ECONOMICS OF IMPROVED FODDER PRODUCTION UNDER DIFFERENT PRODUCTION TREATMENTS AT ASAS FARM IN IRINGA REGION, TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL AND APPLIED ECONOMICS OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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EXTENDED ABSTRACT

Tanzania is an agricultural country, and nearly three-fourths of her population depends on agriculture for livelihood. In Tanzania, dairy farmers do not often meet their all-year-round animal feed demand from on-farm production. This is due to several reasons including large livestock numbers for the available fodder and low yields from forages because of the seasonality of rainfall and or poor fodder production practices. Due to the fodder shortage, farmers have engaged in fodder production. Fodder production combined with different agronomic practices has been going on to alleviate the problem in the country. However, there is a paucity of knowledge on the economics of fodder production in the study area. This study was conducted to estimate Rhodes yield and analyze the economics of fodder production under different production treatments (cost-benefit analysis), including Treatment one (T_1) Control, Treatment two (T_2) Cattle Farm Yard Manure (CFYM), Treatment three (T_3) CFYM +Nitrogen, Phosphorus, Sulphur and Zinc (NPSZn), Treatment four (T_4) NPSZn, Treatment five (T_5) NPSZn +Sulphate of Ammonium (SA) and Treatment six (T_6) NPSZn + Urea. Data were recorded from each plot of 0.01 hectares, to establish costs and returns per each 0.01 hectare. Cost-benefit analysis was used to establish costs and benefits accrued per each plot. The findings show that, fodder production by the ASAS Dairies Limited was more beneficial than the alternative source of purchasing it from fodder sellers. Treatment (T_3) which is CFYM+NPSZn and Treatment (T_6) which is NPSZn + Urea of the experiments yielded the highest returns with the Net Present Values (NPVs) of TZS 599 129.6 and TZS 964 429.3 respectively; Benefit Cost Ratio (BCRs) of 1.4 and 1.8 respectively; and Internal Rate of Return (IRR) of 15% and 16% respectively. The two treatment methods also registered higher yields of 16.31 tons per hectare and 20.878 tons per hectare, respectively, compared to other methods of treatment. It is concluded that higher yield is

obtained when Rhodes grass are grown and using Cattle Farm Yard Manure mixed with NPSZn or NPSZn mixed with Urea. It is recommended that with the experiments, companies may produce enough fodder for themselves and extra to sell to other livestock keepers. Moreover, smallholder dairy farmers should embark on improved fodder production systems to bridge the existing dairy feed gap.

DECLARATION

I, Aurelia Issack Mbwaga, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor concurrently being submitted in any other institution.

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Prof. R. Kadigi   Date
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DEDICATION

I dedicate this work to my husband (Raphael), our sons (Henry Kasiga and SantiCazorla) and our daughter (Anna) for their prayers.

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LIST OF ABBREVIATION AND ACRONYMS

BCR	Benefit Cost ratio
CBA	Cost Benefit Analysis
CFYM	Cattle Farm Yard Manure
DAEA	Department of Agricultural Economics and Agribusiness
FAO	Food and Agriculture Organization of the United Nations
FC	Fixed Cost
GDP	Gross Domestic Product
IRR	Internal Rate of Return
MLF	Tanzania Ministry of Livestock and Fisheries
NPSZn	Nitrogen, Phosphorus, Sulphur and Zinc
NPV	Net Present Value
SA	Sulphate of Ammonium
TC	Total Cost
TR	Total Revenue
TSZ	Tanzania Shorthorn Zebu
URT	United Republic of Tanzania
WHO	World Health Organization

CHAPTER ONE

1.0 GENERAL INTRODUCTION

1.1 Background to the Study

Tanzania is an agricultural country with nearly three-fourths of its population depending on crop production and livestock keeping for livelihood (FAO, 2020). The country has the second largest livestock population in Africa of 39.9 million cattle, 99.6 percent of which are indigenous breeds, 24.5 million goats, 8.5 million sheep, 3.2 million pigs, and 87.6 million chickens (URT, 2021). The country also has outstanding natural resources for livestock development, including resilient livestock breeds, extensive rangelands, and diverse natural vegetation. In general, the country has a competitive advantage of a large livestock sector. However, the current opportunities, for example, commercial fodder production or cultivation, within the dairy sector are still under-utilized (URT, 2019). Different reasons for the underutilization of the existing opportunities in the livestock sector in Tanzania are poor genetic potential and long calving interval (Msalya *et al*., 2017; Häsler *et al*., 2019). Furthermore, the livestock sector is the latent sector in the economy. It stimulates an increase of income from sales of milk and milk products and improves people’s living standards through improved nutrition arising from milk consumption (URT, 2011). The sector contributes 6.9 percent to the country’s GDP (URT, 2017a).

Specifically, the dairy industry is a potential subsector in the livestock economy, contributing 30 percent of domestic production in the livestock sector and about 1.2 percent of the national Gross Domestic Product (GDP) (URT, 2017b). Due to economic benefits arising from the livestock sector and dairy industry, companies and individuals have invested in livestock keeping and milk production in Tanzania. Some of these companies include, among others, ASAS Dairies Farm Limited and Tanga Fresh Limited in Iringa and Tanga Regions, respectively. ASAS are involved in keeping dairy cattle, and due to that, they are engaged in fodder production for feeding their cattle. To improve fodder production, they have been experimenting on the best way to improve fodder production.

There are approximately 680 000 dairy cattle in Tanzania mainly crosses of Friesian, Jersey, and Ayrshire breeds with the Tanzania Shorthorn Zebu (TSZ) (Njombe *et al*., 2011). The total annual milk production is currently estimated at 2.7 billion litres (URT, 2019). The traditional sector (indigenous cattle) kept in rural areas produce 70 percent of the milk while the remaining 30 percent comes from better-quality cattle mainly kept by smallholder producers (Njombe *et al*., 2011). However, the number of traditional cattle producing 70 percent of milk is proportionately smaller than the number of improved dairy cattle producing 30 percent of the total milk production (Wassena *et al*., 2015). For example, the majority of indigenous Tanzania Shorthorn Zebu (TSZ) cattle have been shown to produce less than 2 litres of milk per day (Msalya *et al*., 2017) while improved cross breeds of dairy cattle produce between 18 to 45 litres per day. Currently, milk production (2.7 billion litres) is still low in the country because of relative availability and increasing costs of production compared to the per capita milk consumption. Per capita milk consumption is 47 litres per year, which is far less than the World Health Organization (WHO) recommendation of 200 litres per capita (URT, 2019a), animal health and reproductive problems, lack of good quality animal feed in sufficient quantities and limited supply of dairy cattle (Njombe *et al*., 2011; Swai and Karimuribo, 2011; Kabirizi *et al*., 2013; Abdisa, 2018).

For the farmers to increase milk production and their associated by-products, fodder production is important. Producing fodder and other feeds to animals may lead to an increase of 6 to 8 litres per day (URT, 2019a). Similarly, improved milk production may lower the cost per litre produced reflecting a stronger profit margin for commercial milk producers (Sikumba and Maass, 2015; URT, 2019b).

Based on this background information, a study was conducted to investigate the economics of fodder production treatments being experimented at ASAS Dairies Farm Limited in the Iringa Region. Experimental treatments data from the study were used to address the inadequate availability of fodder to both large and smallholder dairy farmers in Tanzania.

1.2 Problem Statement and Justification

Milk production can provide regular cash income (FAO, 2020). Essentially, smallholder farmers produce milk for their consumption and for sale. However, smallholder dairy farmers do not often meet their all-year-round feed demand from on-farm production due to several reasons. Firstly, dairy farming with indigenous cattle involves keeping many livestock, secondly, low yields from available forages due to effects of the seasonality of rainfall and/or poor fodder production practices. Thirdly, inadequate extension services and lastly, inadequate quality and certified forage seed supply (Lukuyu *et al*., 2016a; Waziri and Uliwa, 2020).

The persistence of these challenges, as depicted by Lukuyu *et al*. (2016); Waziri and Uliwa (2020) constrain smallholder dairy farmers from exploiting the available opportunity in dairy subsector and especially poor fodder production which results in low yields (URT, 2015; URT, 2017b). This has severe implications for efficiency, cost and benefits (Mwajombe and Mlozi, 2015; Lukuyu *et al*., 2016).

Along these lines, several other studies have been conducted on dairy farming. A study by Notenbaert *et al*. (2020) focused on environmentally sound intensification pathways for dairy development. Again, MLF (2019) studied livestock sector economics in Tanzania, while, the Ministry of Livestock and fisheries conducted a baseline survey to develop a Tanzania livestock master plan (URT, 2017a). Another study was conducted by Njombe *et al.* (2011) who explored milk and fodder production identification and status in Tanzania.

These studies by Notenbaet *et al*. (2020); MLF (2019); Njombe *et al.* (2011) and URT (2017a), suggested recommendations that include dairy farmers (milk producers) to cultivate fodders to reduce the scarcity of fodders, especially during dry seasons. This would enable them to meet the yearly milk consumption per capita, which is currently about 47 litres of milk, far less than the World Health Organization (WHO) recommendation of 200 litres per capita. Moreover, farmers need to use improved fodder production technologies and fodder conservations (Lukuyu *et al.*, 2016). Considering this view, there have been different efforts by the government of Tanzania and other stakeholders to provide education and emphasize on the fodder production (URT, 2016). ASAS is one of the stakeholders who went further to undertake experiments on different fodder production systems by applying different treatments (for example application of fertilizers) to measure the costs and benefit of producing fodder to increase annual feed availability.

Additionally, there are similar studies that have been conducted on livestock, milk and fodder production (e.g., Lukuyu *et al.*, 2016b; Kashangaki and Ericksen, 2018; Baltussen *et al.*, 2020; Lukuyu *et al.*, 2011, 2017) but have not adequately covered the economics of improved fodder production treatments. Therefore, this study aimed to determine the yield, costs and returns of fodder production treatments being experimented at ASAS Dairies Farm Limited from different treatments. The findings from the experiment provided a way forward for ASAS dairy farms and smallholder dairy farmers to embark on fodder production treatments in order to curb dairy feed deficits, especially during the dry season.

1.3 Objectives of the Study

1.3.1 Overall objective

The overall objective of this study was to:

Examine the economics of improved fodder production under different production treatments in the Iringa Region, focusing on ASAS farm.

1.3.2 Specific objectives

The specific objectives were to:

i) Estimate the fodder yields of different fodder treatments in the ASAS Farm.

ii) Determine the feasibility of various fodder production treatments at the ASAS Farm.

1.3.3 Research questions

The guiding research questions in this study were:

i) How much do fodder yields differ among fodder treatments at ASAS Farm?

ii) What are the costs and benefits of improved fodder production from different fodder treatments at ASAS Farm?

1.4 Conceptual Framework

The conceptual framework as provided by Fig. 1.1 is conceptualized by using the profit maximization model. The costs of production came from the inputs used on the production. From profit maximization theory, the costs from inputs used such as land purchase, seeds, fertilizers, soil testing, cattle farm yards manure and management practices done by labours, costs of carriage, costs of preservation of fodders which all together combined to the total costs of production. From the theory of cost benefit analysis, these costs were discounted to get costs at present value. Total revenue was obtained after estimating the yield from fodder production and the market price of fodders (Rasmussen, 2012; Lukuyu *et al*., 2016a; Waziri and Uliwa, 2020) discounted the expected revenue to get revenue at present value. The viability of the projects is analyzed by different scholars by using costs and benefits analysis (Papendiek *et al*., 2016; Kadigi *et al.*, 2021) to reach the explained decision.

Therefore, to study the economics of fodder production under different production treatments, yields estimation of Rhodes grass and the costs-benefits analysis was necessary.

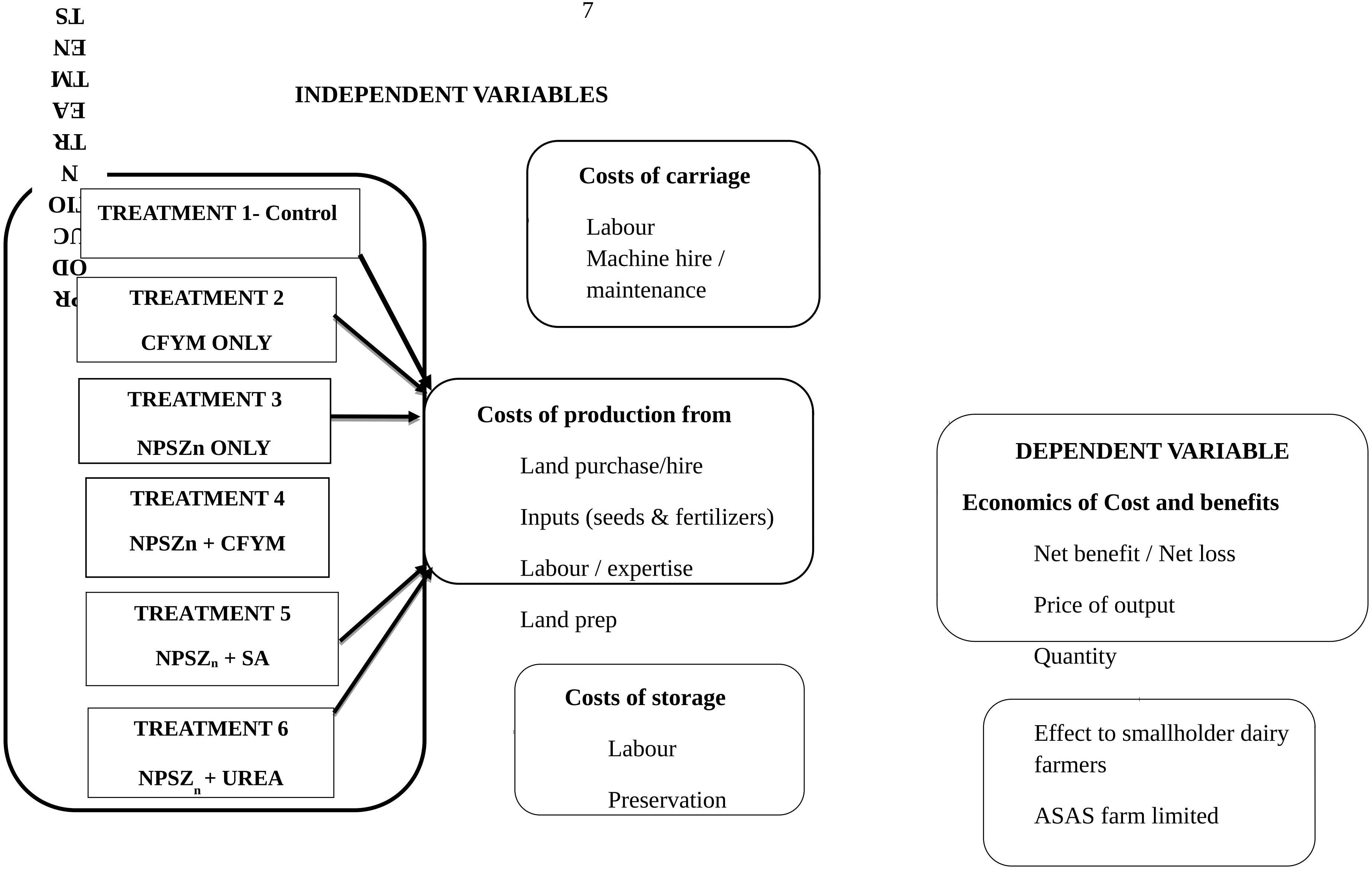

Figure 1.1: Conceptual framework (Researcher’s Own Construct, 2021)

1.5 Organization of the Dissertation

This dissertation is organized into four chapters; chapter one presents background information of the study, problem statement, objectives, research questions, the conceptual framework and organization of the work. Chapter two presenting the estimation of Rhodes grass production, an experimental approach at ASAS farm in Iringa Region. Manuscript two which is in chapter three presenting the Economics of Improved Fodder Production under Different Production Treatment at ASAS farm in Iringa Region, Tanzania, Chapter four presents' conclusions and recommendations.

References

Abdisa, T. (2018). Mechanism of retained placenta and its treatment by plant medicine in ruminant animals in Oromia, Ethiopia. *Journal of Veterinary Medicine and Animal Health* 10(6): 135-147.

Baltussen, W., Berkum, S., Dijkxhoorn, Y., Helmes, R. Özkan, Ş., Vellinga, T. V., Massawe, G., Galgani, P., Borniotto, D., Elzen, F. and Smith, T. (2020). Traditional livestock systems in Tanzania; An application of the TEEB Framework. 98pp.

FAO (2020). Tanzania at a Glance, *FAO.* [http://www.fao.org › tanzania › tanzania-at-a-glance] site visited on 15/11/2020.

Häsler, B., Msalya, G., Roesel, K., Fornace, K., Eltholth, M., Sikira, A. and Grace, D. (2019). Using participatory rural appraisal to investigate food production, nutrition and safety in the Tanzanian dairy value chain. *Global Food Security* 20: 122-131.

Kabirizi, J., Zziwa, E., Mugerwa, S., Ndikumana, J. and Nanyennya, W. (2013). Dry season forages for improving dairy production in smallholder systems in Uganda. *Tropical Grasslands - Forrajes Tropicales* 1(1): 212-214.

Kadigi, W. R., Ngaga, Y. M. and Kadigi, R. M. J. (2021). Economic Viability of Smallholder Agroforestry and Beekeeping Projects in Uluguru Mountains, Tanzania: A Cost Benefit Analysis. *Open Journal of Forestry* 11(2): 83-107.

Kashangaki, J. and Ericksen, P. (2018). Cost–benefit analysis of fodder production as a low emissions development strategy for the Kenyan dairy sector. ILRI Project Report. Nairobi, Kenya: ILRI. 40pp.

Lukuyu, B. (2017). Rhodes Grass. Management, September 2007, 100–100.*Measurement. Australian Journal of Agricultural Economics* 30(1): 219-245.

Lukuyu, B., Franzel, S., Ongadi, P. M. and Duncan, A. J. (2011). Livestock feed resources: Current production and management practices in central and northern Rift valley provinces of Kenya. *Livestock Research for Rural Development* 23(5): 232-239.

Lukuyu, B., Sikumba, G., Baltenweck, I. and Njehu, A. (2013). Costs and benefits analysis of feed technologies promoted by the East Africa Dairy Development Project (EADD): Study conducted in Rwanda, Uganda and Kenya. 19pp.

Lukuyu, B., Romney, D., Ouma, R. and Sones, K. (2016a). Feeding dairy cattle: A manual for smallholder dairy farmers and extension workers in East Africa. Retrieved from [https://cgspace.cgiar.org/handle/10568/478] site visited on 28/11/2020.

Lukuyu, M., Njehu, A., Mwilawa, A. and Lukuyu, B. (2016b). A study to understand fodder markets and fodder trading patterns in More MilkiT sites and other selected regions in Tanzania. [ResearchGate " figure › Map-of-MilkIT-project-sites-in-Tanzania-s] site visited on 12/04/2021.

MLF (2019). *Tanzania Livestock Master Plan*. Tanzania Ministry of Livestock and Fisheries (MLF) and the International Livestock Research Institute (ILRI) livestock master plan team. Nairobi, Kenya. 104pp.

Msalya, G., Chenyambuga, S. W., Laisser, E. L. K., Karimuribo, E. D., Kipanjula, M. J., Mwilawa, A. J., Mdegela, R. H. and Kusiluka, L. J. M. (2017). Tropical Animal Health and Production “A review of prevalence, control measure, and torelence of Tanzania Shorthon Zebu cattle to East Coast fever in Tanzania. [https://journals.plos.org › plosone › article › file.PDF] site visited on 28/11/2021.

Mwajombe, K. K. and Mlozi, M. R. (2015). Measuring farm-level technical efficiency of urban agriculture in Tanzanian towns: the policy implications. *World Journal of Social Science* 2(2): 62-72.

Njombe, A. P., Msanga, Y., Mbwambo, N. and Makembe, N. (2011). United Republic of Tanzania Ministry of Livestock and Fisheries Development the Tanzania Dairy Industry: Status, Opportunities and Prospects. In: *7th African Dairy Conference and Exhibition.* MovenPick Palm Hotel, 25-27 May 2020. pp. 25–27.

Notenbaert, A., Jeroen, C. J., Groot, M. H., Birnholz, C., Birthe, K. P., Pfeifer, C. S., Fraval, M. L., Jamie, N., McFadzean, J. A. J., Dungait, J. M., Ran, Y., Barron, J. and Tittonell, P. (2020). Towards environmentally sound intensification pathways for dairy development in the Tanga region of Tanzania. *Regional Environmental Change* 20: 1-14.

Papendiek, F., Tartiu, V. E., Morone, P. and Venus, J. (2016). Assessing the economic profitability of fodder legume production for green biorefineries – a cost-benefit analysis to evaluate farmers profitability. *Journal of Cleaner Production* 112: 3643–3656.

Rasmussen, S. (2012). *Production Economics: The Basic Theory of Production Optimization*. Springer Science and Business Media, Copenhagen. 287pp.

Sikumba, G. and Maass, B. L. (2015). Effects of season and location on cattle milk produced and producer milk prices in selected villages of Tanga and Morogoro Regions, Tanzania. *Livestock Research for Rural Development* 27(10).

Swai, E. S. and Karimuribo, E. D. (2011). Smallholder dairy farming in Tanzania: Current profiles for developments. *Outlook on Agriculture* 40(1): 21–27.

URT, United Republic of Tanzania (2011). MLFD, "Budget speech and annual estimates of MLFD,." Tanzania Country Report. 80pp.

URT, United Republic of Tanzania (2015). Perspectives on Climate-Smart Agriculture from Across the Globe Tanzania Country Case Study Report. 50pp.

URT, United Republic of Tanzania (2016). Agricultural Sector Development Strategy -II Republic of Tanzania. 97pp.

URT, United Republic of Tanzania (2017a). Tanzania Country Climate Risk Profile Series in Iringa District. 30pp.

URT, United Republic of Tanzania (2017b). Tanzania Livestock Analysis (2016/2017-2031/2032). Ministry of livestock and fisheries. 58pp.

URT, United Republic of Tanzania (2019a). *Livestock and Fisheries Commodity Value Chain Briefs*. Ministry of Livestock and Fisheries, Tanzania. 15pp.

URT, United Republic of Tanzania (2019b). United Republic of Tanzania, Ministry of Livestock and Fisheries (MLF), Ministry Budget Speech. National Livestock Research Agenda. 58pp.

URT, United Republic of Tanzania (2021). Ministry of Livestock and Fisheries, Tanzania Livestock Master Plan (2017/2018 - 2021/2022). [https://webapps.ifad.org › members › docs › EB-20...PDF] site visited on 20/12/2021.

Wassena, F. J., Mangesho, W. E., Chawala, A., Laswai, G. H., Bwire, J. M. N., Kimambo, A. E. and Lukuyu, B. (2015). Effects of season and location on cattle milk produced and producer milk prices in selected villages of Tanga and Morogoro Regions, Tanzania. *Livestock Research for Rural Development* 27(10): 22-27.

Waziri, M. D. and Uliwa, P. (2020). Supply and Commercial Viability of Forage in Tanzania. *American Scientific Research Journal for Engineering, Technology, and Sciences* (*ASRJETS*) 66(1): 145-156.

CHAPTER TWO

2.0 YIELD ESTIMATION OF RHODES GRASS (CHLORIS GAYANA) AT ASAS FARM IN IRINGA REGION, TANZANIA AN EXPERIMENTAL APPROACH

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2.1 Abstract

Shortage of forage, especially during dry seasons despite the presence of conducive environment for growing Rhodes grass in Tanzania prompted for this study. An experiment was conducted at ASAS Dairies farm (Matembo Farm) in Iringa region from December 2020 to April 2021. The objective of the research was to estimate the yield from Rhodes grass production. An experimental plot of 2400m^2 which has 24 plots (six treatments and four replicants) was used and the size of each plot was (10m x10m). The seeds were sown in each plot and fertilizer were applied in T_2 (CFYM), T_3 (CFYM+NPSZn), T_4 (NPSZn), T_5 (NPSZn+SA) and T_6 (NPSZn + Urea) while T_1 remained as a control (no fertilizer) plot. The study was conducted in Complete Randomized Design (CRD). The results revealed that the T_3 (8170.62kg/acre, 3152.51kg/acre, and 2994.68kg/acre) and T_6 (9995.75kg/acre, 4042.82kg/acre, and 3832.38kg/acre) showed significantly high yielding results for green grass, partially dried and totally dried respectively. It can be concluded that, for the purpose of maximum yield of green grass, partially dried and totally dried, the best treatment options are T_3 and $T_{6.}$

Key words: Rhodes grass, Yield estimation, Forage, Treatments.

2.2 Introduction

Rhodes grass (Chloris Gayana) is important and useful forage for pastures and hay, drought resistant and very productive (Ashrad *et al.*, 2016). Rhodes grass is a perennial or annual tropical grass and it originated from Rhodesia, now Zimbabwe and it is widely cultivated as a livestock crop (Ogedegbe and Ewansiha, 2016). Rhodes grass is a summer growing plant which is the best grass for land rotation in tropical and subtropical areas (Yossif and Ibrahim, 2012) and it is suitable for hay making.

Feed scarcity in both qualitative and quantitative dimensions is one of the key barriers to livestock and dairy production in Tanzania (Lukuyu *et al.*, 2016). The quality and quantity of feed resources available to the animals in most parts of the country are mainly affected by different reasons such as seasonality of rainfall (Lukuyu *et al*., 2016; Waziri and Uliwa, 2020). Tanzania has outstanding natural resources for livestock development, including resilient livestock breeds, extensive rangelands, and diverse natural vegetation. Overall, the country has a competitive advantage of a large livestock sector. However, the current opportunities, for example, commercial fodder production or cultivation, within the dairy sector are still under-utilized (URT, 2019). Despite, having outstanding natural resources, still livestock suffers during dry seasons from hunger; however, economic benefits arising from livestock sector are immeasurable (UTR, 2019).

In Tanzania, production of forage is mainly rain fed and is predominantly by large scale producers (Waziri and Uliwa, 2020). However, there are few small-scale producers with less than five acres of land allocated to forage production (URT, 2011). Large scale farms including public and private institutional farms (colleges, university, prison, military) and large company farms produce mainly natural grass mixture and Rhodes grass hay (ASAS, 2020 and Waziri and Uliwa, 2020). In 2016/17, about 1 150 916 bales of hay were produced by public and private farms largely concentrated in Pwani and Tanga, which jointly contributed 64% of the total national hay production (URT, 2017).

Moreover, given the economic benefits arising from the livestock sector and dairy industry, companies and individuals have invested in livestock keeping and milk production in Tanzania. Some of these companies include, among others, ASAS Dairies Farm Limited and Tanga Fresh Limited in Iringa and Tanga Regions respectively. ASAS are involved in keeping dairy cattle, and due to that, they are engaged in fodder production for feeding their cattle. To improve fodder production, ASAS, have been experimenting on the best way to improve fodder production.

Therefore, this study was conducted to estimate the yield of Rhodes grass (Chloris Gayana) at ASAS Farm in Iringa region from different applications of fertilizers. Experimental treatments data from the study area were collected and used to estimate Rhodes grass production in one acre.

2.3 Literature Review

In Rhodes grass production, Rhodes seeds and fertilizers are used. Fertilizer is a very important input which improves yield of a plant. Many studies have investigated fodder production. Muck and Shinner (2001), for example, explored ways to conserve forages for future use in Brazil. Ragkos *et al*. (2015) researched on the dairy farmers' strategies against the crisis and economic performances of farms in Greece. Another study by Lukuyu *et al*. (2016) in Tanzania explored on better ways to feed dairy cattle for more milk. All the reviewed studies recommended smallholders dairy farmers to invest in cultivating forages and learn on ways to conserve them. Msalya *et al*. (2017), in their study on tropical animal health and production, explored those tropical animals faced with limited feeds during the dry season; hence attacked by diseases which led to 6 litres of milk per cow per day from 10 litres. However, there was no enough information on the best approach to be used to increase fodder production in Tanzania.

Moreover, Na-Allah and Bello (2019), in their study conducted in Nigeria, observed that Nitrogen (N) and Phosphorus application to Rhodes grass play a vital role in enhancing fodder production and high yield both in quality and quantity. Yossif and Ibrahim (2013) in their study on the Effects of Organic and Inorganic Fertilizers on Proximate Analysis of Rhodes grass in Sudan did a field experiment composed of three fertilizer treatments 100N/ha as Urea (U) 5 ton of Cattle Farm Yard Manure (CMFY) and Chicken Manure (CHM) with three replications. Treatments were arranged in a Randomized Complete Block Design (RCBD) with 8 cuts and concluded that the best Rhodes grass in terms of quality and quantity comes from the mixture of both three types of fertilizers. Therefore, on this ground, the current study employed experimental data to estimate the fodder production and high yield in quantity by using the CFYM, NPSZn, Urea, and SA.

2.4 Methodology

2.4.1 Research site description and selection criteria

In this study, the experiment was carried out at ASAS Dairy (Matembo) Farm, located in Iringa Region. The rainfall ranges from 600-1 000 millimetres (mm) per annum. The selection of the area was based on the existence of ASAS Dairy farm on which experiments on fodder production treatments were conducted (Appendix 1).

2.4.2 Research design and sampling procedures

This is an experimental (Complete Randomised Design-CRD) type of research whereby six treatments with four random replications were studied by looking at inputs costs used in each treatment to produce fodders (output) out of other agronomic practises. The treatments are assigned to the experimental units at random plots such that each treatment appears in each plot and each plot receives each treatment.

The experiment consisted of twenty-four (24) sub-plots resulting from six (6) treatments with their four (4) replications arranged in a randomised plot of $100m^2$. The treatments included no fertilizer/control, Cattle Farm Yard Manure (CFYM), CFYM mixed with NPSZn, NPSZn mixed with Sulphate of Ammonium and NPSZn mixed with UREA. These treatments were applied on Rhodes's grass (*Chloris gayana*) as selected forage to be established. Each subplot (replicate) had 10 m x 10 m dimension making a $100m^2$ which is equivalent to 0.025 acres each spaced 0.5 m apart from the adjacent plot which received different treatments of fertilizer and there was a 1 m wide path around the plot's boundaries. The total area for Rhodes's grass study was $2835m^2$ (Appendix 2) for the layout.

2.4.3 Data collection and sampling procedures

The experiment was carried out by ASAS, SUA students from the Animal Science Department and the Department of Agricultural Economics and Agribusiness (DAEA) from December 2020 to April/May 2021. The data were collected and used to estimate the fodder yield. The sample was taken at the stage of flowering and the plants within each plot were cut with hand sickle to the ground level. Sub-samples of an average of 350g fresh fodders from each treatment were weighed and taken to the laboratory for dry matter determination (totally dried Rhodes grass). All the inputs used were recorded in the notebook throughout the experiment. At the end of the experiment the data were entered into Microsoft Excel for analysis.

2.4.4 Data analysis

Data were analysed descriptively using Microsoft Excel. The analysis involved estimation of fodder yield from the experimented plots of Rhodes grass with six different treatments. Fodder yield estimates were measured in grams for fresh (green grass), partially dried and totally dried forage. This enabled comparison of weight among fresh (green grass), partially dried and totally dried forages.

2.4.4.1 Estimation of fodder yield

Quantity of fodder harvested in the area from different plots divided by area of each plot, provided the fodder yields. For the monetary term, quantity harvested was multiplied by the estimated unit price of fodder from the market price of fodder in Tanzania.

Mathematically

$$Yields\ in\ kg = \frac{Kg\ of\ harvested\ fodders}{m^2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (1)$$

2.5 Findings

For the first treatment (T_1) with no fertilizer, the estimated yields were 6.2 t/ha and (T_2, T_3, T_4, T_5 and T_6) were 9.89 t/ha, 20.19t/ha, 12.63 t/ha, 14.19t/ha and 24.7 t/ha for fresh grass respectively. The results from the laboratory for partially dried in an oven at 65^0C to 72^0C for 48 hours was 2.19t/ha, 3.93t/ha, 7.79t/ha, 4.93t/ha, 5.16t/ha and 9.99t/ha for T_1, T_2, T_3, T_4, T_5 and T_6 fodder yields respectively. Moreover, totally dried in an oven at 105^0C for 24 hours were 2.08t/ha, 3.74t/ha, 4.65t/ha, 4.96t/ha and 9.47 t/ha for T_1, T_2, T_3, T_4, T_5 and T_6 fodder yields, respectively (Appendix 7). It can be noted that there is variation in terms of quantity of fodder produced per each treatment, which could be attributed to different soil nutrients and fertilizer application between the treatments.

2.6 Discussion

The findings can be supported by those of FAO (2014), where it was found that different soil nutrients and fertilizer applications lead to variation in both quality and quantity of fodder yields. Moreover, a difference in weight can be noted in terms of fresh forage compared with partially dry and totally dry forage.

The results from T_1 (6.20 t/ha, 2.19 t/ha, 2.08 t/ha) and T_2 (9.89 t/ha, 3.93 t/ha, 3.74 t/ha) for fresh, partially dried and totally dried, respectively were lower compared to T_3 (20.19 t/ha, 7.40 t/ha, 7.03 t/ha) and T_6 (24.70 t/ha, 9.10 t/ha, 8.63 t/ha) for fresh, partially and totally dried, respectively was higher. This implies that, Cattle farm yard manure when mixed with NPSZn brings high yields (fresh forage and dry forage) also NPSZn when mixed with Urea provided more yields compared to all treatments in the experiment. These findings contradict with those of other researchers when applied Nitrogen, Phosphous and Urea alone to the Rhodes during production (Na-Allah and Bello, 2019; Ogedgbe and Eswansiha, 2016). However, Yossif and Ibrahim (2012) agreed that the best applied fertilizers were the mixture of Nitrogen, phosphorus and other fertilizers such as Urea and FYM because all minerals within these fertilizers incorporated one another.

2.7 Conclusion and Recommendation

Because of subject study, it can be concluded that high yield from T_3 and T_6 were influenced by fertilizers application (CFYM +NPSZn) and (NPSZn + Urea), respectively. It can be deduced from the results that the mixed fertilizers (CFYM +NPSZn) and (NPSZn + Urea) perform better than CFYM alone, NPSZn alone or NPSZn + SA. Farmers who are livestock keepers, small, medium and large may choose to cultivate Rhodes grass by applying either (CFYM +NPSZn) or (NPSZn + Urea).

References

Arshad, I., Ali, W., Khan, A. Z. and Bhayo, A. W. (2016). Effect of Water Stress on the Growth and Yield of Rhodes Grass (Chloris gayana. L. Kunth.) *A Peer-reviewed Journal PSM Biological Research 2016* 1(2): 58-61.

ASAS, (2020). ASAS Dairies farm LTD. [https://asasgrouptz.com] site visited on 08/08/2020.

FAO (2014). *Grassland Index.* A searchable catalogue of grass and forage legumes. FAO, Rome, Italy. [www.fao.org ›.] site visited on 12/08/2021.

Lukuyu, M., Njehu, A., Mwilawa, A. and Lukuyu, B. (2016). A study to understand fodder markets and fodder trading patterns in More MilkiT sites and other selected regions in Tanzania. [ResearchGate " figure › Map-of-MilkIT-project-sites-in-Tanzania-s] site visited on 12/04/2021.

Msalya, G., Chenyambuga, S. W., Laisser, E. L. K., Karimuribo, E. D., Kipanjula, M. J., Mwilawa, A. J., Mdegela, R. H. and Kusiluka, L. J. M. (2017). Tropical Animal Health and Production "A review of prevalence, control measure, and torelence of Tanzania Shorthon Zebu cattle to East Coast fever in Tanzania. [https://journals.plos.org › plosone › article › file.PDF] site visited on 28/11/2021.

Muck, R. E. and Shinners, K. J. (2001). Conserved Forage (Silage and Hay): Progress and Priorities. [https://agris.fao.org › agris-search › search] site visited on 28/11/2021.

Na-Allah, Y. N. and Bello, A. (2019). The Potentials of Rhodes Grass (Chloris Gayana Kunth) as Drought Resistant Perennial Forage Grass in Nigeria. *American Journal of Biomedical Science and Research 2019* 6(3).

Ogedegbe, S. A. and Ewansiha, S. U. (2016). Effects of Fertilizers and Rates of Application on Growth and Yield of Rhodes Grass (Chloris gayana Cv. Callide). Department of Crop Science, University of Benin, PMB 1154, Benin City, Edo State, Nigerian. *Journal of Animal Science* 2016 (1): 257 – 265.

Ragkos, A., A., Theodoridis, A. and Fachouridis, C. B. (2015). Dairy farmers' strategies against the crisis and the economic performance of farms. Procedia, Economics and Finance 33. The 7th International Conference, The Economies of Balkan and Eastern Europe Countries in the changed world, EBEEC, May 8 - 10, 2015. pp518 - 527.

URT, United Republic of Tanzania (2011). MLFD, "Budget speech and annual estimates of MLFD,. " Tanzania Country Report. 80pp.

URT, United Republic of Tanzania (2019). United Republic of Tanzania, Ministry of Livestock and Fisheries (MLF), Ministry Budget Speech. National Livestock Research Agenda. 58pp.

Waziri, M. D. and Uliwa, P. (2020). Supply and Commercial Viability of Forage in Tanzania. *American Scientific Research Journal for Engineering, Technology, and Sciences* (*ASRJETS*) 66(1): 145-156.

Yossif, M.A and Ibrahim, Y, M (2012). Effect of Organic and Inorganic Fertilizers on Proximate Analysis of Rhodes Grass (*Chloris gayana* L. Knuth). *Universal Journal of Plant Science* 1(4): 137-140.

CHAPTER THREE

3.0 ECONOMICS OF IMPROVED FODDER PRODUCTION UNDER DIFFERENT PRODUCTION TREATMENTS AT ASAS FARM IN IRINGA REGION, TANZANIA

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3.1 Abstract

Inadequate fodder production and availability has been a challenge to the livestock farmers in Tanzania. The study assessed the economic viability of fodder production using on-farm treatments at ASAS farm in Iringa Region. A Complete Randomized Design was employed to arrange 24 sub-plots (six treatments and four replicants) in plots of 10m x10m dimension making a 100m^2 which is equivalent to 0.025 acres. Sub-plots were spaced each 0.5m apart from the adjacent plot by a 1m wide path around the plot's boundaries receiving different treatments of fertilizer. The total area for Rhodes's grass study was 2835m^2. The seeds were sown in each plot and fertilizers were applied in T_2 Cattle Farm Yard Manure (CFYM), T_3 (CFYM+ Nitrogen, Phosphorus, Sulphur, Zinc (NPSZn)), T_4 (NPSZn), T_5 (NPSZn+ Sulphate of Ammonium (SA)) and T_6 (NPSZn + Urea) while T_1 remained as a control (no fertilizer). Through Microsoft Excel, Cost-

Benefit Analysis was done to assess the economic feasibility of each treatment. Results revealed that Treatment T_3 and Treatment T_6 of the experiments yielded positive Net Present Values (NPVs) of TZS 599 129.6 and TZS 964 429.3, Benefit Cost Ratio (BCRs) of 1.4 and 1.8 and Internal Rate of Return (IRR) of 15% and 16% respectively. It is concluded that the application of T_3 and T_6 to the Rhodes grass would improve fodder availability. It is recommended that with the experiment, large and smallholder farmers may produce enough fodder for themselves and surplus for sale to other livestock keepers.

Key Words: Production treatment, Fodder production, Rhodes, Cost-benefit analysis (CBA)

3.2 Introduction

Knowledge of economics of improved fodder production is essential for large and smallholder farmers involved in livestock keeping and the dairy sector. Due to economic benefits arising from the livestock sector and dairy industry, dairy companies and individuals have invested in livestock keeping and milk production in Tanzania. Tanzania is an agricultural country with nearly three-fourths of its population depending on crop production and livestock keeping for livelihood (FAO, 2020). The country has the second largest livestock population in Africa, that is, 39.9 million cattle, 99.6 percent of which are indigenous breeds, 24.5 million goats, 8.5 million sheep, 3.2 million pigs, and 87.6 million chickens (URT, 2021). In general, the country has a competitive advantage of a large livestock sector; however, the current opportunities for example, commercial fodder production or cultivation, within the dairy sector are still under-utilised (URT, 2019).

Specifically, the dairy industry is a potential subsector in the livestock economy contributing 30 percent of domestic production in the livestock sector and about 1.2

percent of the national Gross Domestic Product (GDP) (URT, 2017). In Tanzania, the total annual milk production is currently estimated at 2.7 billion litres (URT, 2019). Currently, milk production is still low in the country because of relative availability and increasing costs of production compared to the per capita milk consumption. Per capita milk consumption is 47 litres per year, which is far less than the World Health Organisation (WHO) recommendation of 200 litres per capita (URT, 2019). This has been due to, among others, animal health and reproductive problems, lack of good quality animal feed in sufficient quantities and limited supply of dairy cattle (Njombe *et al*., 2011; Swai and Karimuribo, 2011; Kabirizi *et al*., 2013; Abdisa, 2018). Consequently, large and smallholder dairy farmers do not often meet their all-year-round feed demand from on-farm production (Lukuyu *et al*., 2016; Waziri and Uliwa, 2020). It follows, low yields from available forages due to effects of the seasonality of rainfall and/or poor fodder production practises (Waziri and Uliwa, 2020) necessitated research on the economics of improved fodder production under different six (6) treatments.

Several studies have been conducted on dairy farming. A study by Notenbaert *et al*., (2020) focused on environmentally sound intensification pathways for dairy development. Again, MLF (2019) studied livestock sector economics in Tanzania, while the Ministry of Livestock and fisheries conducted a baseline survey to develop a Tanzania livestock master plan (URT, 2017). Another study was conducted by Njombe *et al.* (2011) who explored milk and fodder production identification in Tanzania. These studies by Notenbaert *et al*. (2020); MLF (2019); Njombe *et al.* (2011) and URT (2017b), suggested recommendations which include dairy farmers (milk producers) to cultivate fodders to reduce the scarcity of fodders especially during dry seasons. For the farmers to increase milk production and their associated by-products, fodder production is important. Producing fodder and other feeds for cattle may lead to an increase of 6 to 8 litres per day

(URT, 2019). Similarly, improved milk production may lower the cost per litre produced and this may reflect a stronger profit margin for commercial milk producers (Sikumba and Maass, 2015; URT, 2019). Considering this view, there has been different efforts by the government of Tanzania and other stakeholders (companies and individuals) to provide education and emphasis on fodder production (URT, 2016). Some of these companies include, among others, ASAS Dairies Farm Limited and Tanga Fresh Limited in Iringa and Tanga Regions, respectively. ASAS, in particular, went further to undertake experiments on different fodder production systems by applying six (6) treatments (differentiated by application of fertilizers) to measure the costs and benefit of fodder production. Therefore, this study aimed to determine the feasibility (costs and benefits) of fodder production treatments being experimented at ASAS Dairies Farm Limited.

3.3 Theoretical and Empirical Reflection

The theory of Cost-Benefit Analysis (CBA) provides the theoretical basis of this study. CBA in economics is a very important, appropriate and popular method of appraising a project at micro and macro level (Papendiek *et al*., 2016). CBA serves two purposes: to determine the soundness of investment/decision to make-justification or feasibility and provide a basis for comparing the projects (Kashangaki and Ericksen, 2018). CBAs are expressed in monetary terms and are adjusted for the time value of money so that all flows of project costs over time are typically described in terms of their Net Present Value (FAO, 2016). This theory was adopted in this study because it is appropriate for analysing cost-benefit of a project and comparing project alternatives. Adoption of this theory was based on other studies such as a study by Islam *et al*. (2017) from India, calculated profits in terms of gross returns, gross margin, net returns, and benefit cost ratio and concluded that fodder production along with dairy cattle was profitable and increased employment opportunities. Another study by Lukuyu *et al.* (2013) used the CBA approach in Rwanda, Kenya, and Uganda. They used gross returns, gross margin, and net returns to conclude that labour constitutes the highest cost of production for all technologies applied. Moreover, Papendiek *et al*. (2016) used the CBA approach in two scenarios (1st without fodder production and 2nd with fodder production). They found that both scenarios experienced positive NPVs, BCR greater than one and IRR greater than 5% discount rate used for comparison. Kadigi *et al.* (2021) from Tanzania used the CBA approach and the results showed positive NPVs and BCR more significant than 1 for both agroforestry and bee-keeping projects at discount rates not higher than 8.2% and 8.5%, respectively and IRR was a bit higher for beekeeping rather than agroforestry. Therefore, all projects could be implemented.

3.4 Methodology

3.4.1 Research site description and selection criterion

In this study, the experiment was carried out at ASAS Dairy (Matembo) Farm, located about 22km of Iringa Municipality in Iringa Region. The selection of the area was based on the existence of ASAS Dairy farm on which experiments on fodder production treatments were conducted and aimed at determining the most economical fodder production technology that can be used by the farm and smallholder dairy farmers.

3.4.2 Research design and sampling procedures

This was an experimental (Complete Randomised Design-CRD) type of research whereby six treatments with four random replications were studied by looking at inputs costs used in each treatment to produce fodders (output) out of other agronomic practises. The treatments were assigned to the experimental units at random plots such that each treatment appears in each plot and each plot receives each treatment.

The experiment consisted of twenty-four (24) sub-plots resulting from six (6) treatments with their four (4) replications arranged in a randomised plot of $100m^2$. The treatments included no fertilizer (used as a control), Cattle Farm Yard Manure (CFYM), Cattle Farm Yard Manure mixed with NPSZn, NPSZn mixed with Sulphate of Ammonium and NPSZn mixed with UREA. These treatments were applied on Rhodes's grass (*Chloris gayana*) as selected forage to be established. Each subplot (replicate) had 10 m x 10 m dimension making a $100m^2$ which is equivalent to 0.025 acres each spaced 0.5 m apart from the adjacent plot which received different treatments of fertilizer and there was a 1 m wide path around the plot's boundaries. The total area for Rhodes's grass study was $2835m^2$ (Appendix 2) for the layout.

3.4.3 Data collection

The experiment was carried out by ASAS, SUA students from the Animal Science Department and the Department of Agricultural Economics and Agribusiness (DAEA) from December 2020 to April/May 2021. The data collected include amount of seeds (in kg), number of hired labourers (expertise), amount of manure (in kg), type and amount of fertilizers (in kg), soil tests, manure tests, and transport costs. Fixed input costs were from land purchase and machine depreciation. The data were used to estimate the costs and benefits then discounted investments appraisal was calculated for each farming treatment for decision making. The sample was taken at the stage of flowering and the plants within each plot were cut with hand sickle to the ground level. Sub-samples of an average of 350g fresh fodders from each treatment were weighed and taken to the laboratory for dry matter determination (totally dried Rhodes grass). At the end of the experiment the costs were entered to Microsoft Excel for analysis.

3.4.4 Data processing and analysis

Feasibility analysis involved calculation of Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) and decisions were made by considering the criteria of each method. The estimated investment life span was 5 years (ILRI *et al*., 2020). The estimates were done based on the Bank of Tanzania's (BOT) official interest rate. The BOT's discount rate was 5% as per monthly economic review in July (BOT, 2021). Social Discount Rate (SDR) was very important to be determined in this study as it can take into account the spill-over effect of the investment. The European Commission (EC, 2008) recorded a 5% SDR as a widely acceptable rate used as the opportunity cost of the capital. Moreover, in CBA, consideration of the country's inflation rate is inevitable; in April 2021, the inflation rate was recorded at 3.2% (BOT, 2021). For sensitivity analysis (What-If-Analysis), the CBA was repeated using different discounting rates (3.2%, 5%, 8%, 9%, 10%, 11% and 12%). Since the interest rates change overtime, the sensitivity analysis was considered to examine how CBA changes under different discount rates (Appendix 6).

NPV is calculated as in Equation (2)

$$NPV = \sum_{t=0}^{n} \frac{B_t - C_t}{(1+r)^t} \quad \text{...} (2)$$

C_t=Cost in period t, B_t=benefit in period t, r= discounted rate in %

The investment is profitable or feasible if the calculated NPV is positive when discounted at the opportunity cost of capital, accepts the investment and rejected when the NPV is negative.

BCR is calculated as in Equation (3)

$$B/C\ ratio = \frac{\sum_{t=0}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=0}^{n} \frac{C_t}{(1+r)^t}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where:

B_t=benefit in period t, C_t=Cost in period t, r= discounted rate in %, t=year in project duration. An investment with a BCR of 1 or greater is economically acceptable when the costs and benefits are discounted at the opportunity cost of capital.

IRR is calculated as in Equation (4)

$$IRR = r_1 + \left[(r_1 - r_2) * \left(\frac{NPV_1}{NPV_1 - NPV_2} \right) \right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where:

$r_{1=Lower\ discount\ rate}$, r_2=*higher discount rate*, NPV_1=*Net Present value at lower discount rate*, NPV_2=*Net Present Value at a higher discount rate*. If NPV$> 0, Accept$, If IRR $> cost\ of\ capital, accept$ the project.

3.5 Results and Discussion

3.5.1 Costs of Rhodes fodder production from different treatments

Costs are the expenses for organising and carrying out the production process. The production costs include different variable costs such as land preparation, hired labour, seeds and fertilizers. For the six treatments with the same areas of 400m^2 each, - in treatment one (T_1) the total variable costs of producing fodders were estimated to be TZS 163 324; T_2, TZS 210 224; T_3, TZS 216 984; T_4, TZS 171 644; T_5, TZS 175 228 and T_6, TZS 180 484. The variation of costs was based on different prices of inputs and other associated costs. Cost of seeds was TZS 20 000 per kg; NPSZn, TZS 65 000 per 50kg; SA, TZS 32 000 per 50kg and Urea, TZS 6 500 per 5kg. Additional costs involved were soil and farm yard manure testing which amounted to TZS 81 750 and 81 000, respectively. Forage sample test at Tanzania Veterinary Laboratory Agency was TZS 420 000 for all forage samples and transportation cost was TZS 279 000 for the whole time of the experiment. Costs per treatment are as presented in Figure 3.1.

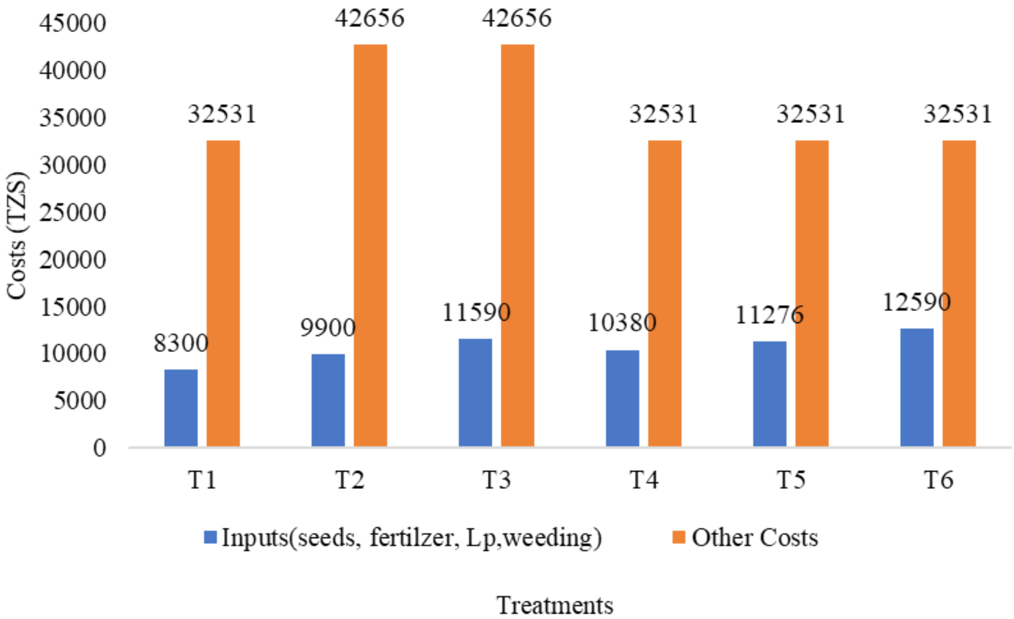


Figure 3.1: Variation of costs (TZS) per each treatment: Plot of 100m^2

Gross return was found to be different from all treatments for fresh, partially and totally dried fodder because of the differences in estimated yields and the prices. Therefore, the estimated price should not be the same for fresh, partially and totally dried fodders. However, a study conducted in Tanzania by Waziri and Uliwa (2020) shows that the prices of Rhodes fodder (hay) were TZS 414 per kg, while a study by Lukuyu *et al.* (2016) shows the average price of fodder was TZS 3 500 per 15kg of the bale. Moreover, according to the Sokoine University of Agriculture (SUA – Animal science department) the price of hay (Rhodes fodder) was TZS 3 500 per 15kg as of June, 2021. However, there was no enough information of prices for fresh forages in Tanzania even though smallholder farmers, during wet seasons, prefer to buy fresh forage and sometimes offer manure to producers to get fresh forage (Waziri and Uliwa, 2020). In this study therefore, the current market price was estimated to be TZS 233.33 per kg (hay) (Appendix 8).

3.5.2 Feasibility of using Different Fertilizers for Fodder Production (two seasons per year per acre)

CBA results for investing in one acre of land were presented as per Figures 3.2 - 3.6 and Tables 3.1 - 3.6 considering the discounting measurements for five years.

In year zero, the investment costs tend to differ in all treatments due to the costs of fertilizers. For example, in T_1, the investment costs were TZS 360 000 which include costs to acquire land, land preparation and costs of seeds while in T_2, the investment costs were TZS 427 750, which include costs of fertilizer used which were not included in T_1, and therefore T_3, T_4, T_5 and T_6 include all the costs in T_1 plus the costs of fertilizers which distinguish the treatments. Furthermore, the variable costs were high in year one for all treatments and this was because of labour costs which differ in all treatments.

Table 3.1: T_1-control (two seasons per year per acre)

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Revenue		392810	392810	392810	392810	392810
Variable Costs		405500	225000	225000	225000	225000
Investment costs (Capital)	360000	0	0	0	0	0
Net Revenue/Benefit		-12190.1	167809.9	167809.9	167809.9	167809.9
Present Value (11%)				**85623.15**		
NPV (11%)				**-488921**		
BCR				**0.149**		

Table 3.2: T_2 - CFYM only (two seasons per year per acre)

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Revenue		706303.91	706303.91	706303.91	706303.91	706303.91
Variable Costs		405500	292750	292750	292750	292750
Investment costs (Capital)	427750	0	0	0	0	0

Net Revenue/Benefit	301303.91	413553.91	413553.91	413553.91	413553.91
Present Value (11%)			**386417.3**		
NPV (11%)			-274890		
BCR			0.5		
IRR			4.2%		

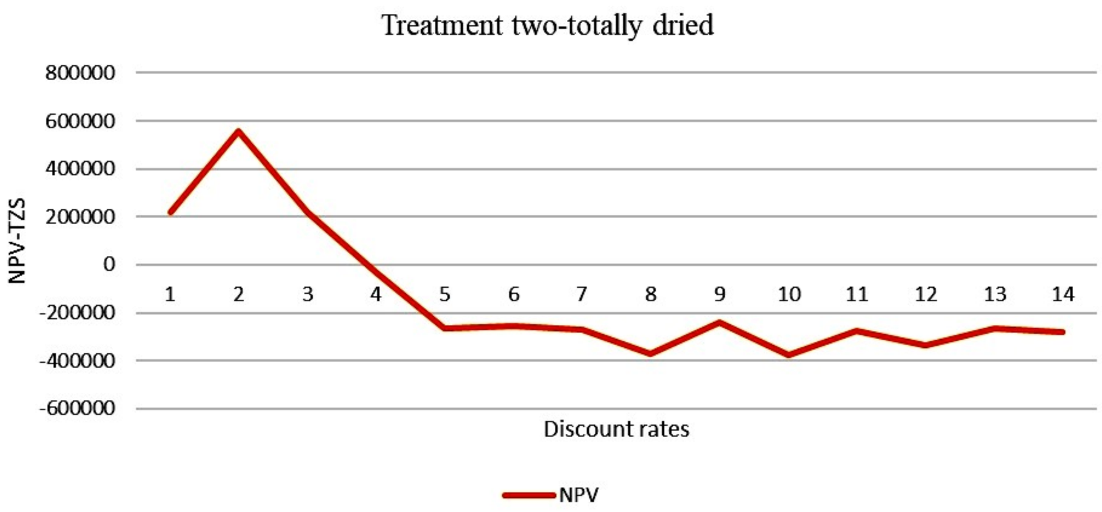


Figure 3.2: T_2 - A plot line of NPVs of T_2 at different discount rates per acre

Table 3.3: T_3- CFYM & NPSZn (two seasons per year per acre)

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Revenue		1397497.37	1397497.37	1397497.37	1397497.37	1397497.37
Variable Costs		405000	360350	360350	360350	360350
Investment costs (Capital)	443200	0	0	0	0	0
Net Revenue/Benefit		992497.37	1037147.37	1037147.37	1037147.37	1037147.37
Present Value (11%)			1094480			
NPV (11%)			346601.3			
BCR			1.4			
IRR			15.00%			

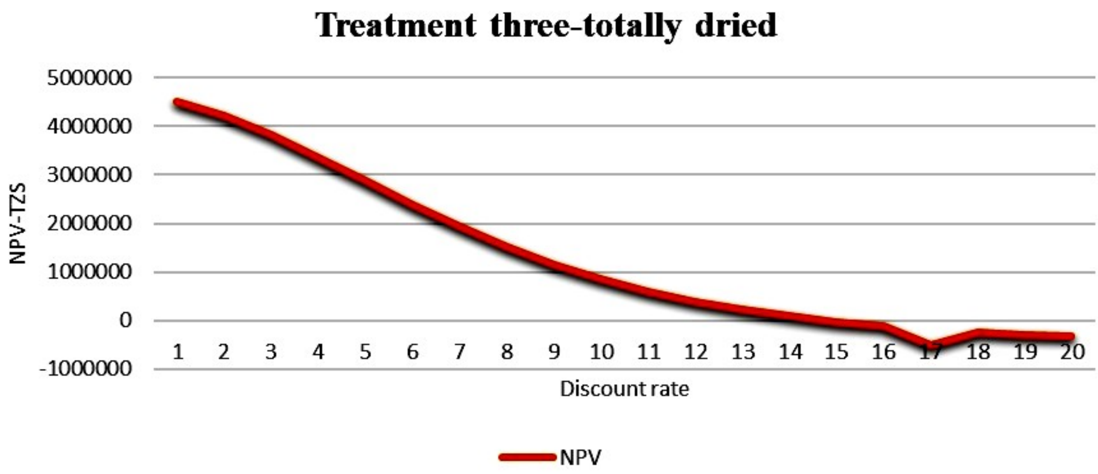


Figure 3.3: T_3 - A plot line of NPVs of T_3 at different discount rates per acre

Table 3.4: T_4- NPSZn only (two seasons per year per acre)

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Revenue		878 156	878 156	878 156	878 156	878 156
Variable Costs		405 000	308 200	308 200	308 200	308 200
Investment costs (Capital)	443 200	0	0	0	0	0
Net Revenue/Benefit		473 156	569 956	569 956	569 956	569 956
Present Value (11%)			**563 208.3**			
NPV (11%)			**-117885**			
BCR			**0.8**			
IRR			**2.00%**			

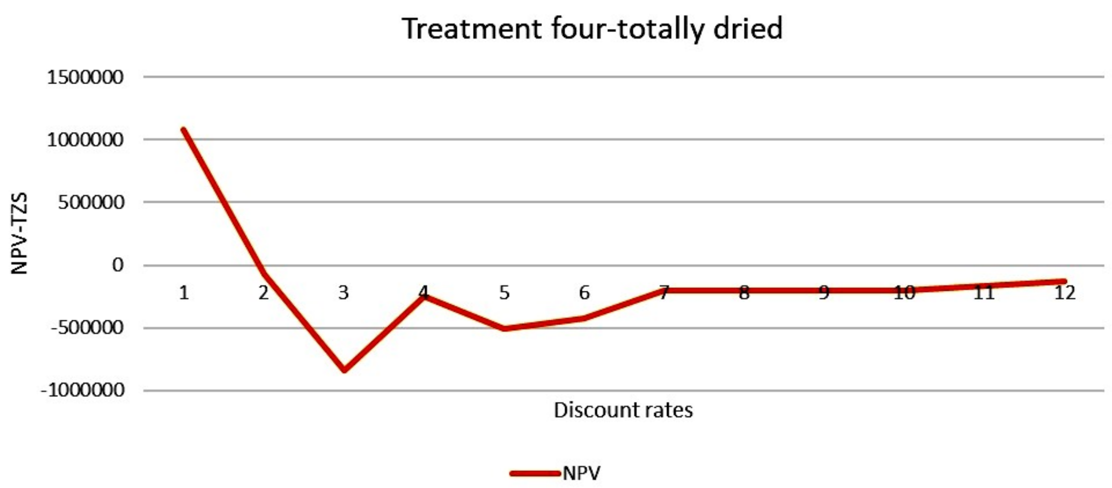


Figure 3.4: T_4 - A plot line of NPV s of T_4 at different discount rates per acre

Table 3.5: T_5-NPSZn & SA (two seasons per year per acre)

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Revenue		936 699	936 699	936 699	936 699	936 699
Variable Costs		405 000	344 680	344 680	344 680	344 680
Investment costs (Capital)	479 680	0	0	0	0	0
Net Revenue/Benefit		531 699	592 019	592 019	592 019	592 019
Present Value (11%)			**606 305.3**			
NPV (11%)			**-554 216**			
BCR			**0.8**			
IRR			**1.50%**			

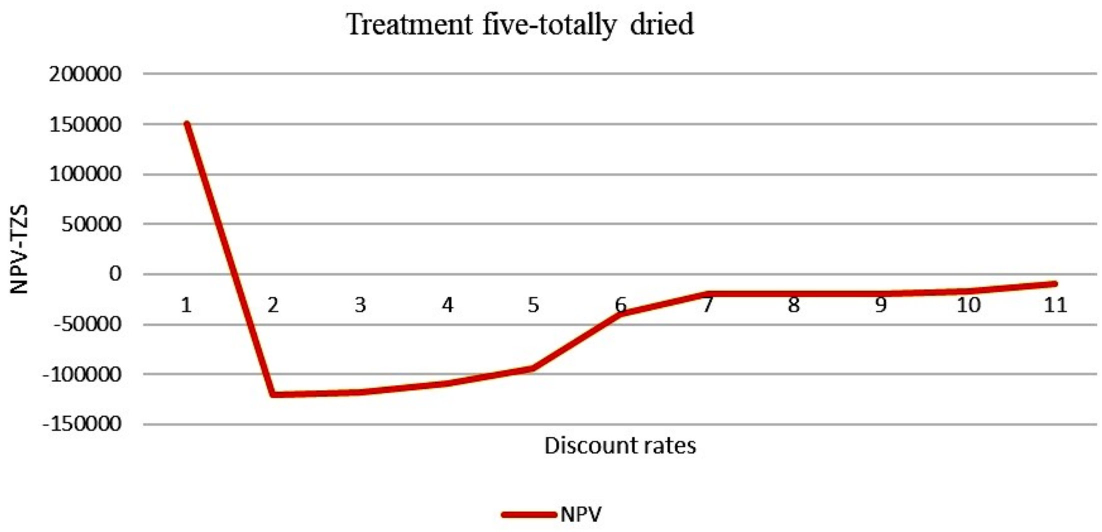


Figure 3.5: T_5 - A plot line of NPVs of T_5 at different discount rates per acre

Table 3.6: T_6 – NPSZn & Urea (two seasons per year per acre)

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Revenue		1 788 418.45	1 788 418.45	1 788 418.45	1 788 418.45	1 788 418.45
Variable Costs		405 000	396 600	396 600	396 600	396 600
Investment costs (Capital)	531 600	0	0	0	0	0
Net Revenue/Benefit		1 383 418.45	1 391 818.45	1 391 818.45	1 391 818.45	1 391 818.45
Present Value (11%)			**1 496 029**			
NPV (11%)			**1 324 422**			
BCR			**1.72**			
IRR			**16.00%**			

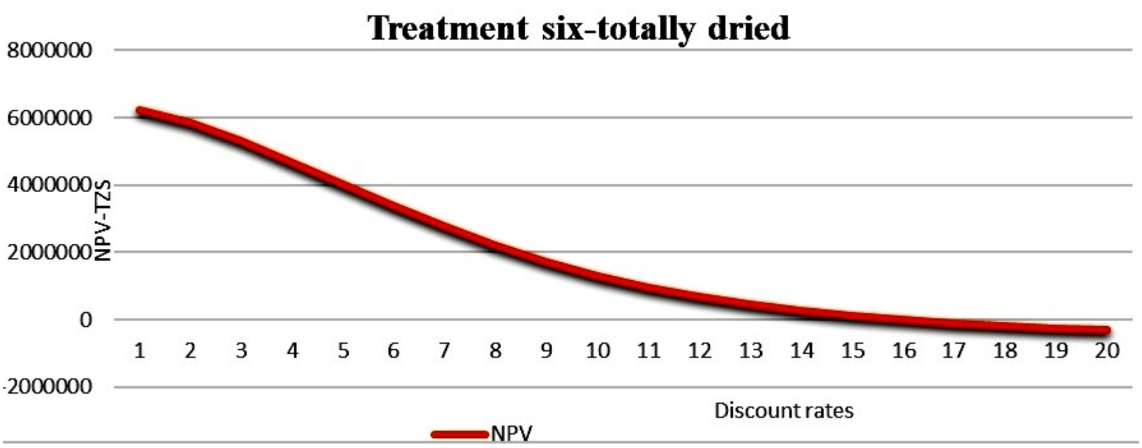


Figure 3.6: T_6 – A plot line of NPVs of T_6 at different discount rates per acre

The findings indicated that in all treatments, the cost of seeds rarely changed and operating costs (variable costs) changed due to differences in the application of fertilizers from one treatment to another. For example, T_2, T_3, T_4, T_5 and T_6 were treated with a different type of fertilizer, thus, leading to variation in costs. Moreover, the Rhodes grass production outputs differ from all treatments (totally dried) as the estimation was based on the analysis of the one-acre farm size for each treatment. The T_3 and T_6 have potential advantages as the NPVs are positive, IRR is more than an 11% discounted rate which was used as a benchmark. Moreover, the BCR for $T_{6,}$ and T_3 are greater than one and this implies that based on BCR criteria, the project was worth implementing. However, treatments T_1, T_2, T_4 and T_5 have BCR less than one and NPV negative at different discounted rates (8%, 9%, 10%,11% and 12%) and therefore, were not worth it but at 3.2% and 5% discount rates, the NPVs were positive for T_4 and $T_{5,}$ respectively. This implies that T_1 was not worth investing in irrespective of discount rates used. Furthermore, the CBA indicates that the production treatments (T_2, T_3, T_4, T_5 and T_6) were feasible at a discount rate equal to the inflation rate (i.e., r=3.2%) with positive NPVs (Appendix 6). The two production treatments (T_3 and T_6) were viable even at a higher discount rate of 9% yielding, NPVs of TZS 694 549.2, TZS 1 211 366 per acre, respectively. Overall, the results of comparisons of economic feasibility between the six production treatments indicated that the production treatments T_3 and T_6 were more profitable investing in terms of expected revenue than T_1, T_2, T_4 and T_5.

If the on-farm management parameters and market prices of Rhodes grass hay which are currently at TZS 3 500/15kg or TZS 233.33/kg, remain constant, it is economical to produce fodder at a micro level or typical smallholder farmers who have about five acres of land (Kashangaki and Ericksen, 2018; MLF, 2019: Waziri and Uliwa, 2020). Smallholder farmers may produce Rhodes grass by using either CFYM mixed with

Nitrogen Phosphorus Sulphur Zinc (NPSZn) or NPSZn mixed with Urea of which the results from the experiments were used to estimate one acre of land and they provided good results for two cuts a year (harvested twice a year).

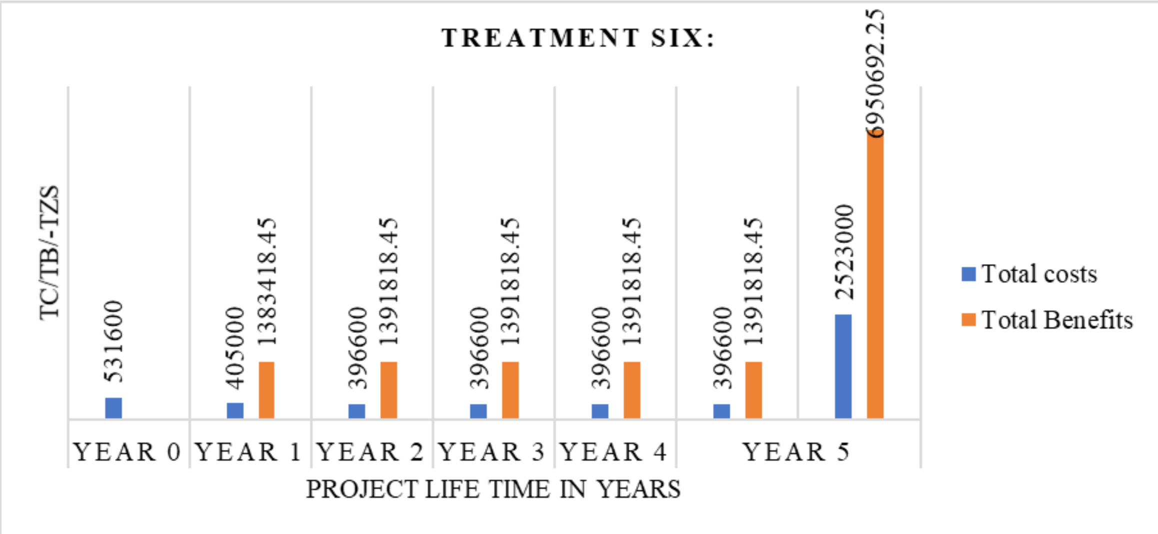


Figure 3.7: Estimated total benefits and costs of fodder with NPZn & Urea application (one acre of land)

Furthermore, smallholder farmers could get enough revenue/profits on the first year of cultivating the Rhodes grass (hay), for example, Figure 3.7 and, therefore, they should pay attention to the improved fodders (hay). At the macro level, the adoption of fodder farming over a five years investment would have economic viability to ASAS farms. The total benefits exceeded total costs by year one of implementation through T_3 and T_6, Figure 3.7. At the project termination in year five, the total net benefit was TZS 1 037 147.37 and 1 391 818.45 for the T_3 and T_6, but T_6 was more profitable than other treatments and it is suitable for investment because T_6 used the mixer of NPSZn and Urea which are considered to be the best fertilizers for the Rhodes grass production.

3.6 Conclusion and Recommendations

An experimental study was done at ASAS Farm Limited in Iringa, Tanzania to examine the economic viability of improved fodder production under different fertilizer applications. Cost-Benefit Analysis (CBA) was used to measure and compare the costs and benefits used on the production and to see the economic viability of the fodder production. Based on the findings, Rhodes grass, when sold as hay (totally dried) with the market price of 233.33TZS within two seasons, could provide more benefits for both smallholder farmers and ASAS farms. The analysis results showed positive NPVs for T_6 and T_3, while T_1, T_2, T_4 and T_5 showed negative NPV. In order to make a good decision and to see if the project was feasible, it was necessary to check on BCR and IRR. Similarly, the results indicated that for T_6 and T_3, the BCR was more credible than one and IRR was greater than 11 percent.

Based on the results of the experiments, dairy companies may produce enough fodders for themselves and extra fodders to sell to other livestock keepers. This should go hand in hand with efforts to use the experimental plots at ASAS Farm as demonstration plots to enhance adoption of fodder production by smallholder livestock keepers in Iringa. Moreover, smallholder dairy farmers should embark on improved fodder production treatments (after receiving education and orientation on how to produce them) to minimise shortage of fodder during dry seasons in the country. Moreover, fertilizer applications such as NPSZn, CFYM and Urea should be promoted to improve the quantity of Rhodes grass production.

References

Abdisa, T. (2018). Mechanism of retained placenta and its treatment by plant medicine in ruminant animals in Oromia, Ethiopia. *Journal of Veterinary Medicine and Animal Health* 10(6): 135-147.

Bank of Tanzania, BOT (2021). Monthly Economic Review. [https://www.bot.go.tz/Publications/Regular/Monthly%20Economic%20Review/en/2021020412091680.pdf] site visited on 15/08/2021.

European Commission, EC (2008). Guide to Cost Benefit Analysis of Investment Projects-Structural Funds, Cohesion Fund and Investment for Pre-Accession. Europe Commission, Directorate General Regional Policy. 257pp.

FAO (2016). Handbook on Agricultural Cost of Production Statistics Guidelines for Data Collection, Compilation and Dissemination. [https://www.fao.org/3/ca6411en/ca6411en.pdf] site visited on 15/11/2020.

FAO (2020). Tanzania at a Glance, *FAO*. [http://www.fao.org › tanzania › tanzania-at-a-glance] site visited on 15/11/2020.

ILRI; CIAT; NARO; KIT; CGIAR; GIZ; BMZ; IFAD; SNV. (2020). Factsheets on forage species in East Africa. Nairobi (Kenya): Alliance of Bioversity International and CIAT. 16pp.

Islam, S., Begum, J., Sarker, N. R. and Khatun, M. (2017). Economics of fodder production for dairying in selected areas of Bangladesh. *Journal of Animal Science* 46(2): 140-149.

Kabirizi, J., Zziwa, E., Mugerwa, S., Ndikumana, J. and Nanyennya, W. (2013). Dry season forages for improving dairy production in smallholder systems in Uganda. *Tropical Grasslands - Forrajes Tropicales* 1(1): 212-214.

Kadigi, W. R., Ngaga, Y. M. and Kadigi, R. M. J. (2021). Economic Viability of Smallholder Agroforestry and Beekeeping Projects in Uluguru Mountains, Tanzania: A Cost Benefit Analysis. *Open Journal of Forestry* 11(2): 83-107.

Kashangaki, J. and Ericksen, P. (2018). Cost–benefit analysis of fodder production as a low emissions development strategy for the Kenyan dairy sector. ILRI Project Report. Nairobi, Kenya: ILRI. 40pp.

Lukuyu, B., Sikumba, G., Baltenweck, I. and Njehu, A. (2013). Costs and benefits analysis of feed technologies promoted by the East Africa Dairy Development Project (EADD): Study conducted in Rwanda, Uganda and Kenya. 19pp.

Lukuyu, M., Njehu, A., Mwilawa, A. and Lukuyu, B. (2016). A study to understand fodder markets and fodder trading patterns in More MilkiT sites and other selected regions in Tanzania. [ResearchGate " figure › Map-of-MilkIT-project-sites-in-Tanzania-s] site visited on 12/04/2021.

MLF (2019). *Tanzania Livestock Master Plan*. Tanzania Ministry of Livestock and Fisheries (MLF) and the International Livestock Research Institute (ILRI) livestock master plan team. Nairobi, Kenya. 104pp.

Njombe, A. P., Msanga, Y., Mbwambo, N. and Makembe, N. (2011). United Republic of Tanzania Ministry of Livestock and Fisheries Development the Tanzania Dairy Industry: Status, Opportunities and Prospects. In: *7th African Dairy Conference and Exhibition.* MovenPick Palm Hotel, 25-27 May 2020. pp. 25–27.

Notenbaert, A., Jeroen, C. J., Groot, M. H., Birnholz, C., Birthe, K. P., Pfeifer, C. S., Fraval, M. L., Jamie, N., McFadzean, J. A. J., Dungait, J. M., Ran, Y., Barron, J. and Tittonell, P. (2020). Towards environmentally sound intensification pathways for dairy development in the Tanga region of Tanzania. *Regional Environmental Change* 20: 1-14.

Papendiek, F., Tartiu, V. E., Morone, P. and Venus, J. (2016). Assessing the economic profitability of fodder legume production for green biorefineries – a cost-benefit analysis to evaluate farmers profitability. *Journal of Cleaner Production* 112: 3643–3656.

Sikumba, G. and Maass, B. L. (2015). Effects of season and location on cattle milk produced and producer milk prices in selected villages of Tanga and Morogoro Regions, Tanzania. *Livestock Research for Rural Development* 27(10).

Swai, E. S. and Karimuribo, E. D. (2011). Smallholder dairy farming in Tanzania: Current profiles for developments. *Outlook on Agriculture* 40(1): 21–27.

URT, United Republic of Tanzania (2016). Agricultural Sector Development Strategy -II Republic of Tanzania. 97pp.

URT, United Republic of Tanzania (2017). Tanzania Livestock Analysis (2016/2017-2031/2032). Ministry of livestock and fisheries. 58pp.

URT, United Republic of Tanzania (2019). United Republic of Tanzania, Ministry of Livestock and Fisheries (MLF), Ministry Budget Speech. National Livestock Research Agenda. 58pp.

URT, United Republic of Tanzania (2021). Ministry of Livestock and Fisheries,Tanzania Livestock Master Plan (2017/2018 - 2021/2022). [https://webapps.ifad.org › members › docs › EB-20...PDF] site visited on 20/12/2021.

Waziri, M. D. and Uliwa, P. (2020). Supply and Commercial Viability of Forage in Tanzania. *American Scientific Research Journal for Engineering, Technology, and Sciences* (*ASRJETS*) 66(1): 145-156.

CHAPTER FOUR

4.0 CONCLUSION AND RECOMMENDATIONS

An experimental study was done at ASAS Farm Limited in Iringa, Tanzania to examine the economics of improved fodder production under different production treatments. Cost-Benefit Analysis (CBA) was used to measure and compare the costs and benefits used on the production and to see the feasibility of the project in five years. The study estimated the rhodes grass from green grasses to totally dried (hay) and saw the differences in quantities. Based on the findings, the rhodes grass when cultivated by applying Cattle Farm Yard Manure mixed with NPSZn or NPSZn mixed with Urea the quantity obtained was higher at 7.03 tons per hectares and 8.63 tons per hectares respectively. This was easier for dried fodder for storage purposes, and this implies that rhodes grass, when sold as hay (totally dried) with the market price of 233.33TZS within two seasons, could provide more benefits for both smallholder farmers and ASAS farms.

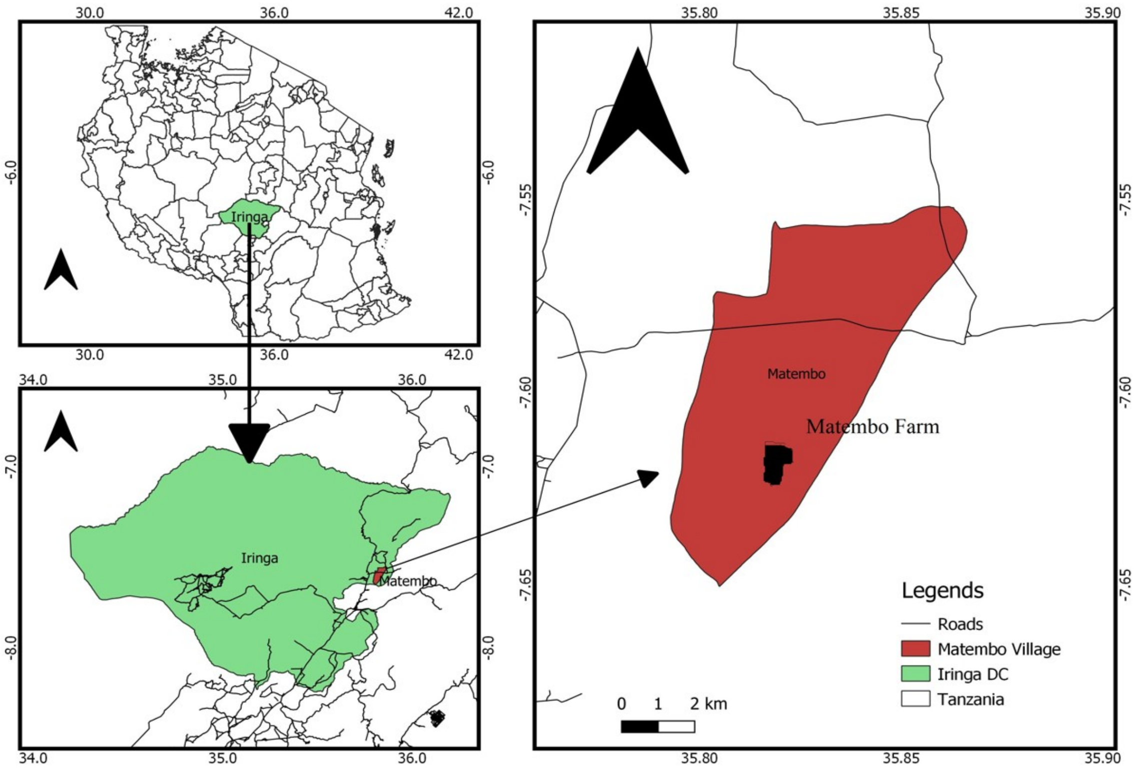
The analysis results showed positive NPVs for T_6 and T_3, while T_1, T_2, T_4 and T_5 showed negative NPV. To make an economic decision and to see if the project was feasible, it was necessary to check on BCR and IRR. Similarly, the results indicated that for T_6 and T_3, the BCR was more credible than one, and IRR was greater than 11 percent.

It is recommended that; companies may produce enough fodders for themselves for example ASAS farms for feeding dairy animals and extra fodders to sell to other livestock keepers. Moreover, smallholder dairy farmers should embark on improved fodder production treatments (after receiving education and orientation on how to produce them) to minimize the shortage of fodder during dry seasons in the country.

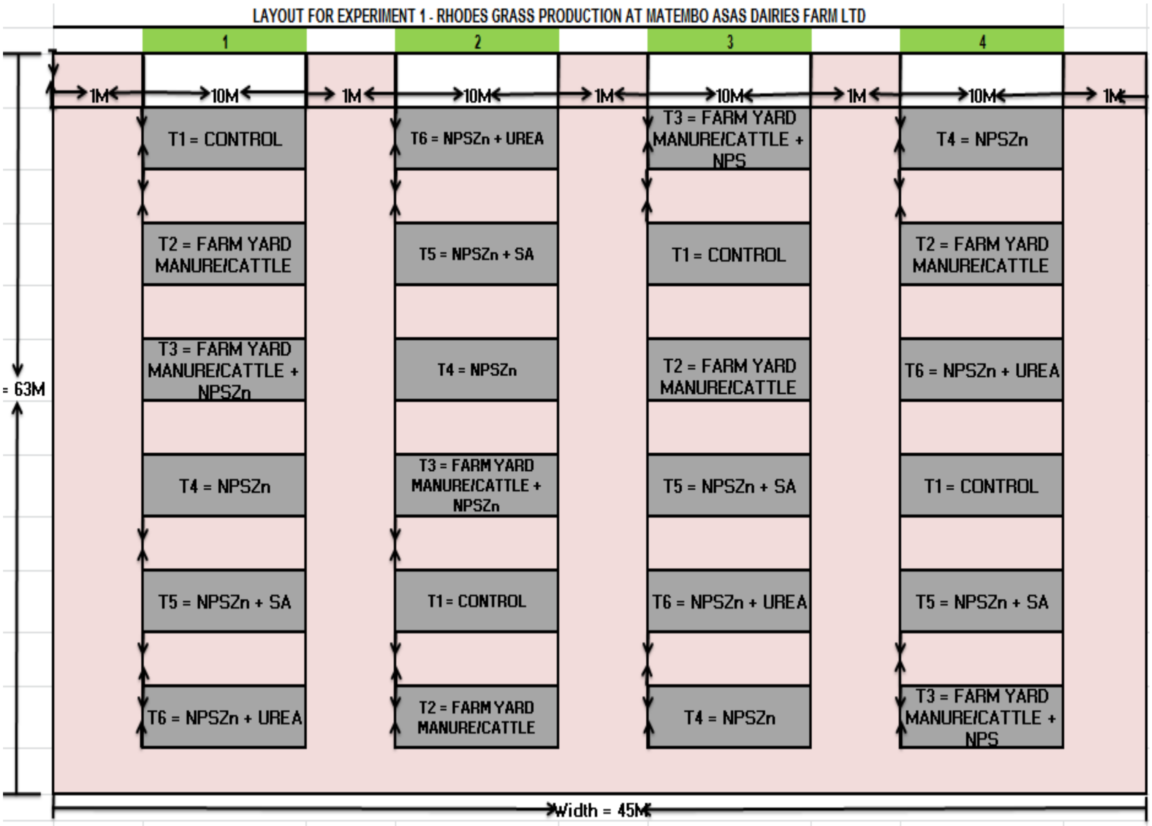
Moreover, fertilizer applications such as NPSZn, CFYM and Urea should be promoted to improve the quantity of rhodes grass and the prices for the fertilizers should be reasonable to allow smallholder dairy farmers to cultivate fodder.

APPENDICES

Appendix 1: Tanzania Map showing Iringa Region-Matembo Farm



Appendix 2: The layout of the experiment



Each replicate/Plot w	*10M X 10M*	*100M*
Area to be planted	*10M x 10M*	*100M x 24 = 2400M*
Inter Experimental p	*0.5M X 10M*	*5M x 24 = 120M*
Walking Area (Left + Centre and Right)	*63M X 1M*	*63M X 5 = 315M*
TOTAL Area		*2835M*

Appendix 3: A check list for data collection

i) What are the estimates of fodder yield of different fodder systems in the case study area?

VARIABLE	PLOTS			
	PLOT 1	PLOT 2	PLOT 3	PLOT 4
Plot size (in m^2) or (hector)				
Yield Estimates (in Kg)				
Estimated unit price of fodder (TZS/kg)				

ii) What are the costs and net benefits of producing fodder resources from different fodder systems in the case study area?

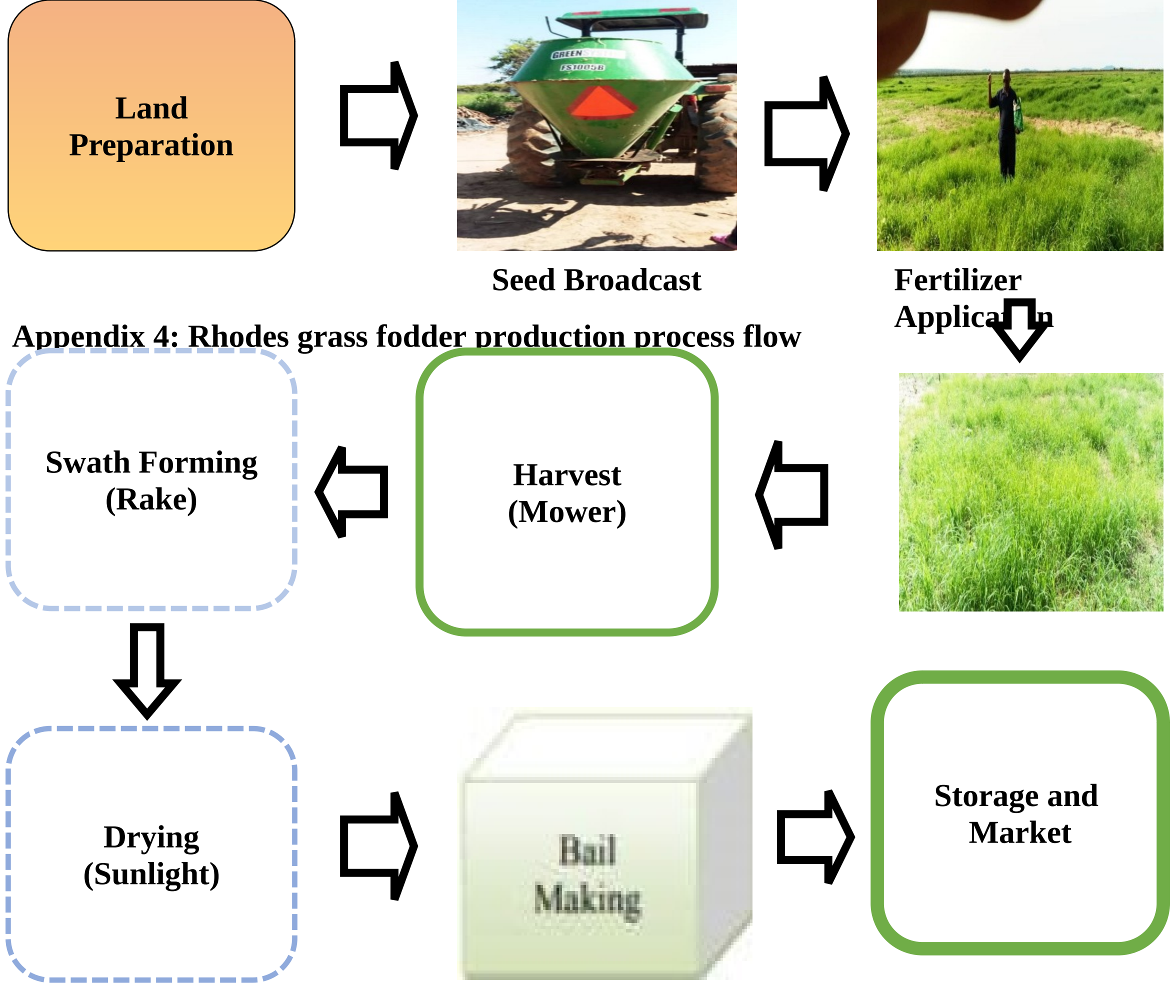
COSTS OF PRODUCTION (TZS)	**PLOTS/**			
	PLOT 1	**PLOT 2**	**PLOT 3**	**PLOT 4**
Land purchase (if any)				
Land preparation				
Inputs				
Labour/expertise				
Weeding				
CARRIAGE COSTS				
Labour				
Machine hire/maintenance				
STORAGE COSTS				
Preservation				
Labour				
Pesticides				
Total Costs				
Benefits as per each block				

iii) What is the feasibility of fodder production for different farming system scenarios?

VARIABLE	**PLOTS**			
	PLOT 1	**PLOT 2**	**PLOT 3**	**PLOT 4**
Total costs incurred				
Amount of yield				
Production Time (Duration)				
Estimated fodder price				

- How is the quality of fodder produced in different fodder production systems?
- What are the benefits associated with different fodder production systems?
- What are the possible trickle-down effects of the experimented fodder production systems to the small holder farmers in the study area?

Appendix 4: Rhodes grass fodder production process flow



Appendix 5: Pictures from the experimental site

a) Labeled Bags and papers used for recoding the yields and costs

b) Cutting down of the fodders with hand sickle for weighs before taking them to the laboratory (Mr J. Tembo-Animal science department)

c) Weighing of the green fodders

d) Rake

e) Tractor used for land preparation at Matembo farm (ASAS farm-experiment site)

f) Measurement of CFYM before being applied on the plot.

Appendix 6: Comparison of Economic Feasibility between treatments (Totally Dried-sensitivity analysis)

TREATMENT 1

	Discount rate						
	3.2%	**5%**	**8%**	**9%**	**10%**	**11%**	**12%**
PVB	535120.1	395 750.6	203870.1	155 769.6	116 586.9	85 623.2	61 780.9
PVC	1173843	1034727.5	338134.7	717 824.3	247 456.7	574544.01	172801.04
NPV	-638723	-638977	-134265	-562055	-130869.8	-488921	-111020
BCR	0.456	0.383	0.321	0.217	0.4711	0.149	0.358

TREATMENT 2

	Discount rate						
	3.2%	**5%**	**8%**	**9%**	**10%**	**11%**	**12%**
PVB	1631025	1234651.8	735869	598052.21	482019.67	386417.27	308866.62
PVC	1410075	1261251.9	1106152	838244.54	857879.11	661307.20	647320.4
NPV	220950	-266600	-370283	-240192.3	-375859	-274890	-338454
BCR	1.15669	0.764	0.66	0.713	0.562	0.584	0.477

TREATMENT 3

	Discount rate						
	3.20%	**5%**	**8%**	**9%**	**10%**	**11%**	**12%**
PVB	4313650	3367494	2969149	1652947	2328777	1094480	886556.78
PVC	1645783	1434133	2012355	958398.2	1348033	747878.3	781721.66
NPV	2667867	1933361	956794	694549.2	980744.7	346601.3	104835.12
BCR	2.621	2.348	1.475	1.724	1.728	1.463	1.134108

TREATMENT 4

	Discount rate						
	3.20%	**5%**	**8%**	**9%**	**10%**	**11%**	**12%**
PVB	2302430	1788215	1054962	861655.6	698338.3	563208.3	453044.7
PVC	1463946	1280243	1572167	865705.7	1225665	681093.1	930831.4
NPV	1859230	1345015	-517205	-4050.11	-527327	-117885	-477787
BCR	1.573	1.397	0.67	0.995	0.569	0.827	0.487

TREATMENT 5

	Discount rate						
	3.20%	5%	8%	9%	10%	11%	12%
PVB	2429468	1892154	921011.7	606305.3	1124141	749008.7	489595.6
PVC	1591145	1387893	930546	727810.7	1666151	1303225	993751.1
NPV	838323	504261.2	-9534.26	-121505	-542010	-554216	-504155
BCR	1.527	1.363	0.989	0.833	0.68	0.575	0.493

TREATMENT 6

	Discount rate						
	3.20%	**5%**	**8%**	**9%**	**10%**	**11%**	**12%**
PVB	5837331	4563531	2251502	2425448	1496029	3163711	4026926
PVC	1772180	1541104	1022830	1214081	794301.4	1839289	2736813
NPV	4065151	3022427	1228673	1211366	701727.9	1324422	1290113
BCR	3.293	2.961	2.201	1.998	1.8	1.72	1.471

Appendix 7: Findings from the experimental plots

Table for fresh Biomass Yield t DM/ha

	T_1	T_2	T_3	T_4	T_5	T_6
Fresh Biomass	**6.20**	**9.89**	**20.19**	**12.63**	**14.19**	**24.70**

Table for dry matter as fed t DM/ha

	T_1	T_2	T_3	T_4	T_5	T_6
Partially dry matter	**2.19**	**3.93**	**7.40**	**4.93**	**5.16**	**9.10**

Table for Total Dry matter t DM/ha

	T_1	T_2	T_3	T_4	T_5	T_6
Total Dry matter	**2.08**	**3.74**	**7.03**	**4.65**	**4.96**	**8.63**

Appendix 8: Presentations of gross returns from fresh, partially and totally dry fodder

Table 1: Gross return from fresh forage yields

	T_1	T_2	T_3	T_4	T_5	T_6
	Control/ No fertilizer	**CFYM only**	**CFYM & NPSZn**	**NPSZn only**	**NPSZn & SA**	**NPSZn & Urea**
Fresh Forage Biomass (Kg/100m^2)	62	99	202	126	142	247
Price per Kg (market price)	233.33	233.33	233.33	233.33	233.33	233.33
Total sales (**TZS**)	14 466.46	22 109.67	47 132.66	29 399.58	33 132.86	57 632.5
Total sales per 4 replicants (400m^2)	57 865.84	88 438.68	188 530.64	117 598.32	132 531.44	230 530

Table 2: Gross return from partially dried forage yields

	T_1	T_2	T_3	T_4	T_5	T_6
	Control/ No Fertilizer	**CFYM Only**	**CFYM & NPSZn**	**NPSZn Only**	**NPSZn & SA**	**NPSZn & Urea**
Partially Dried (Kg/100m^2)	22	39	78	49	52	100
Price per Kg	233.33	233.33	233.33	233.33	233.33	233.33
Total sales	5 133.26	9 099.87	18 199.74	11 433.17	12 133.16	23 333
Total sales per 4 replicants (400 m^2)	20 533.04	36 399.48	72 798.96	45 732.68	48 532.64	93 332

Table3: Gross return from totally dried forage yields

	T_1	T_2	T_3	T_4	T_5	T_6
	Control/ No Fertilizer	**CFYM Only**	**CFYM & NPSZn**	**NPSZn Only**	**NPSZn & SA**	**NPSZn & Urea**
Totally Dried (Kg/100m^2)	21	37	74	47	50	95
Price /Kg	233.33	233.33	233.33	233.33	233.33	233.33
Total sales	4 899.93	8 633.2	17 266.42	10 966.5	11 666.5	22 166.35
Total sales per 4 replicants (400 m^2)	19 599.72	34 533	69 065.68	43 866	46 666	88 665.4