2023) delved into the specific challenges faced by European dairy farmers when utilizing Rumen8 software. Issues such as data integration with existing farm systems, training requirements, and customization for regional variations were identified (Mbuku *et al.*, 2020). The study recommended tailored training programs and ongoing technical support to enhance uptake.

In Kenya, the adoption of Rumen 8 has been significant, with numerous reports highlighting its positive impact on dairy farming (Pepeta, 2019). For instance, a study conducted Pepeta (2019) revealed that using Rumen8 led to an average increase of 5.3% in milk yield and a reduction of 4.5% in feed costs for smallholder dairy farmers. Moreover, the authors noted that the software's user-friendly interface made it accessible to farmers with minimal formal education. In Ethiopia Rumen8 has gained popularity among dairy farmers (Brand *et al.,* 2019). Brand *et al.,* (2019) reported that using the software resulted in improved milk production and reduced feed costs for smallholder farmers. Furthermore, they emphasized that training programs were essential for effective implementation and usage of the software.

In South Africa, Rumen8 has been used extensively for optimizing rations for both commercial and smallholder dairy farms (Van Heerden *et al.,* 2020). Van Heerden *et al.*, (2020) highlighted that the software's ability to account for variations in feed composition and animal requirements was crucial for achieving optimal ration formulation. They also noted that ongoing collaboration between researchers, extension agents, and farmers was essential for ensuring continued success with the software.

Studies have shown that balanced rations formulated using Rumen8 can significantly increase milk production in dairy cattle (Brand *et al.,* 2019). By providing essential nutrients in the correct proportions, Rumen8 helps optimize rumen function, leading to improved digestion and nutrient utilization, ultimately resulting in higher milk yields. Proper nutrition is essential for maintaining the health and well-being of dairy cattle (Abdela *et al.,*2019). Rumen8-formulated balanced rations ensure that cows receive adequate levels of protein, energy, vitamins, and minerals, thereby reducing the risk of nutritional deficiencies and associated health issues (Jordaan, 2022). This can lead to lower veterinary costs and improved animal welfare. Implementing Rumen8-formulated balanced rations can potentially increase the profitability of dairy farming operations (Owolabi *et al.,*2020). Higher milk production, improved feed efficiency, and reduced incidence of health problems can contribute to increased revenue and reduced production costs, resulting in higher profits for farmers (Jordaan, 2022).

Cost Considerations. One of the primary challenges faced by dairy farmers when implementing Rumen8-formulated balanced rations is the cost associated with purchasing the necessary feed ingredients (Sakwa *et al.,* 2020). These specialized rations may require specific components that can be expensive, impacting the overall profitability of the farm. According to a Deen *et al.,* (2019) the primary reason for the reluctance of dairy farmers to adopt Rumen8-formulated balanced

rations is the perceived increase in feed costs. The study found that while these rations can lead to improved milk production and reduced nutrient excretion, the initial investment required for their implementation can be substantial. This includes the cost of purchasing new feed ingredients, such as by-product feeds and specialized minerals and vitamins, as well as the cost of modifying existing feeding systems to accommodate these new rations.

According to Kashongwe *et al.,* (2014) while Rumen8-formulated balanced rations can lead to increased milk production and improved animal health, the high initial investment required for their implementation can be a significant barrier for small-scale dairy farmers. The study also highlighted that the long-term economic benefits of these rations may not be immediately apparent, making it difficult for farmers to justify the initial investment. Kashangaki and Ericksen (2018) also emphasized the importance of cost considerations in the adoption of Rumen8-formulated balanced rations. Kashangaki and Ericksen (2018) noted that while these rations can lead to significant improvements in milk production and animal health, they often require a higher investment in feed ingredients and feeding systems compared to traditional ration formulations. The authors also highlighted that the variability in feed prices and availability can make it challenging for farmers to consistently implement these rations in a cost-effective manner.

According to Mungube *et al.,* (2014), another challenge is the availability of all the required ingredients for formulating balanced rations. Rumen8 formulations may require specific ingredients that are not readily available in all regions. Dairy farmers might face challenges in sourcing these ingredients locally, leading to increased transportation costs or the need to import ingredients from distant locations (Lemma *et al.,* 2017). Some ingredients recommended in Rumen8 formulations may be expensive or subject to price fluctuations (Owolabi *et al.,* 2020). A study conducted by Mutavi (2017) reported that farmers need to balance the nutritional

requirements of their cattle with the cost-effectiveness of sourcing ingredients and therefore limited availability of cost-effective alternatives can impact the feasibility of implementing Rumen8-formulated rations.

According to Richards *et al.,* (2015) implementing Rumen8-formulated balanced rations requires a certain level of knowledge and expertise in animal nutrition. Lack of proper training among dairy farmers can hinder their ability to accurately formulate and administer these rations, leading to suboptimal results. Richards *et al.,* (2016) further revealed that Rumen8 formulations are designed to optimize rumen function, but many dairy farmers may not have a deep understanding of rumen physiology and how different ingredients affect rumen health. Lack of knowledge about the principles underlying Rumen8 formulations can hinder farmers' ability to effectively implement balanced rations (Cordeiro *et al.,* 2022). Formulating balanced rations requires expertise in animal nutrition and ration formulation. According to Sherasia *et al.,* (2016) dairy farmers may lack the necessary training or access to nutritionists who specialize in formulating rations based on Rumen8 principles. Without proper training, farmers may struggle to adjust rations according to changing herd requirements or ingredient availability (Gitari *et al.,* 2020).

Formulating and managing balanced rations using Rumen8 can be time-consuming, especially for farmers who already have busy schedules managing other aspects of their dairy operations (Lawrence, 2019). This time constraint can discourage some farmers from fully committing to the implementation process. Developing a balanced ration using Rumen8 principles requires time and expertise (Kariuki *et al.,* 2019). Farmers must analyze the nutritional needs of their herd, assess the availability and cost of various feed ingredients, and formulate rations that optimize rumen function and overall cattle health (Kilelu *et al.,* 2018). Time constraints may limit farmers' ability to dedicate sufficient time to this process, leading to suboptimal ration formulations (Sakwa *et al.,*

2020). Dairy farming involves a multitude of daily tasks, including milking, feeding, health monitoring, and facility maintenance (Mokolopi *et al.,* 2019). Farmers may struggle to find time to prioritize the formulation and adjustment of balanced rations based on Rumen8 principles amidst their other responsibilities. This can result in the use of generic or outdated ration formulations that do not fully optimize cattle nutrition (Sakwa *et al.,* 2020).

According to Muia *et al.*, (2011) resistance to change is a common challenge in any new farming practice. Some dairy farmers may be hesitant to switch from traditional feeding methods to Rumen8-formulated rations due to skepticism about its effectiveness or concerns about disrupting their existing routines. Many dairy farmers have established routines and practices for feeding their cattle based on traditional methods passed down through generations. According to Mutavi (2017) introducing Rumen8-formulated rations requires a departure from these familiar practices, which can be met with resistance due to concerns about disrupting established routines or skepticism about the effectiveness of new approaches. Purcell *et al.,* (2016) revealed that implementing Rumen8-formulated rations may be perceived as complex or challenging by some farmers, particularly those with limited experience or expertise in animal nutrition. The need to understand rumen physiology, formulate balanced rations, and monitor cattle performance according to Rumen8 principles can seem daunting, leading to resistance to change.

2.3 Factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers

According to Somvanshi *et al.*, (2015) milk prices play a vital role in the decision-making process of dairy farmers. Fluctuations in milk prices can significantly impact a farmer's revenue and profitability. When milk prices are high, farmers may have more financial resources to invest in innovative technologies such as Rumen8-formulated balanced rations (Mlambo *et al.,* 2017). Higher milk prices can incentivize farmers to adopt these rations as they seek to maximize milk production and capitalize on favorable market conditions (Jacobs, 2014). Conversely, low milk prices can pose challenges for dairy farmers, limiting their ability to invest in expensive feed formulations like Rumen8 (Ssewanyana *et al.,* 2020). In times of economic hardship, farmers may prioritize cost-cutting measures over investing in premium feed options, leading to a reluctance to adopt Rumen8-formulated rations despite their potential benefits (Johnson *et al.,* 2016).

According to Sakwa *et al.,* (2020) production efficiency is another critical factor that can influence the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers. Efficient dairy operations are characterized by optimized feed utilization, improved milk yields, and overall cost-effectiveness. Farmers who prioritize production efficiency are more likely to consider adopting advanced feed formulations like Rumen8 to enhance their herd's performance (Mpairwe *et al.,* 2017). Ndambi *et al.,* (2017) revealed that dairy farmers with high production efficiency standards may view Rumen8-formulated rations as a strategic investment that aligns with their goal of maximizing output while minimizing input costs. These farmers recognize the potential long-term benefits of using specialized feed formulations tailored to meet their herd's nutritional requirements efficiently.

According to Ndambi *et al.,* (2018) farmers' knowledge about the benefits, ingredients, and functioning of Rumen8-formulated balanced rations plays a significant role in their adoption decisions. A study conducted by O'Callaghan *et al.,* (2016) revealed that farmers who are well-informed about the nutritional advantages of such rations are more likely to adopt them. On the other hand, lack of awareness or misconceptions about Rumen8 may lead to skepticism or rejection among dairy farmers. Farmers who have a strong understanding of the nutritional requirements of their dairy herd are more likely to appreciate the benefits of balanced rations. Rumen8-formulated rations are designed to meet these requirements efficiently, optimizing milk production and overall herd health (Ndambi *et al.,* 2018).

According to a study conducted by Rademaker *et al*., (2016) farmers' beliefs and attitudes towards new feeding practices can heavily influence their willingness to try Rumen8-formulated balanced rations. Positive attitudes towards innovation, trust in scientific research supporting the efficacy of such rations, and perceived benefits in terms of animal health and productivity can drive adoption (Arthur *et al.,* 2019). On the other hand, deeply rooted traditional beliefs, concerns about cost-effectiveness, or fear of negative impacts on milk quality may deter farmers from embracing Rumen8. Farmers who prioritize animal welfare may be more inclined to adopt Rumen8-formulated rations if they believe these rations contribute to better overall health and well-being of their dairy herd (Lidfors, 2019). Rademaker *et al*., (2016) further revealed that if they have concerns about the impact of new feeding practices on animal health or behavior, they may reject them. Farmers' beliefs about the economic benefits of adopting Rumen8-formulated rations are crucial. If they believe that these rations can lead to cost savings, improved milk production, and overall profitability, they are more likely to adopt them. if they doubt the economic viability or perceive the initial investment as too high, they may reject them.

According to Richards *et al.* (2016) the social context within which dairy farmers operate also shapes their decisions regarding adopting new feeding strategies like Rumen8-formulated balanced rations. Peer networks, extension services, agricultural advisors, and community norms all play a role in either promoting or inhibiting the uptake of innovative practices. Farmers who receive support from their social circles or have access to reliable information sources are more likely to consider integrating Rumen8 into their feeding regimes. Corea *et al.,* (2017) farmers often trust and rely on the experiences and recommendations of their peers. Positive testimonials or success stories shared within social networks can encourage adoption, while negative experiences or skepticism can lead to rejection. Social networks serve as channels for disseminating information about new technologies or practices like Rumen8-formulated balanced rations. Farmers may learn about these rations through discussions with peers, agricultural groups, or industry influencers on platforms like Facebook groups, WhatsApp, or agricultural forums (Corea *et al.,* 2017).

According to Lawrence (2019) economic factors such as initial investment costs, expected returns on investment, and perceived financial risks associated with transitioning to Rumen8-formulated balanced rations can significantly impact adoption rates among dairy farmers. Clear demonstrations of cost-effectiveness, potential savings in feed expenses, and long-term profitability are crucial for convincing farmers to switch to this advanced feeding technology (Ngugi *et al.,* 2017). Farmers often conduct cost-benefit analyses before adopting new practices or technologies. High initial investment costs for Rumen8-formulated balanced rations may deter adoption if farmers perceive that the potential benefits, such as increased milk production or improved herd health, do not outweigh the costs within a reasonable timeframe (Sherasia *et al.,* 2016). Lawrence (2019) noted that while the initial cost of implementing these rations may be

higher than traditional ones, the long-term cost savings can be substantial due to improved feed conversion efficiency and increased milk production.

According to Ndambi *et al.,* (2018) access to educational resources and technical support on the proper use of Rumen8 can positively impact adoption rates among dairy farmers. Educational support in agriculture encompasses various initiatives aimed at providing farmers with knowledge, skills, and resources to enhance their decision-making processes (Habimana *et al.,* 2020). This support can come in the form of training programs, workshops, extension services, online resources, and peer-to-peer learning opportunities. Somvanshi *et al.,* (2015) reported that education provides farmers with the knowledge and understanding of how Rumen8-formulated balanced rations work, their benefits, and how they can be integrated into existing farming practices. Farmers with higher levels of education may grasp the scientific principles behind the technology more easily and be more receptive to adopting it (Alhassan *et al.,* 2016).

CHAPTER THREE: METHODOLOGY

3.1 Study area

The study was conducted in Rukungiri district. It lies at an approximate altitudinal range of about 615 m to 1864 m above sea level; Latitude 000 47' 21" S and Longitude 290 56' 30" E. The administrative Headquarters of the district is situated in Rukungiri Town Council about 380 km from Kampala, the Capital City of Uganda. The district is bordered by Lake Edward to the North West, Rubirizi District to the northeast, Mitooma District to the northeast and east, Ntungamo District to the east and southeast, Rukiga District and Rubanda District to the south, Kanungu District to the west, and the Democratic Republic of Congo via Lake Edward to the northwest. The district headquarters are approximately 382 kilometres (237 mi), by road, south-west of Kampala, Uganda's capital city (Globefeed.com 2017). Rukungiri District is made up of the following sub-counties: Bugangari, Buhunga, Buyanja Bwambara, Kagunga, Kebisoni, Nyakagyeme, Nyakishenyi, Nyarushanje, Ruhinda and Rukungiri Tc.

3.2 Research design

The study employed a cross-sectional survey using mixed method research design, which involved collection of data using both quantitative and qualitative approaches. Cross sectional study was used for its economic advantage in quantitative data collection. This is also in support to (Sedgwick, 2014) study which revealed that cross sectional studies are quick, easy and cheap to perform as they are often based on questionnaire survey. There is no loss of time in follow-up since respondents are interviewed only once. On the other hand, mixed methods research was appropriate approach for quantitative and qualitative data collection. This is in concurrence with (Creswell and Clark, 2018), who argued that mixed methods research was a combination of

qualitative and quantitative research approaches which could be used to provide a broader purpose and in-depth understanding.

3.3 Study Population

The three categories of respondents involved in the study were dairy farmers trained on use of Rumen8 software, farmers in active use of Rumen8 software and extension service providers. A study population of 180 dairy farmers were trained on the use of rumen8 software by SNV in the two sub-counties Nyakagyeme and Kebisoni sub counties and they were selected because they had the highest number of livestock in the district (Rukungiri District Production Report 2022).

3.4 Sample size determination

This was estimated using proportion estimates according to Terry, (2000) thus:

$$n = \frac{N}{1+N(e)^2}$$

The sample size was determined using Slovins Formula which was used to calculate the sample size (n) given the population size (N) and a margin of error (e).

$n=N/1+Ne2$

Where n=number of samples

N=total population

e=error margin/ margin of error

$n=180/1+180(0.05)2$

$n=180/1.45$

$n=124$

Therefore, the sample size was 124 respondents.

3.5 Sampling procedures

Purposive sampling was used to select the sub counties of Nyakagyeme and Kebisoni, focused group discussions and interviewing of key farmer leaders and stratified random sampling was used to select dairy farmers for administration of questionnaires. Focus groups for discussion and interview with key informants were selected purposively based on their knowledge, experience and interest in livestock farming. Two focus group discussions were held, one in Nyakagyeme Sub County and another in Kebisoni Sub County and these had ten participants each

3.7 Data Collection Method

Data was collected using both qualitative and quantitative methods. Structured questionnaire was designed to collect data from dairy farmers. While interview guide was used to collect information from key informants, access and control profile for resources and benefits was used for collecting data from focus group discussions. Quantitative data was collected from the dairy farmers through administration of structured questionnaires (appendix I). In addition, an interview guide (appendix II) was used to collect qualitative data during the focus group discussions. Two focus group discussions comprising of 10 members were held and these consisted of four females and six males with their ages ranging from 25 to 70 years. Ten key informants were also selected during the focus group discussions and were further engaged for an in-depth analysis of the dynamics of using rumen8 software.

Literature from various library textbooks, government publications such as the District Development plans, District Veterinary Sector Reports, newspapers, journals and Internet websites, dealing with the subject in question were reviewed. Physical observation of what people had achieved in relation to use of rumen8 software and how they were managing their dairy farms was also recorded.

3.8 .1 Quality control

To ensure high data quality, precautionary measures were taken at the various stages of the study. Prior to the survey, a questionnaire pre-test was conducted to ensure that the questionnaire was clear, precise and exhaustive. After the pre-test, some questions were edited and some more information was added for clarity. Simple random sampling was used in selecting respondents. Furthermore, only well-trained research assistants were used in data collection.

3.8.2 Validity of Instruments

In order to ensure the validity and reliability of the content of the questionnaires, the questionnaire was reviewed by the supervisor. The questionnaire was piloted with 05 respondents to test their validity and reliability. The following processes for ensuring validity and reliability, legitimizing the data, and finally lending credibility to the research report were used for this study.

3.8.3 Reliability of Instruments

Reliability of this study's instruments was ascertained by pre-testing and re-testing the questionnaires and interview. Because reliability is consistency of measurement over time or stability of measurement over a variety of conditions, the most commonly used technique to estimate reliability was with a measure of association. Reliability of this study's instruments was ascertained by pre-testing and re-testing the questionnaires and interview guide in the field. The researcher established the reliability of the questionnaire by using pre-testing and re-testing it with the same group of respondents from different case study.

3.9 Ethical consideration

In concert with the rules and regulations of the university with regard to conducting research using human subjects, the following ethical considerations were taken into account during the course of

the research. These considerations were applied to both the quantitative and qualitative research sections of this study.

3.9 .1 Permission

The concept was presented, and now the dissertation was presented and shared with the Research Ethics Committee (REC). The consent letter was included as part of the research's ethical considerations. After presenting the proposal the researcher obtained a written permission from Directorate Graduate Studies Research and Innovation Bishop Stuart University to conduct this research, in order to ensure that it was a legal exercise. The letters of permission for each questionnaire were provided. The researcher also submitted the proposal to Bishop Stuart research commit and the comments and suggestions were incorporated.

3.9.2 Confidentiality and privacy

Confidentiality refers to handling the information concerning the respondents in a confidential manner. Respondents were assured that their names were dealt with in the strictest confidence. This aspect included the principle of trust in which the researcher assured the participants that their trust would not be exploited for personal gain or benefit, by deceiving or betraying them in the research route or its published outcomes.

3.9.3 Voluntary participation and informed consent

The principle of voluntary participation was explained to the respondents and they were also informed that they had the right to withdraw from the study at any time. The principle of informed consent was verbally explained to the interviewees and was included on the questionnaire. Both principles entailed explaining the research process and its purposes to the participants.

3.10 Research procedure

After successfully presenting the proposal, the researcher obtained an introductory letter which was presented to the authorities of Rukungiri District and the researcher embarked on data collection by hand delivering the questionnaires. On receiving permission from the relevant authorities, the researcher administered data collection tools and collected data from the respondents according to the agreed time schedule. In the administration of the questionnaire and interview schedules, the researcher created an understanding with the respondents, guarantee them of concealment and clarify to them the purpose of the study. This approach enabled the researcher to get extreme collaboration with her respondents. The questionnaires and interviews were administered by the researcher at the places of the various respondents. During the survey, the researcher carefully read and explained the content of the interview guide to the respondents and recorded answers on a separate sheet of paper. The researcher then analyzed the data and wrote up the report which was considered as a requirement for the award of master degree. The results were disseminated to different stakeholders by publishing and printing dissertation reports which were placed in both university and public libraries and at the district.

3.11 Data analysis

Collected data was compiled, sorted, edited and coded to have the required quality, accuracy and completeness. Quantitative data from both questionnaires and interview guides was then entered into Statistical Package for Social Scientists (SPSSv26.0) to aid in easy generation of frequency tables. Statistical analyses such as frequencies, percentages were used to quantify the contributions of rumen8-formulated balanced rations on the performance of lactating crossbreed cows in Rukungiri district, South Western Uganda. In addition, inferential statistics such as Chi-square, Pearson correlation and regression coefficients were used to measure the degree of relationship

contributions of rumen8-formulated balanced rations on the performance of lactating crossbreed cows in Rukungiri district, South Western Uganda. To understand these statistics better, the quantitative statistics were supported with qualitative narratives from interviews with key informants.

CHAPTER FOUR

PRESENTATION OF RESULTS

4.0 Introduction

This chapter presents the findings and discussions of the study under thematic sub-sections in line with the research objectives. The thematic subsections include demographic characteristics of respondents, level of awareness and utilization of Rumen8 software among dairy farmers in Rukungiri District for formulating balanced rations, the perceived benefits and challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers and factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers.

4.1 Questionnaire Response Rate

The study achieved a 100% response rate, aligning with Fincham's (2008) recommendation of a 60.0% response rate for survey research. This was achieved through efficient data collection planning, effective contact with respondents and proper mapping of dairy farmers. Callbacks were made for non-local respondents.

4.2. Demographic characteristics of respondents

The study sought to identify the demographic characteristics of respondents and respondents' responses were recorded in table 4.1 below

Parameter	**Category**	**Frequency of respondents**	**Percent**
Gender	Males	102	82.3
	Females	22	17.7
	Total	**124**	**100**
Age of respondents	31-35	7	5.6
	36-40	24	19.4
	41 and above	93	75
	Total	**124**	**100**
Education level	Primary	3	2.4
	Secondary	7	5.6
	Diploma/certificates	49	39.5
	Bachelor's degree or higher	65	52.4
	Total	**124**	**100**
Marital status	Single	10	8.1
	Married	108	87.1
	Widowed	3	2.4
	Separated	3	2.4
	Total	**124**	**100**

Source: Field data, 2024

Results from table 4.1 above indicates that the study had a significantly higher number of male respondents (82.3%) compared to females (17.7%). This indicates that livestock management, particularly dairy farming, was more male-dominated in the region. Traditionally, men often play a larger role in commercial agriculture, including cattle management, in rural Uganda. This further indicates that males dominated decision-making, especially in aspects like feeding practices, use of Rumen8 formulations, or overall herd management, which impacts how performance was assessed.

Results also established that majority of the respondents 93 (75%) were 41 years and above, 24 (19.4%) were between 36-40 years and 7 (5.6%) were between 30-35 years of age. This indicates that larger proportion of respondents were older farmers, who were likely to have more experience in dairy farming. Their experience and traditional knowledge influenced how they perceive and adopt innovations like Rumen8-Formulated Balanced Rations. This group had well-established practices for managing lactating cows, and their openness to using balanced rations affected the study's outcomes significantly.

Results from table 4.1 above indicate that majority of the respondents 65 (52.4%) had completed bachelors or higher, 49 (39.5%) had completed diploma/certificate, 7 (5.6%) had completed secondary education and 3 (2.4%) had completed primary. This indicates that all the respondents had acquired a certain level of education and had a better understanding of modern agricultural practices, including the use of Rumen8-Formulated Balanced Rations. This is because education typically correlates with increased access to information, better decision-making, and a greater likelihood of adopting innovations. Educated farmers were more open to trying new feeding

regimens and monitoring their cows' performance closely, understand the scientific rationale behind balanced rations, which influenced their acceptance and proper use of Rumen8.

Results also established that 108 (87.1%) of the respondents were married, 10 (8.1%) were single, 3 (2.4%) were widows and had separated respectively. The overwhelming majority of respondents were married (87.1%) indicating that dairy farming in Rukungiri District was largely managed by married individuals, which suggested that farming was a family or household activity. Married respondents adopted practices that would improve livestock productivity since they often had long-term investment goals for family welfare. In the context of Rumen8-Formulated Balanced Rations, married individuals were more willing to adopt balanced rations to increase milk production and support household income, particularly to sustain their families through dairy farming.

4.2 Level of awareness and utilization of Rumen8 software among dairy farmers in Rukungiri District for formulating balanced rations

One of the modern tools that has gained recognition for assisting farmers in this task is Rumen8 software**,** a decision-support tool designed to help farmers and nutritionists formulate balanced diets for dairy cows. Respondents were asked about the level of awareness and utilization of Rumen8 software among dairy farmers in Rukungiri District for formulating balanced rations and their responses were recorded in tables below.

4.2.1 Number of lactating dairy cows

The study sought to identify the number of lactating dairy cows owned and responses were recorded in table 4.2 below.

Table 4.2 Number of lactating dairy cows

Number of lactating		Frequency	Valid Percent
Valid	1-5	15	12.1
	6-10	24	19.4
	11-20	52	41.9
	21-50	26	21.0
	More than 50	7	5.6
Total		124	100

Source: Field data, 2024

Results indicate that 15 (12.1%) had between 1-5 lactating cows, 24 (19.4%) had between 6-10 lactating cows, 52 (41.9%) had between 11-20 lactating cows, 26 (21.0%) had between 21-50 lactating cows and 7 (5.6%) had more than 50 lactating cows. The largest proportion of farmers (41.9%) had between 11 and 20 lactating cows. This indicates that mid-sized dairy farms were prevalent in the study area. Farms with this number of lactating cows had more organized management practices, including feed formulation strategies. The large representation of farmers with 11-20 cows was significant because this group stands to benefit the most from the adoption of Rumen8-Formulated Balanced Rations. Given the size of their herds, these farmers experienced noticeable improvements in milk production and herd health after using balanced rations consistently. Additionally, managing mid-sized herds was labor-intensive, and Rumen8 software assisted in simplifying ration formulation, thereby improving farm efficiency.

4.2.2 Average milk per cow per day in liters

The study sought to establish the average milk per cow per day in liters and respondents' responses were recorded in table 4.3 below.

Table 4.3: Average milk per cow per day in liters

Average milk per cow per day in liters		Frequency	Percent
Valid	Less than 5	9	7.3
	5-10	100	80.6
	11-15	15	12.1
	Total	124	100

Source: Field data, 2024

Results indicate that 9 (7.3%) obtained an average of less than 5 liter of milk per cow per day, 100 (80.6%) obtained an average between 5-10 liters of milk per cow per day and 15 (12.1%) obtained an average between 11-15 liters of milk per cow per day. The vast majority of farmers (80.6%) report that their lactating cows produce between 5 and 10 liters of milk per day. This range indicates a typical milk production level for crossbreed cows under moderate management practices. Given that the study focuses on assessing the contributions of Rumen8-Formulated Balanced Rations**,** this high percentage indicates that most farmers were achieving average productivity but would benefit from further optimization through improved feeding practices. This is because the use of Rumen8 software helps farmers to fine-tune the nutritional intake of their cows, potentially pushing milk production beyond the 5–10-liter range by addressing deficiencies or imbalances in the cows' diets.

4.2.3 Number of years spent while practicing dairy farming

The sought to determine the number of years spent while practicing dairy farming and their responses were recorded in table 4.4 below

Table 4.4 Number of years spent while practicing dairy farming

Number of years spent while practicing dairy farming		Frequency	Percent
Valid	Between 5-10 years	11	8.9
	More than 10 years	113	91.1
Total		124	

Source: Field data, 2024

Results indicates that 11 (8.9%) of the respondents had spent between 5-10 years while practicing dairy farming whereas 113 (91.1%) had spent more than 10 years. This indicates that a significant majority of respondents (91.1%) had been practicing dairy farming for more than 10 years. This implies that most farmers in Rukungiri District had substantial experience in dairy farming. This is because experienced farmers had developed a good understanding of livestock management practices, including feeding strategies, which were crucial for ensuring the productivity of lactating cows. The high level of experience suggests that these farmers were well-positioned to adopt and benefit from advanced tools like Rumen8-Formulated Balanced Rations.

4.2.4 Analysis of the level of awareness and utilization of Rumen8 software among dairy farmers in Rukungiri District for formulating balanced rations

The results presented in this table 4.5 provide insights into how many dairy farmers in Rukungiri District were aware of the software and to what extent they are actively utilizing it.

Table 4.5: showing frequency, percentage, chi-square and p-value for the analysis of the level of awareness and utilization of Rumen8 software among dairy farmers in Rukungiri District for formulating balanced rations.

Parameters	**Category**	**Frequency**	**Percent**	**Chi-square**	**p-value**
Have you ever heard of Rumen8 software for formulating balanced rations	Yes	124	100	-	0.000
	Total	**124**	**100**		
If yes, where did you first hear about Rumen8 software	Agricultural extension services	71	57.3	7.062	0.001
	Fellow farmers	10	8.1		
	Agricultural workshops or seminars	43	34.7		
	Internet or social media	00	00		
	Agricultural supply stores	00	00		
	Total	**124**	**100**		
Do you use Rumen8 software to formulate rations for your cows	Yes	63	52.5		0.002
	No	57	47.5		
	Total	**124**	**100**		
	Less than 6 months	2	1.6	1.3364	0.0467
	6-12 months	12	10		

If yes, how long have you been using Rumen8 software	1-2 years More than 2 years Non adopters	20 29 57	16.7 24.2 47.5		
	Total	**130**	**100**		
How frequently do you use Rumen8 software to formulate rations	Daily Weekly Monthly Occasionally **Non adopters**	43 12 - 8 57	35.8 10.0 - 6.7 47.5	**4.08**	**0.001**
	Total	**120**	**100**		
Who helps you with using Rumen8 software	I use it by myself Family member Farm worker Agricultural extension officer Non adopters	9 17 30 7 57	7.5 14.2 25 5.8 47.5	1.427	0.003
	Total	**130**	**100**		
Where did you learn to use Rumen8 software	Training session/workshop Agricultural extension services Online tutorials Fellow farmers Self-taught Non adopters	21 37 - 5 00 57	17.5 30.8 - 4.2 00 47.5	**3.561**	**0.0026**
	Total	**120**	**100**		

Source: Field data, 2024

The chi-square test ($\chi^2 = 7.062$, $p = 0.001$) shows a statistically significant relationship between the source of information and awareness of Rumen8 software, since the p-value (0.001) was less than the 0.05 threshold. This implies that farmers' first exposure to Rumen8 was not by chance but

strongly influenced by specific information channels. Agricultural extension services (57.3%) and workshops/seminars (34.7%) were the most influential sources, while fellow farmers played a smaller role (8.1%), and no respondents cited internet/social media or agricultural supply stores. This indicates that structured extension platforms and training events are the most effective pathways for promoting awareness and adoption of Rumen8 among dairy farmers, while digital and commercial channels remain underutilized.

The results (χ^2 test, $p = 0.002$) indicated a statistically significant difference in the use of Rumen8 software among farmers, as the p-value was below the 0.05 threshold. This meant that the observed variation between those who used Rumen8 (52.5%) and those who did not (47.5%) was unlikely to have occurred by chance. The finding suggested that while a slight majority of farmers had adopted the software, nearly half still resisted or faced challenges in its use. This highlighted the need for interventions such as training, awareness campaigns, and technical support to bridge the adoption gap and increase utilization of Rumen8 in ration formulation.

The chi-square test ($\chi^2 = 1.3364$, $p = 0.0467$) indicated a statistically significant variation in the duration of Rumen8 software use among farmers, since the p-value was less than 0.05. The results showed that most adopters had been using Rumen8 for more than 2 years (24.2%), followed by those who had used it for 1–2 years (16.7%) and 6–12 months (10%), while only 1.6% had adopted it within the last 6 months. However, nearly half of the respondents (47.5%) were still non-adopters. This suggested that while the software had gained traction over time, adoption was relatively recent for many farmers and remained limited overall, highlighting the need for continuous training and support to encourage broader and sustained use.

The chi-square test ($\chi^2 = 4.08$, $p = 0.001$) showed a statistically significant difference in the frequency of Rumen8 software use among farmers, since the p-value was below 0.05. The results revealed that the majority of adopters used the software daily (35.8%), followed by weekly users (10.0%) and occasional users (6.7%), while nearly half of the respondents (47.5%) remained non-adopters. The absence of monthly users suggested that those who adopted the software tended to integrate it either regularly (daily/weekly) or sporadically (occasionally). This pattern implied that Rumen8 was highly valuable for frequent users, but the large proportion of non-adopters highlighted the need for further sensitization and support to expand consistent utilization among dairy farmers.

The results indicated that among adopters of Rumen8 software, most farmers relied on farm workers (25%) or family members (14.2%) for assistance, while a smaller proportion used the software independently (7.5%) or received help from agricultural extension officers (5.8%). Nearly half of the respondents (47.5%) were non-adopters. This suggests that successful use of Rumen8 often depends on support from household or farm staff, and limited direct assistance from extension services may constrain adoption. It highlights the importance of providing more structured technical support and training to ensure farmers can effectively use the software themselves.

The chi-square test ($\chi^2 = 3.561$, $p = 0.0026$) indicated a statistically significant variation in how farmers learned to use Rumen8 software, as the p-value was below 0.05. The results showed that most adopters learned through agricultural extension services (30.8%) and training sessions or workshops (17.5%), while a smaller proportion learned from fellow farmers (4.2%) or were self-taught (0%). Nearly half of the respondents (47.5%) were non-adopters. This suggests that structured learning opportunities and extension support were the primary pathways for acquiring

skills in using Rumen8, emphasizing the need to expand these avenues to improve adoption and effective utilization among dairy farmers.

4.3 The perceived benefits and challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers.

The study sought to establish the perceived benefits and challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers and their responses were recorded in table 4.6 and 4.7 respectively.

4.3.1 The perceived benefits associated with implementing Rumen8-formulated balanced rations among dairy farmers.

The table presents an analysis of dairy farmers' perceived benefits associated with implementing Rumen8-formulated balanced rations and their respondents were recorded in table 4.6 below.

Table 4.6: The perceived benefits associated with implementing Rumen8-formulated balanced rations among dairy farmers

Perceived benefits of using Rumen8 software	Frequency		Percent	
	Yes	No	Yes	No
Increased milk yield	96	28	77.4	22.6
Improved cow health	84	40	67.7	32.3
Cost savings on feed	28	96	22.6	77.4
Better reproductive performance	69	55	55.6	44.4
More consistent feed quality	68	56	54.8	45.2
Reduced feeding-related diseases	62	62	50.0	50.0

Results indicate that 96 (77.4%) of the respondents reported an increase in milk yield as a perceived benefit of using Rumen8, 84 (67.7%) perceived improved cow health, 69 (55.6%) reported better reproductive performance in their herds, 68 (54.8%) perceived more consistent feed quality, 62 (50.0%) perceived a reduction in feeding-related diseases and 28 (22.6%) reported cost savings on feed.

4.3.2 Challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers

Table 4.7 Model Summary challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.552[a]	.305	.269	.24400

Results indicate a moderate positive relationship between challenges and the outcome of implementing Rumen8-formulated balanced rations among dairy farmers. The R square, or coefficient of determination, explains 30.5% of the variation in adoption or effectiveness. The adjusted R square, which accounts for multiple predictors, explains 26.9% of the variation. The standard error of the estimate,.24400, indicates a moderate level of precision in predictions, with an average deviation of 0.244 units, indicating a better fit of the model.

Table 4.8 ANOVA of the challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.058	6	.510	8.562	.000[b]
	Residual	6.966	117	.060		
	Total	10.024	123			

a. Dependent Variable: number of years spent while practicing dairy farming

The p-value was 0.000, less than the commonly accepted threshold of 0.05, indicating the model was statistically significant, suggesting that challenges associated with implementing Rumen8-formulated balanced rations had a significant effect on the number of years spent practicing dairy farming. The F-statistic (8.562) and the highly significant p-value (0.000) confirm that the challenges had a significant effect on the dependent variable. However, the relatively small regression sum of squares (3.058) compared to the total (10.024) suggests that while the model was significant, it explains a modest portion of the variation in the years of dairy farming experience.

Table 4.7: Analysis of [challenges] associated with implementing Rumen8-formulated balanced rations among dairy farmers

Challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.217	.089		36.000	.000
	Technical difficulties with the software	-.216	.092	-.370	-2.338	.021
	Difficulty in understanding ration recommendations	.177	.087	.310	2.032	.044
	High cost of recommended ingredients	-.109	.070	-.191	-1.549	.124
	Lack of technical support	.250	.091	.425	2.738	.007
	Limited access to necessary technology (computer/smartphone	.042	.079	.074	.531	.036
	Resistance to change from traditional methods	-.345	.066	-.578	-5.261	.000

a. Dependent Variable: number of years spent while practicing dairy farming

Results established significant challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers as technical difficulties with the software (P=0.021), Difficulty in understanding ration recommendations (p=0.044), lack of technical support (p=0.007), resistance to change from traditional methods (p=0.000) limited access to necessary

technology (computer/smartphone) (p=0.036) and least significant challenges as high cost of recommended ingredients (p=0.124).

4.4 Factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers

The are different factors influencing the adoption of Rumen8 formulated balanced rations among dairy farmers and analysis of these factors are listed below.

Table 4.7: Model Summary of factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.847[a]	.717	.710	.36426

The model summary indicates that the factors influencing the adoption or rejection of Rumen8-formulated balanced rations had a strong positive relationship with the outcome, as reflected by the high R value (0.847**).** The R value of 0.847 indicates a strong positive relationship and suggests that the factors included in the model had a strong influence on whether farmers adopt or reject Rumen8-formulated balanced rations. The R Square (0.717) also known as the coefficient of determination indicates that 71.7% of the variation in the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers is explained by the factors included in the model.

Table 4.8 ANOVA of the factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	114.726	9	12.747	96.073	.000[b]
	Residual	45.245	341	.133		
	Total	159.972	350			

The ANOVA results indicate that the model was highly significant in explaining the factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers. The large F-statistic (96.073) and the p-value of 0.000 confirm that the independent variables (factors) collectively had a strong effect on the use of Rumen8 software.

Table 4.9: Analysis of the factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers

Factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers.	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.900	.205		4.386	.000
Access to information	1.496	.416	.386	3.597	.000
Understanding of Benefits	.911	.060	1.112	15.059	.000
Farm size	.042	.093	.033	.457	.648
Income levels	.050	.391	.013	.128	.006
Education levels and availability of trainings	-.110	.136	-.060	-.811	.008
Peer Influence	-.349	.103	-.245	-3.398	.001
Extension services	-.528	.059	-.529	-9.015	.000

Results established the most significant the factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers as access to extension services (P=0.000), peer influence (p=0.001)**,** education levels and availability of trainings (p=0.008), Income levels (p=0.006), access to information (p=0.000), understanding software benefits (p=0.000) and the leas significant factor as farm size (p=0.648).

CHAPTER FIVE: DISCUSSION OF THE FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the discussion of the findings, conclusions and recommendations

5.1 Discussion of the findings

Discussion of the findings was dealt with basing of the study objectives

5.1.1 The level of awareness and utilization of Rumen8 software among dairy farmers in Rukungiri District for formulating balanced rations.

Results established that all the respondents all 124 respondents (100%) have heard of the Rumen8 software for formulating balanced rations. The p-value of 0.000 indicates statistical significance, affirming that the observed result (100% awareness) however results also shows that awareness alone did not necessarily translate into actual utilization. Results also established that 71 (57.3%) of the respondents heard about Rumen8 software from agriculture extension services, 10 (8.1%) mentioned fellow farmers, 43 (34.7%) revealed agricultural workshops or seminars, none mentioned internet or social media and agricultural supply stores respectively. During an interview one of the agriculture extension workers had this to say;

"*Despite the high level of awareness about the Rumen8 software among dairy farmers, adoption and utilization is still low due to disconnect which is common in many agricultural technologies and innovations, where farmers would knowledgeable about a tool but face challenges in adopting it"*

This is in line with Kaur *et al.*, (2023) who pointed out that awareness of digital tools like Rumen8 among European dairy farmers is increasing but remains relatively low compared to traditional methods of ration formulation due to different barriers such as cost, technical complexity, and resistance to change were identified as key factors hindering widespread adoption.

Results shows that 52.5% of respondents used Rumen8 software for cow ration formulation, indicating a positive response to the software. However, 47.5% did not use Rumen8, indicating barriers such as limited access to technology, lack of training, resistance to change, or satisfaction with traditional feeding methods.

During an interview one of the farmers had this to say;

"Although we were trained on the benefits of Rumen8 software in enhancing our productivity, adopting it is still challenge since we still lack enough capital to acquire the different ingredients required" This can be compared to Ndambi *et al.,* (2020) who pointed out that while awareness levels are improving, the actual utilization of Rumen8 software among European dairy farmers is still limited.

Results show that 2 (1.6%) of farmers had spent less than 6 months while using Rumen8 software, 12 (10%) had spent between 6-12 months, 20 (16.7%) had spent between 1-2 years and 29 (24.2%) had spent more than 2 years and 57 (47.5%) who were aware had not used the software. Results indicate that the adoption of the Rumen8 software was still relatively new for many farmers, with only a small percentage having used it for longer than two years. Most farmers had adopted the software within the last two years. The higher percentages in the categories "1-2 years" and "more than 2 years" (16.7% and 24.2%, respectively) indicate that there is a growing base of users who

are becoming familiar with the software over time. However, the small percentages of users in the "less than 6 months" and "6-12 months" categories implies that recent adoption rates were low.

Results shows that a small percentage of farmers use Rumen8 software independently, indicating a strong digital literacy and familiarity with the software. 14.2% relied on family members for assistance, suggesting some farmers preferred to share responsibility. 25% relied on farm workers, possibly due to time constraints or lack of technical skills. 5.8% were assisted by agricultural extension officers, highlighting the role of external support systems in promoting and facilitating the use of Rumen8, but a low percentage suggested limited direct involvement due to resource constraints or personnel shortages. This can be compared with Marinchenko (2021) who pointed out that to enhance the awareness and utilization of Rumen8 software among dairy farmers in Uganda, it is essential to focus on capacity building through training programs, workshops, and demonstrations. Collaboration between government agencies, agricultural institutions, and technology providers can facilitate the dissemination of information and resources needed for successful implementation.

Results indicate that a small percentage of respondents (17.5%) learned about Rumen8 through structured training or workshops, suggesting that formal efforts had not reached a large proportion of farmers. The majority (30.8%) learned about Rumen8 through agricultural extension services, highlighting the importance of extension officers in promoting technology use in farming. However, there was a lack of online tutorials and self-taught learning, suggesting limited digital literacy or in-person learning preferences. A small percentage of respondents 5 (4.2%) learned from their peers, indicating the need for more structured peer-learning. This is in line with MAAIF (2021) which stated that awareness levels regarding Rumen8 software among dairy farmers in

Uganda vary. Some farmers are well-informed about the benefits of using Rumen8 for ration formulation, while others lack knowledge about its existence or functionalities. Factors influencing awareness include access to information, training programs, and extension services provided by agricultural organizations.

5.1.2 The perceived benefits and challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers in Rukungiri District.

5.1.2.1 The perceived benefits associated with implementing Rumen8-formulated balanced rations among dairy farmers in Rukungiri District

Results indicate that 96 (77.4%) of respondents reported that use of Rumen8 software leads to an increase in milk yields. This is because One of the core benefits of Rumen8 is its ability to ensure that cows receive balanced rations rich in energy, protein, fiber, vitamins, and minerals. Balanced nutrition has a direct effect on milk production, as underfeeding or overfeeding certain nutrients that compromise a cow's health and productivity. This results in enhanced milk production because the cows receive rations that promote better digestion, efficient nutrient absorption, and overall health, all of which are critical for high milk yields. During an interview one of the agriculture extension workers had this to say;

"*Rumen8 assists in calculating the optimal amounts and proportions of feeds, ensuring that cows convert their feed more efficiently into milk"* This is in line with Nakalembe *et al.* (2020) who pointed out that the use of Rumen 8 in dairy cows resulted in increased milk yield and improved feed efficiency.

Results established that 84 (67.7%) use of rumen8 software results to improved cow health. This is because Rumen8 calculates the ideal ratios of proteins, carbohydrates, fats, minerals, and vitamins in the feed, which are critical for maintaining cow health. An imbalance, such as too much energy or too little protein, leads to health problems like ketosis or acidosis. The use of the software enables farmers to prevent such imbalances, promoting better overall health and reducing the risk of disease. During an interview one of the agriculture extension workers had this to say;

"Nutrient deficiencies, such as calcium, phosphorus, or vitamin D, result in serious health issues like milk fever, lameness, and reproductive problems. The software helps farmers address these deficiencies by formulating diets that contain the necessary micronutrients for maintaining strong bones, a healthy immune system, and proper metabolic function. This reduces the likelihood of nutritional disorders, which directly affects cow health"

This is in line with Kugonza *et al.* (2021) who pointed out that Rumen8 assists in striking nutrient imbalance by recommending the right levels of digestible and indigestible fibers. This enhances rumen activity, promotes better digestion, and helps avoid issues like bloating or ruminal acidosis, which can arise from feeding too much starch or low-quality fiber hence improving cow health.

Results established that 69 (55.6%) of the respondents reported that Rumen8 leads better reproductive performance in their herds. This is because cows that are well-nourished recover more quickly after calving and return to estrus sooner, which allows them to conceive earlier. The software's formulations ensure that cows receive the energy and nutrients needed for post-calving recovery, reducing the risk of postpartum complications such as milk fever or ketosis, which can delay the cow's return to estrus. This is in line with Abdela *et al.* (2019) who pointed out that Rumen8-formulated balanced rations ensure that cows receive adequate levels of protein, energy,

vitamins, and minerals, thereby reducing the risk of nutritional deficiencies and associated health issues.

Result indicates that 28 (22.6%) of the respondents reported that Rumen8 leads to cost savings on feed. This is because overfeeding not only wastes feed but also lead to health problems and poor productivity. Farmers using Rumen8 precisely control the amount of each feed ingredient, reducing unnecessary feed costs. The 22.6% of respondents who reported cost savings were those who had optimized their feed usage through the software, leading to reduced feed expenses without compromising cow health or productivity. Rumen8 allows farmers to explore cost-effective feed options while maintaining nutritional balance. By inputting different local feed ingredients into the software, farmers identify affordable alternatives that meet the cows' nutritional requirements. This can be compared with Olorunju *et al.* (2018) who pointed higher milk production, improved feed efficiency, and reduced incidence of health problems can contribute to increased revenue and reduced production costs, resulting in higher profits for farmers.

5.1.2.2 Challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers

Results established technical difficulties with the software among the most significant challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers since the p-value was less than 0.05 ($p=0.021$). Technical difficulties arise from various factors, including user unfamiliarity with the software, limited access to digital resources, inadequate training, or software usability issues such as complex interfaces or bugs. These difficulties hinder the effective adoption and utilization of the Rumen8 software, thereby affecting farmers' ability to formulate

and implement balanced rations for their dairy cows. As a result, the intended benefits of improving cow performance through tailored nutrition might not be fully realized.

During an interview one of the respondents had this to say;

"*Technical issues with the software may hinder farmers from fully adopting the Rumen8 tool, reducing its potential benefits. Without proper use, dairy farmers cannot be able to achieve the optimal feed formulation, which is essential for enhancing milk production and overall cow performance. This could limit the software's effectiveness in improving agricultural productivity and food security"*

This is in line with Richards *et al.* (2015) who pointed out that implementing Rumen8-formulated balanced rations requires a certain level of knowledge and expertise in animal nutrition. Lack of proper training among dairy farmers can hinder their ability to accurately formulate and administer these rations, leading to suboptimal results.

Results established difficulty in understanding ration recommendations among the most significant challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers since the p-value was less than 0.05 ($p=0.044$). This is because Ration formulation is a scientifically complex process, requiring careful consideration of a cow's nutritional needs based on factors such as stage of lactation, age, weight, and health condition. Rumen8 generates recommendations that are based on sophisticated algorithms to ensure optimal nutrition. During an interview one of the agriculture extension workers had this to say;

"*The difficulty in understanding ration recommendations also stem from the fact that the recommendations provided by Rumen8 would not always align with local feeding practices, available resources, or the farmers' contextual knowledge. For instance, if the software suggests*

specific feed types or supplements that are either unavailable or expensive in the farmer's locality, the recommendations may seem impractical or confusing" This is in line with Richards *et al.,* (2016) further revealed that Rumen8 formulations are designed to optimize rumen function, but many dairy farmers may not have a deep understanding of rumen physiology and how different ingredients affect rumen health. Lack of knowledge about the principles underlying Rumen8 formulations can hinder farmers' ability to effectively implement balanced rations.

Results established resistance to change from traditional methods among the most significant challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers since the p-value was less than 0.05 (p=0.000). Many farmers, especially in rural settings, have developed strong attachments to traditional farming methods that have been passed down through generations. These practices, although familiar are not the most efficient or scientifically grounded in terms of optimizing dairy cow nutrition. The resistance to shift from these customary methods indicates that farmers are hesitant to adopt practices that seem unfamiliar or complex, even when presented with evidence of their potential benefits. This can be compared with Muia *et al.,* (2011) the reluctance to adopt Rumen8-formulated balanced rations are also driven by a perceived risk. Farmers often fear that moving away from established practices may lead to negative outcomes, such as reduced milk yields, increased costs, or even loss of livestock. Despite the potential advantages of Rumen8, these perceived risks create uncertainty.

Results established limited access to necessary technology (computer/smartphone among the most significant challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers since the p-value was less than 0.05 (p=0.036). Rural farming communities, where many dairy farmers are based, often face significant technological limitations. Many farmers lack access to the computers or smartphones needed to run software like Rumen8, making it difficult

for them to integrate such digital solutions into their farming practices. This digital divide, driven by factors such as geographical isolation, lack of infrastructure, and lower income levels, prevents farmers from benefiting from technology-driven innovations that can improve their efficiency and productivity. This can be compared to Purcell *et al.,* (2016) who revealed that implementing Rumen8-formulated rations may be perceived as complex or challenging by some farmers, particularly those with limited experience or expertise in animal nutrition. The need to understand rumen physiology, formulate balanced rations, and monitor cattle performance according to Rumen8 principles can seem daunting, leading to resistance to change.

5.1.3 Factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers in Rukungiri District

Results established access to extension services most significant the factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers since the p-value is less than 0.05 (P=0.000). This is because extension services act as the primary conduit for knowledge transfer from research and technology developers to farmers. In the case of Rumen8-formulated balanced rations, extension agents help farmers understand the benefits of using the software, provide guidance on how to implement it, and address any concerns or difficulties faced during its use. During an interview one of the agriculture extension workers confirmed this when he said this;

"For many farmers, particularly those in rural or under-resourced areas, the technical knowledge required to use digital tools like Rumen8 is a significant barrier. Extension agents help bridge this knowledge gap by simplifying complex technical information and demonstrating the practical applications of such tools. They play a key role in ensuring that farmers are not only aware of the

technology but also understand how to use it to optimize feed formulations for improved dairy production"

This is in agreement with Ndambi *et al.,* (2018) who pointed out that access to educational resources and technical support on the proper use of Rumen8 from extension workers can positively impact adoption rates among dairy farmers. Educational support in agriculture encompasses various initiatives aimed at providing farmers with knowledge, skills, and resources to enhance their decision-making processes.

Results established peer influence most significant the factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers since the p-value is less than 0.05 (P=0.001). This is because farmers often rely on their peers for advice, guidance, and validation when adopting new practices. In many agricultural communities, the experiences and opinions of fellow farmers carry significant weight, especially when it comes to adopting new technologies such as Rumen8. Farmers are more likely to try a new tool or method if they see others in their community successfully using it. During an interview one of the local leaders had this to say;

"Peer influence helps reduce the perceived risk of adopting new technologies like Rumen8. Dairy farmers, particularly those with limited resources, may view technology adoption as a risky investment, as it requires both time and financial resources. However, when farmers observe their peers successfully using Rumen8 to formulate balanced rations and improve livestock performance, they gain confidence that the tool is effective and worth the investment"

This is in agreement with Corea *et al.,* (2017) who pointed out that farmers often trust and rely on the experiences and recommendations of their peers. Positive testimonials or success stories shared

within social networks can encourage adoption, while negative experiences or skepticism can lead to rejection.

Results established education levels and availability of trainings most significant the factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers since the p-value is less than 0.05 (P=0.008). This is because Farmers with higher levels of formal education are generally more likely to adopt new agricultural technologies. Education enhances a farmer's ability to process information, understand complex concepts, and effectively implement modern farming practices. In the case of Rumen8, which is a software-based tool for formulating balanced rations, dairy farmers with higher education levels are likely to better comprehend the technical aspects of the software, such as interpreting nutrient requirements, adjusting feed formulations, and analyzing the expected impact on milk production. During an interview one of the local leaders had this to say;

"Rumen8 requires users to input data and interpret the recommendations provided by the software. Farmers with higher education levels are more likely to be comfortable with these processes, as they may have prior experience with computers, smartphones, or software systems in other contexts. In contrast, farmers with lower education levels might struggle to navigate the software or fully understand the feed recommendations it provides, leading to lower adoption rates"

This is in line with O'Callaghan *et al.,* (2016) who revealed that farmers who are well-informed about the nutritional advantages of such rations are more likely to adopt them. On the other hand, lack of awareness or misconceptions about Rumen8 may lead to skepticism or rejection among dairy farmers. Farmers who have a strong understanding of the nutritional requirements of their dairy herd are more likely to appreciate the benefits of balanced rations.

Results established income levels most significant the factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers since the p-value is less than 0.05 (P=0.006). This is because farmers with higher income levels are generally more capable of investing in new technologies such as Rumen8. The adoption of this software involves not just the initial costs associated with purchasing or subscribing to the service, but also ongoing expenses related to technology maintenance, training, and potential upgrades. For farmers with limited income, these costs can be prohibitive, leading to a reluctance to adopt such innovations. During an interview one of the local leaders had this to say;

"Income levels influence access to complementary resources necessary for the successful implementation of Rumen8. Higher-income farmers are more likely to have access to necessary infrastructure such as reliable internet connectivity, modern computing devices, and technical support, which are critical for using software tools effectively"

This is in line Mpairwe *et al.,* (2017) who pointed out that Income levels influence the ability to access information about new technologies. Higher-income farmers have better access to networks, resources, and information channels that promote the advantages of Rumen8.

Results established access to information among most significant the factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers since the p-value is less than 0.05 (P=0.000). This is because access to information directly influences farmers' awareness and understanding of Rumen8, its functionalities, and its benefits. When farmers have reliable access to information, they are more likely to learn about the software's potential to enhance feed formulation and improve milk production. The availability of information empowers farmers to make informed decisions regarding the adoption of new technologies. During an interview one of the respondents had this to say;

"Farmers who are well-informed about Rumen8 can better understand how the software works, how to implement its recommendations, and the specific advantages of using balanced rations. Conversely, a lack of information can lead to misconceptions, uncertainties, and ultimately, rejection of the technology"

This is in line with Richards *et al*., (2016) who pointed out that the type of information available to farmers plays a crucial role in their decision-making process. Key information sources may include extension services, agricultural training programs, peer networks, and media outlets. Effective information dissemination must cover various aspects, such as the technical capabilities of Rumen8, success stories from other farmers, and the economic benefits associated with its use.

5.2 Summary of the findings

The study found that 124 respondents (100%) have heard of Rumen8 software for formulating balanced rations, but its actual utilization remains low due to barriers such as cost, technical complexity, and resistance to change. The majority of respondents heard about Rumen8 from agriculture extension services, fellow farmers, workshops, and seminars. However, only 52.5% of respondents used Rumen8 for cow ration formulation, indicating a positive response. Barriers such as limited access to technology, lack of training, resistance to change, and satisfaction with traditional feeding methods hindered widespread adoption. Most farmers had adopted Rumen8 within the last two years, with higher percentages in the "1-2 years" and " 5.8% were assisted by agricultural extension officers. To enhance awareness and utilization of Rumen8 software among dairy farmers in Uganda, capacity building through training programs, workshops, and demonstrations is essential.

Results indicate that dairy farmers are overwhelmingly positive about Rumen8-formulated balanced rations, with 77.4% reporting increased milk yield and improved cow health, while over

half noted enhanced reproductive performance, feed quality, and reduced feeding-related diseases, indicating its potential for improved productivity.

Results established that dairy farmers faced challenges in implementing Rumen8-formulated balanced rations, including resistance to change, technical difficulties, and lack of support. Limited access to technology and high ingredient costs also hinder adoption. Addressing both technological and behavioral barriers is crucial for successful implementation.

The study found that access to extension services, peer influence, education, training opportunities, and income levels significantly influence the adoption of Rumen8-formulated balanced rations among dairy farmers. Farm size was found to be less significant, suggesting the need for targeted interventions

5.3 Conclusion

The study concludes that although awareness of Rumen8 software among farmers in Rukungiri District is universal (100%), its actual utilization remains limited, with only 52.5% adopting it for ration formulation due to barriers such as high costs, technical complexity, lack of training, and preference for traditional methods. Most adopters are relatively new users, having started within the past two years, with agricultural extension services, workshops, and peer influence being the main sources of information. These findings highlight the need for increased capacity building through targeted training, demonstrations, and farmer-to-farmer learning to overcome adoption barriers and enhance the effective use of Rumen8 in improving dairy production and productivity. The study concludes that Rumen8-formulated balanced rations can improve dairy productivity, but adoption is hindered by resistance, technical difficulties, limited technology access, high ingredient costs, and inadequate support services.

The study concludes that adoption of Rumen8-formulated balanced rations among dairy farmers is largely driven by access to extension services, peer influence, education, training opportunities, and farmers' income levels, while farm size plays a minimal role. This indicates that improving farmer knowledge, creating more training avenues, and strengthening extension support are more critical than focusing on herd or land size.

5.4 Recommendations

The study recommends that government, NGOs, farmers organisations should;

Provide training program aims to equip dairy farmers with the use of Rumen8 software, incorporating hands-on workshops and practical demonstrations to enhance their confidence in ration formulation.

Launching awareness campaigns highlighting the benefits of using Rumen8 software for formulating balanced rations. Utilize local radio stations, community meetings, and agricultural fairs to reach a wider audience.

Create forums for farmers to share their experiences and best practices related to Rumen8 software and balanced rations. Peer-to-peer learning can enhance adoption and utilization.

Investigate the potential for financial support or incentives for farmers who adopt Rumen8-formulated rations, such as subsidies or low-interest loans for purchasing feed ingredients.

5.5 Area for further research

Comparing Rumen8 rations vs farmer-practice rations across multiple herds in Rukungiri District, Southwestern Uganda.

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APPENDICES

APPENDIX I: QUESTIONNAIRE FOR DAIRY FARMERS

Dear Sir/Madam,

My name is Atukunda Joan, a student from Bishop Stuart University pursuing a degree of Master of Agriculture and Rural Innovations. Thank you for taking the time to participate in this study. The purpose of this survey is to assess the contributions of Rumen8-Formulated Balanced Rations on the Performance of Lactating Crossbreed Cows in Rukungiri District, Southwestern Uganda. All responses will be kept confidential and anonymous.

DEMOGRAPHIC CHARACTERICS

1. Gender

(a) Male ☐ (b) Female ☐

2. Age

(a) 20 – 25 ☐ (b) 26 – 30 ☐ (c) 31 – 45 ☐

(d) 36 – 40 ☐ (e) 41 and above ☐

3. Education level

(a) No formal education ☐ (b) Primary school ☐ (c) Secondary school ☐

(d) Diploma/certificate ☐ (e) Bachelor's degree or higher ☐

4. Marital status

(a) Married ☐ (b) single ☐ (c) widowed ☐ (d) separated ☐

Section b: level of awareness and utilization of Rumen8 software among dairy farmers in Rukungiri District for formulating balanced rations?

5 How many lactating cows do you currently have?

(a)1-5 ☐ (b) 6-10 ☐ (c)11-20 ☐ (d)21-50 ☐ (e)More than 50 ☐

6. What is the average milk yield per cow per day (in liters)?

(a)Less than 5 ☐ (b)5-10 ☐ (c)11-15 ☐ (d)16-20 ☐ (e)More than 20 ☐

7. Have you ever heard of Rumen8 software for formulating balanced rations?

(a)Yes ☐ (b) No ☐

8. if yes, where did you first hear about Rumen8 software?

(a)Agricultural extension services ☐ (b) Fellow farmers ☐

(c)Agricultural workshops or seminars ☐ (d) Internet or social media ☐

(e)Agricultural supply stores ☐ (f) Other (please specify): _____

9. Do you use Rumen8 software to formulate rations for your cows?

(a)Yes ☐ (b)No ☐

10. If yes, how long have you been using Rumen8 software?

(a)Less than 6 months ☐ (b)6-12 months ☐ (c)1-2 years ☐ (d)More than 2 years ☐

11. How frequently do you use Rumen8 software to formulate rations?

(a)Daily ☐ (b)Weekly ☐ (c)Monthly ☐ (d)Occasionally ☐

12. Who helps you with using Rumen8 software?

(a)I use it by myself ☐ (b)Family member ☐ (c)Farm worker ☐

(d)Agricultural extension officer ☐ (e)Other (please specify): _____

13.How would you rate the ease of use of Rumen8 software?

(a)Very easy ☐ (b)Easy ☐ (c)Moderate ☐ (d)Difficult ☐ (e)Very difficult ☐

14. How do you access Rumen8 software?

(a)Personal computer ☐ (b)Smartphone ☐ (c)Tablet ☐

(d)Other (please specify): _____

15. Where did you learn to use Rumen8 software?

(a)Training session/workshop ☐ (b)Agricultural extension services ☐ (c)Online tutorials

(d)Fellow farmers ☐ (e) Self-taught ☐ (f) Other (please specify): _____

Section c: The perceived benefits and challenges associated with implementing Rumen8-formulated balanced rations among dairy farmers in Rukungiri District?

16.What benefits have you observed since using Rumen8-formulated rations? (Select all that apply)

(a)Increased milk yield ☐ (b)Improved cow health

(c)Cost savings on feed ☐ (d)Better reproductive performance ☐

(e)More consistent feed quality ☐ (f)Reduced feeding-related diseases ☐

(g) Other (please specify): _____

17. How has Rumen8 software impacted your farm's productivity?

(a)Significantly improved ☐ (b) Somewhat improved ☐ (c)No impact ☐

(d)Somewhat decreased ☐ (e)Significantly decreased ☐

18. How would you rate the overall effectiveness of Rumen8 software in improving your farm's performance?

(a)Very effective ☐ (d)Effective ☐ (c)Neutral ☐ (e)Ineffective ☐

(f) Very ineffective ☐

19. Would you say that using Rumen8 has improved your cows' overall health?

(a)Strongly agree ☐ (b)Agree ☐ (c)Neutral ☐ (d)Disagree ☐ (e)Strongly disagree ☐

20.What challenges have you faced while using Rumen8-formulated rations? (Select all that apply)

(a)Technical difficulties with the software ☐

(b)Difficulty in understanding ration recommendations ☐

(c)High cost of recommended ingredients ☐ (d)Lack of technical support ☐

(e)Limited access to necessary technology (computer/smartphone) ☐

(d)Resistance to change from traditional methods ☐

(e)Other (please specify): _____

21 How often do you encounter technical issues with Rumen8 software?

(a)Very frequently ☐ (b)Frequently ☐ c)Occasionally ☐ (d)Rarely ☐ (e)Never ☐

22.Do you feel that the cost of the ingredients recommended by Rumen8 is justifiable?

(a)Yes, completely ☐ (b)Yes, to some extent ☐ (c)Neutral ☐

(d)No, not really ☐ (e)No, not at all ☐

23.How easy is it for you to obtain the ingredients recommended by Rumen8?

(a)Very easy ☐ (b)Easy ☐ (c)Moderate ☐ (e)Difficult ☐ g)Very difficult ☐

24.How well do you understand the nutritional recommendations provided by Rumen8?

(a)Completely understand ☐ (b)Mostly understand ☐ (c)Neutral ☐

(d) Slightly understand ☐ (e)Do not understand at all ☐

25.What type of support would help you better utilize Rumen8 software? (Select all that apply)

(a)More training sessions/workshops ☐ (b)Improved technical support ☐

(c)More training sessions/workshops ☐ (d)Improved technical support

(e)More user-friendly interface ☐ (f)Access to cheaper ingredients ☐

(g)Peer support groups ☐ (h)Other (please specify): _____

Section d: factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers in Rukungiri District

26. What are the factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers in Rukungiri District?

Factors influencing the adoption or rejection of Rumen8-formulated balanced rations among dairy farmers	**Agreed**	**Not sure**	**Disagreed**
Access to information			
Understanding of Benefits			
Farm Size			
Income levels			
Education levels			
Cost of Adoption			
Peer Influence			
Availability of Training			
Extension Services			
Community Norms			

Thanks for your responses

APPENDICES

Appendix ii: interview guide for agriculture extension workers

Dear Sir/Madam,

My name is Atukunda Joan, a student from Bishop Stuart University pursuing a degree of Master of Agriculture and Rural Innovations. Thank you for taking the time to participate in this study. The purpose of this survey is to assess the contributions of Rumen8-Formulated Balanced Rations on the Performance of Lactating Crossbreed Cows in Rukungiri District, Southwestern Uganda

1. Can you please introduce yourself and describe your role in the community?
2. How long have you been working in the agricultural sector, specifically with dairy farming?
3. How familiar are you with Rumen8-Formulated Balanced Rations?
4. What has been your role in promoting or implementing Rumen8-Formulated Balanced Rations among dairy farmers?
5. Based on your observations, what are the main benefits of using Rumen8-Formulated Balanced Rations for lactating crossbreed cows?
6. Have you noticed any changes in milk yield among farmers who have adopted Rumen8? Please elaborate.
7. How has the health of lactating crossbreed cows improved with the use of Rumen8?
8. What percentage of farmers in your area have adopted Rumen8-Formulated Balanced Rations?
9. What factors do you believe influence farmers' decisions to adopt or reject Rumen8?
10. What are the main challenges farmers face when adopting Rumen8-Formulated Balanced Rations?

11. How has the adoption of Rumen8 affected the economic performance of dairy farms in terms of profitability and cost savings?
12. Do farmers report any financial constraints that prevent them from using Rumen8?
13. What kind of training or support have farmers received to effectively use Rumen8-Formulated Balanced Rations?
14. How effective do you think these training sessions have been?
15. How has the adoption of Rumen8 impacted the local community in terms of employment or other socio-economic factors?
16. Have there been any noticeable environmental impacts from the use of Rumen8, either positive or negative?
17. What feedback have you received from farmers regarding Rumen8-Formulated Balanced Rations?
18. What recommendations would you make to improve the adoption and effectiveness of Rumen8 in the district?
19. How can local leaders and extension workers better support the use of Rumen8 among dairy farmers?
20. What do you see as the future of Rumen8-Formulated Balanced Rations in your district?
21. Are there any upcoming initiatives or plans to further promote the use of balanced rations like Rumen8?
22. Closing
23. Is there anything else you would like to add about the impact of Rumen8-Formulated Balanced Rations on dairy farming in Rukungiri District?

Appendix iii: Consent Form for Research Participants

Title of the Study. Assessing the Contributions of Rumen8-Formulated Balanced Rations on the Performance of Lactating Crossbreed Cows in Rukungiri District, Southwestern Uganda

Principal Investigator: Atunkunda Joan

Introduction.

You are invited to participate in a research study that aims to evaluate the impact of Rumen8-Formulated Balanced Rations on the performance of lactating crossbreed cows in Rukungiri District. Your participation is voluntary and will provide valuable insights into the effectiveness of Rumen8 in improving dairy farming practices.

Purpose of the Study:

The purpose of this study is to assess the contributions of Rumen8-Formulated Balanced Rations on milk yield, cow health, and overall economic performance of dairy farms in Rukungiri District.

Procedures.

You will be asked to;

Complete a questionnaire or participate in an interview lasting approximately 30-45 minutes.

Provide information on your experiences and observations related to the use of Rumen8-Formulated Balanced Rations.

Allow the researchers to collect data on the performance of your lactating crossbreed cows, if applicable.

Potential Risks and Discomforts.

There are no known risks associated with participating in this study. However, if you feel uncomfortable with any question, you may choose not to answer or to withdraw from the study at any time.

Potential Benefits

While there may be no direct benefits to you, your participation will contribute to a better understanding of the effectiveness of Rumen8-Formulated Balanced Rations, which could lead to improved dairy farming practices and benefits for the broader farming community.

Confidentiality.

All information collected in this study will be kept confidential. Your identity will not be revealed in any reports or publications resulting from this study. Data will be stored securely and only accessed by the research team.

Voluntary Participation.

Your participation in this study is entirely voluntary. You may refuse to participate or withdraw from the study at any time without any penalty or loss of benefits to which you are otherwise entitled.

Participant's Statement.

I have read and understood the information provided above. I have had the opportunity to ask questions and have received satisfactory answers. I understand that my participation is voluntary and that I can withdraw at any time without penalty. I consent to participate in this study.

Participant's Name: _____

Participant's Signature: _____

Date: _____

Investigator's Statement.

I have explained the study to the participant and have answered all questions. I will honor all the commitments made in this consent form.

Investigator's Name: _____

Investigator's Signature: _____

Date: _____

Appendix v: Community engagement plan, Covid-19 mitigation plan and Ebola mitigation plan.

Stakeholder Identification: key stakeholders within the community will be identified and be informed and involved in the research process.

Community Sensitization: Research materials (e.g., brochures, posters) explaining the purpose of the research, its benefits, and the importance of participation will be developed

Community Meetings: informational meetings to explain the research objectives, methods, and expected outcomes to community members will be organized and questions and discussions will be allowed.

Local Language Use: All communication materials will be translated into local languages for better understanding and inclusivity.

Inclusivity: potential cultural sensitivities and local customs and practices will be addressed and respected

Feedback Mechanism: A channel for community members to provide feedback will be established to ask questions, and express concerns throughout the research process.

Ethical Considerations: issues related to informed consent, privacy, confidentiality, and data sharing with the community will be considered.

COVID-19 Mitigation Plan

Health and Safety Measures: The measures to prevent the spread of COVID-19 during survey activities, including mask-wearing, hand hygiene, and social distancing will be outlined.

Personal Protective Equipment (PPE): The types of PPE required for both researchers and respondents (masks, gloves, face shields will be specified.

Health Screening: The process for health screening of researchers and respondents before each survey activity will be described.

Limited Contact: Physical contact during surveys by using digital tools, maintaining distance, and avoiding handshakes will be minimized.

Sanitization: Guidelines for sanitizing survey materials, equipment, and commonly touched surfaces will be provided.

Contingency Plans: Steps to take if a participant or researcher shows COVID-19 symptoms during the research will be detailed.

Ebola Mitigation Plan

Awareness: The researcher and respondents will be educated about the signs, symptoms, and prevention of Ebola.

Health Checks: Procedures for daily health checks of the researcher and respondents, including temperature monitoring will be established.

Hand Hygiene: The importance of frequent hand washing and provide access to hand washing stations will be emphasized.

No Physical Contact: A strict no-contact policy, including avoiding physical contact and maintaining distance during interactions will be enforced.

Avoid High-Risk Areas: high-risk areas or locations with recent Ebola cases will be identified and avoided.

Reporting: The process for reporting any suspected Ebola symptoms among researchers or respondents will be clearly defined.

Health Partnerships: Partnerships with local health authorities to ensure a coordinated response in case of any health-related concerns will be established.

APPENDIX VII: PROPOSED BUDGET

S/N	ITEMS	QUANTITY	UNIT COST	AMOUNT
1.	Stationary	3 reams	25,000	75,000=
2.	Typing and printing			150,000=
3.	Computer software			150,000=
4.	Internet data bundles	20 GBs	5,000	100,000=
5.	REC clearance fees			200,000=
6.	Air time			100,000=
7	Incentives to be given to farms	4	4*50,000	200,000
8	Transport			300,000=
9	Research reports binding	3 books	15,000	45,000=
10	Miscellaneous			300,000=

APPENDIX VIII: WORK PLAN

June 2023: presentation of concept paper

August 2023: development of the research proposal

October 2023: presentation of research proposal

December 2023 - Ethics Approval Submit the research design to the ethics committee for approval

January 2024 - Data Collection: Begin data collection using the approved methods and sampling strategy

February 2024 - Data Analysis: Analyze the data using appropriate analytical techniques

February 2024 - Results Interpretation: Interpret the results of the data analysis and begin drafting the research paper

February 2024 - Drafting of Research Paper: Continue drafting the research paper, including the introduction, literature review, methods, results, and discussion sections.

February 2024 - Review and Edit: Review and edit the research paper for clarity, coherence, and adherence to the research question

March 2024 - Finalization: Finalize the research paper and submit it for publication in a peer-reviewed journal