Volume 12, No. 1, June 2022 **ISSN 0856-6070**

EASTERN AND SOUTHERN AFRICA JOURNAL OF AGRICULTURAL ECONOMICS AND DEVELOPMENT

Formerly Known as ***Journal of Agricultural Economics and Development***

The Quest for Development Information

Published by: **The Department of Agricultural Economics & Agribusiness, Sokoine University of Agriculture**

Publication
The *Eastern and Southern Africa Journal of Agricultural Economics and Development* (JAED) formerly known as *Journal of Agricultural Economics and Development* (ISSN 0856-6070) is henceforth published annually by the Department of Agricultural Economics and Agribusiness, Sokoine University of Agriculture, Tanzania. For *Guide to Authors* please see inside back cover.

Annual Subscription Fee
Africa: 20 US Dollars
Rest of the World: 30 US Dollars

For further information on sample copy requests, missing issue claims, orders and subscription enquiries, please contact:
The Managing Editor, Sokoine University of Agriculture
P.O. Box 3007, Chuo Kikuu, Morogoro, Tanzania
Telephone: +255754645157 OR +255764637253
Alternative telephone: +255754284455
Email: esa.jaed@sua.ac.tz

Eastern and Southern Africa

JOURNAL OF AGRICULTURAL ECONOMICS & DEVELOPMENT

Volume 12, No. 1, June 2022

Contents

Economic Viability of Improved Fodder Production in Iringa Region: Comparative Cost - Benefit Analysis of Different On-Farm Treatments

Mbwaga, A.I[1]., Mgeni, C.P.[2] and Kadigi, R.M.J. [3]*

Abstract

Inadequate fodder production and availability has been a challenge to the livestock farmers in Tanzania. This study assessed the economic viability of fodder production using on-farm treatments at ASAS farm in Iringa region. A Completely Randomized Design was employed to arrange 24 sub-plots (six treatments and four replications) in plots of 10m x 10m dimension making a 100m² which is equivalent to 0.025 acres. Sub-plots were spaced each at 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 (Chloris gayana) study was 2835m². The seeds were sown in each plot and fertilizers were applied in Treatment two -Cattle Farm Yard Manure (T2-CFYM), T3 (CFYM)+Nitrogen, Phosphorus, Sulphur, and Zinc (NPSZn), T4 (NPSZn), T5 (NPSZn)+Sulphate of Ammonium (SA) and T6 (NPSZn + Urea) while T1 remained as a control (no fertilizer). Through Microsoft Excel, Cost-Benefit Analysis was done to assess the economic viability of each treatment. The study findings revealed that Treatment 3 and Treatment 6 of the experiments yielded positive Net Present Values (NPVs) of TZS 346 601.3 and TZS 1 324 442; Benefit Cost Ratios (BCRs) of 1.46 and 1.72; and Internal Rates of Return (IRR) of 15% and 16%, respectively. It is concluded that the application of T3 and T6 to the Rhodes grass would improve fodder profitability. 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)

1 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, companies and individuals have invested in livestock keeping and milk production in Tanzania. According to FAO (2020), Tanzania is an agricultural country with nearly three-fourths of its population depending on

[1]Department of Economics and Statistics, Moshi Cooperative University, Tanzania.
[2]Department of Agricultural Economics and Agribusiness, Sokoine University of Agriculture, Tanzania.
[3]Department of Trade and Investment, Sokoine University of Agriculture, Tanzania
*Corresponding Author: aureliaissack@gmail.com

crop production and livestock keeping for livelihood. The country has the second largest livestock population in Africa standing at 39.9 million cattle, 99.6% of which are indigenous cattle 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 in the livestock subsector due to the size of the aforementioned animals. This provides a huge opportunity for fodder production. However, according to URT (2019), the opportunity for commercial fodder production, within the dairy sector is largely unexploited.

The dairy industry is a potential subsector in Tanzania as it contributes 30% of domestic production in the livestock sector and about 1.2% of the national Gross Domestic Product (GDP) (URT, 2017). The total annual milk production is currently estimated to stand at 2.7 billion litres (URT, 2019). Apparently, milk production is still low in Tanzania largely due to increasing cost of production compared to the per capita milk consumption. The per capita milk consumption is 47 litres per year, which is far less than the World Health Organisation (WHO) recommendation of 200 litres (URT, 2019). The low milk production has been associated with problems such as animal health and reproductive problems, lack of good quality animal feed, insufficient quantities and limited supply of dairy cattle (Njombe *et al*., 2011; Swai and Karimuribo, 2011; Kabirizi *et al*., 2013; Abdisa, 2018). Lack of good quality feed is reportedly one of the major contributors of low milk production in Tanzania because large and smallholder dairy farmers do not often meet their all-year-round feed demand from on-farm production (Waziri and Uliwa, 2020) attributable to poor fodder production practises. This concern, partly constitutes the motivation for this study which assesses the economic viability of improved fodder production under different treatments.

Several studies have been conducted on dairy farming in Tanzania. For instance, a study by Notenbaert *et al*. (2020) that focused on environmentally sound intensification pathways for dairy development; a study by the Ministry of Livestock and Fisheries (MLF) (2019) on economics of livestock sector in Tanzania (URT, 2017) and a study by Njombe *et al*. (2011) that explored milk and fodder production identification in Tanzania. Generally, these studies have recommended production of fodders to livestock farmers so as to reduce the scarcity of fodders during dry seasons. 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 of milk 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 have 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 different treatments (for example application of fertilizers) to measure the costs and benefit of fodder production. To that effect, the current study was designed to among other, determine the viability of fodder production being experimented at ASAS Dairies Farm Limited from different treatments.

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 investments at micro and macro level (Papendiek *et al.*, 2016). CBA serves two purposes: first, it determines the soundness of investments; second, it forms the basis for comparing projects (Kashangaki and Ericksen, 2018). CBAs are expressed in monetary terms and are adjusted for the Time Value of Money (TVM) so that all flows of project costs over time are described on a typical basis in terms of their Net Present Value (FAO, 2016). This theory was adopted in this study because it is appropriate for analysing costs and benefits of an investment by comparing the same with alternatives. Adoption of this theory was based on such studies as Islam *et al*. (2017) that 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. A similar study by Lukuyu *et al*. (2013) used the CBA approach to determine gross returns, gross margin, and net returns and conclude that labour constitutes the highest cost of production for all different technologies. Other similar studies that employed CBA include Papendiek *et al*. (2016) and Kadigi *et al*. (2021).

2 Methodology

2.1 Research Site Description and Selection Criteria

In this study, on-farm experiments were carried out at ASAS Dairy (Matembo) Farm, located about 25km from Iringa Municipality. This farm receives an average of 600-1000 millimeters (mm) of rainfall per annum (Appendix 1). ASAS Dairy farm was selected for the study due to on-going experiments on fodder production trials aimed at determining the most economical fodder production technology that can be used by the farm (ASAS) and other dairy farmers in Tanzania.

2.2 Research Design and Sampling Procedures

This was an experimental (Completely Randomised Design-CRD) study in which 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 such that each treatment appears in each plot and each plot receives respective treatment.

The experiment consisted of twenty-four (24) sub-plots resulting from six (6) treatments with 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 as selected forage to be established. Each subplot (replicate) had 10m x 10m dimensionmaking a 100m^2 which is equivalent to 0.025 acres each spaced 0.5m apart from the adjacent plot. Each plot received different treatments of fertilizer and there was a 1m wide path around the plot's boundaries. The total area for Rhodes's grass study was 2 835m^2 for the layout (see Appendix 2).

2.3 Data Collection

The experiment was carried out by ASAS in collaboration with researchers from the Sokoine University of Agriculture (SUA) from December 2020 to May 2021. The data collected include costs on seeds, hired labourers, manure, fertilizers, and transport while the fixed input costs were on land. These costs formed the basis for appraisal 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 averaging 350g fresh fodders from each treatment were weighed and taken to the laboratory for dry matter determination (Appendix4). All the costs (variable costs such as labour, soil testing, transport, seeds, fertilizers and manure testing) were recorded throughout the experiment for analysis in Microsoft Excel.

2.4 Data Processing and Analysis

Cost-Benefit Analysis (CBA) which is a discounted measure of project worthiness, that considers the Time Value of Money (TVM) was employed to determine viability of each block that recdived specified treatment. Net Present Value (NPV), Benefit-Cost Ratio (BCR) and Internal Rate of Return (IRR) were calculated and decisions were made by considering findings in each block (Appendix 3). The Rhodes grass production yields more grass in the second year of production until 6 years before removing all the grass in the farm (ILRI *et al.*, 2020), and for this study, 5 years were taken as a life span of the investment.

In Tanzania, interest rates decisions are taken by the Bank of Tanzania (BoT). As per Monthly Economic Review of July 2021 the BoT's official interest rate herein used as the discount rate was 5% (BOT, 2021). Social Discount Rate (SDR) was very important to be determined in this study as it can take into account the spillover effect of the project. 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, the CBA was repeated using different discounting rates (3.2%, 5%,8%, 9%, 10%, 11% and 12%). Because the interest rates change overtime, the sensitivity analysis was considered to examine how CBA changes under different discount rates (Appendix 2).

NPV was calculated using the formula in Equation (1)

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

Where C_t=Cost in period t; B_t= benefit in period t, and r = discount rate in %

The investment is profitable or feasible if the calculated NPV is positive when the costs and benefits are discounted at the opportunity cost of capital and not feasible otherwise.
The Benefit Cost Ratio is calculated using the formula in Equation (2)

$$B/C\ ratio = \frac{\sum_{t=0}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=0}^{n} \frac{C_t}{(1+r)^t}} \quad (2)$$

Where: B_t= benefit in period t; C_t=Cost in period t; r = discounted rate in % and t = investment period in years.

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.

The Internal Rate of Return was calculated using the formula in Equation (3)

$$IRR = r_1 + \left[\{r_1 - r_2\} * \left(\frac{NPV_1}{NPV_1 - NPV_2}\right)\right] \quad (3)$$

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 $> 0, Accept$ the investment and If IRR$>$ *cost of capital, accept* the investment.

3 Results and Discussion

3.1 Costs of Rhodes Fodder Production from Different Treatments

In this study, the production costs included different variable costs such as land preparation, land valuation, hired labour, seeds and fertilizers for the six treatments each with an area of 400m². The total variable costs of producing fodders were estimated to be TZS 163 324 in treatment one (T_1); TZS 210 224 in treatment two (T_2); TZS 216 984 in treatment three (T_3);TZS 171 644 in treatment four (T_4); TZS 175 228 in treatment five (T_5), and TZS 180 484 in treatment six (T_6),. 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 fertilizer, TZS 65 000 per 50kg; SA fertilizer, TZS 32 000 per 50kg and Urea fertilizer, 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 time of the experiment. Costs per treatment are as presented in Figure 1.

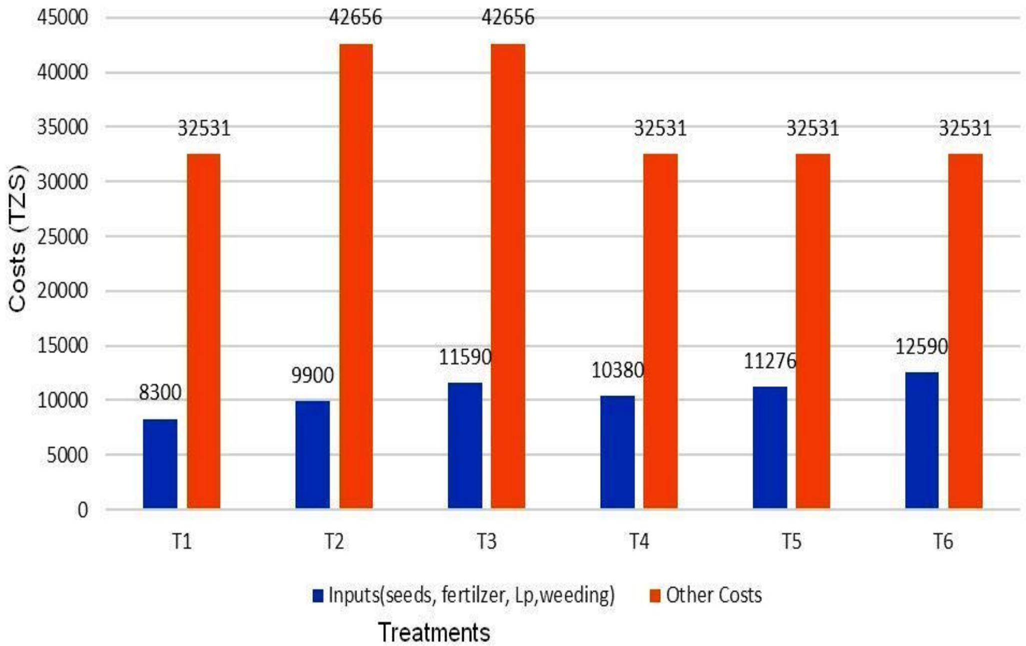


Figure 1: Variation of costs (TZS) by treatment: Plot of 10m x10m

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 their respective prices. Therefore, the estimated yield 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 price of Rhodes fodder (hay) was TZS 414 per kg, while a study by Lukuyu *et al.* (2016) shows the average price of fodder was TZS 3 500 per 15kg bale. Moreover, according to the SUA – Animal Science Department, the price of hay (Rhodes fodder) was 3 500 TZS 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).

3.2 Feasibility of using Different Fertilizers for Fodder Production (Two Cuts-Two Harvests per Year)

The costs and benefits results based on plot level data were converted into costs and benefits for investing in one acre of fodder production. The CBA results for investing in one acre of land are presented in Figures 2 to 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 additional fertilizer 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.

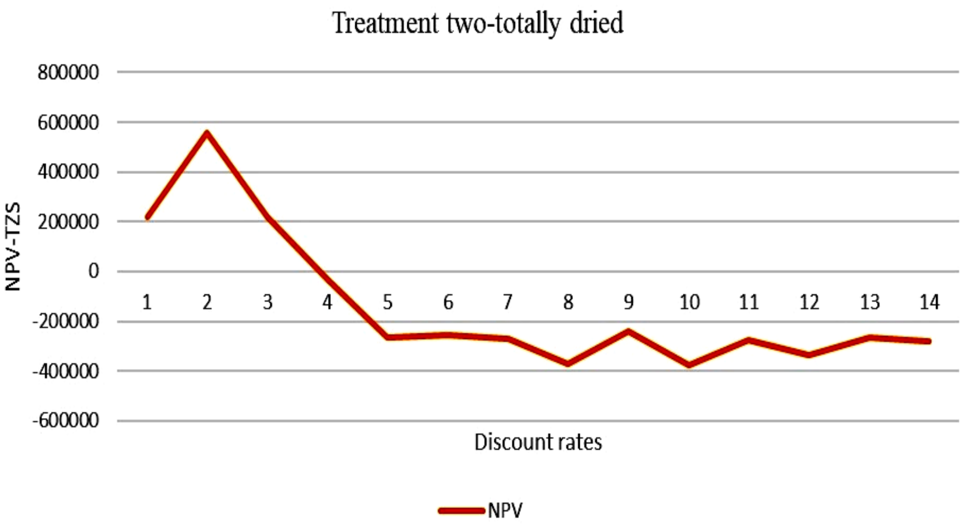


Figure 2: T_2 - A plot line of NPVs of T_2 at different discount rates per acre

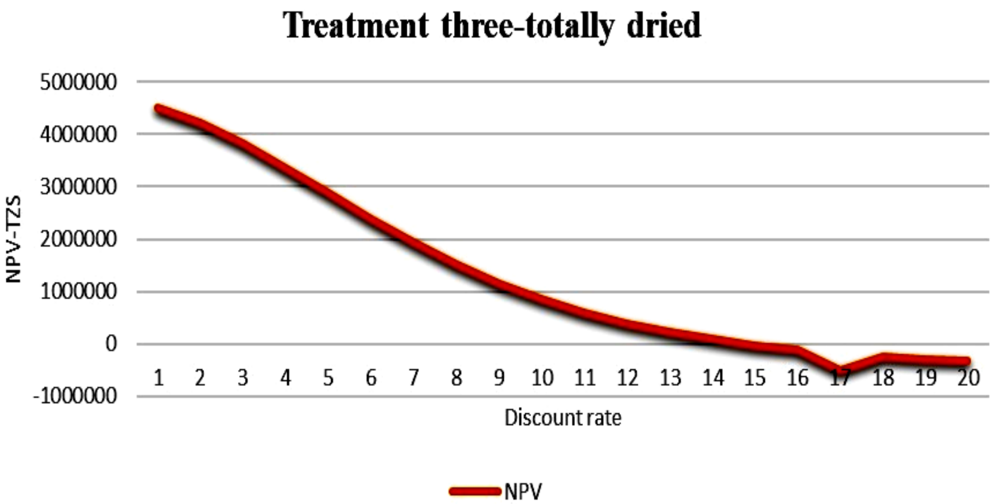


Figure 3: T_3 - A plot line of NPVs of T_3 at different discount ratesper acre

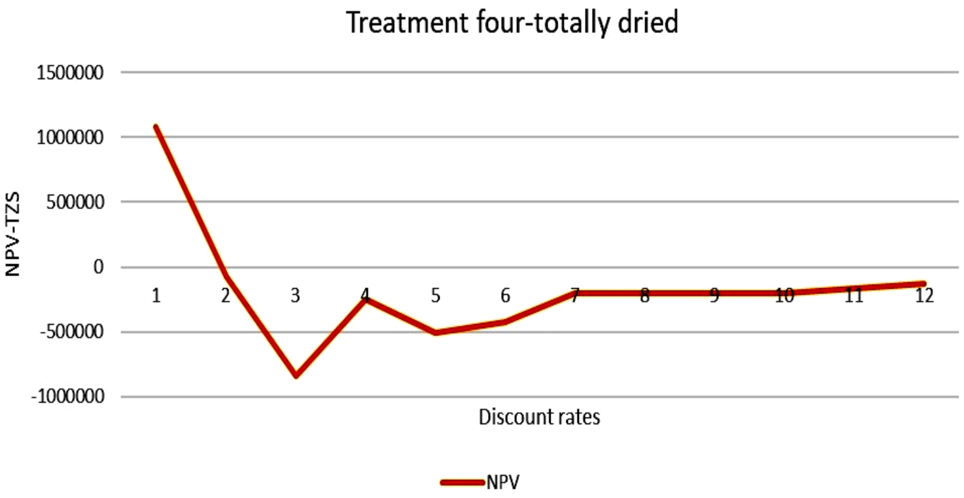


Figure 4: T_4 - A plot line of NPV s of T_4 at different discount ratesper acre

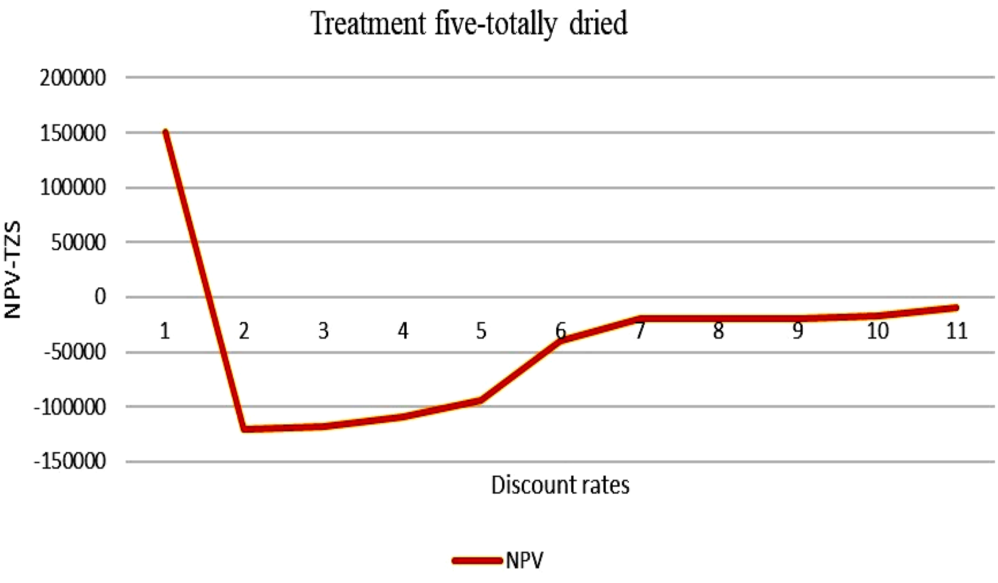


Figure 5: T_5 - A plot line of NPVs of T_5 at different discount ratesper acre

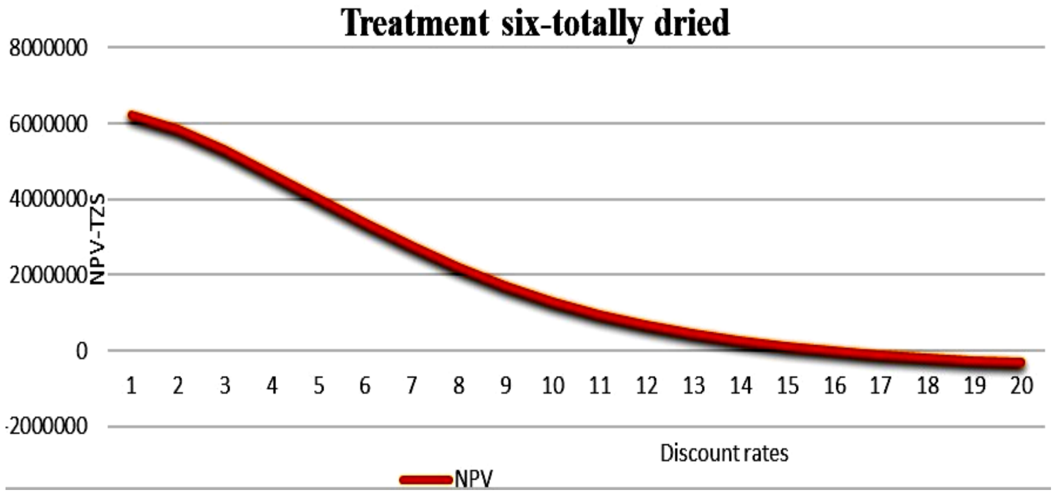


Figure 6: T6 – A plot line of NPVs of T6 at different discount rates per acre

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 investment 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 feasible. 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 feasible 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 3). 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 investiments in terms of expected revenue than T_1, T_2, T_4 and T_5.

If the farm management parameters and market prices of Rhodes grass hay 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). Based on the results from the experiments which were used to estimate costs and benefits from an acre of land planted with fodder, harvested twice a year, smallholder farmers would profitably produce Rhodes grass by using either CFYM mixed with NPSZn or NPSZn mixed with Urea. Furthermore, smallholder farmers could get enough revenue/profits on the first year of cultivating the Rhodes grass (hay) and, therefore, they should pay attention to the improved fodders. At the macro level, the adoption of fodder farming over a five year investment would have economic viability to ASAS farms. The total benefits exceeded total costs in year one of implementation by implementing T_3 and T_6. At the investment termination in year five, the total net benefit was TZS 1 037 147.37 and 1 391 818.45 for T_3 and T_6, respectively but T_6 was more profitable than other treatments and it is suitable for investment because T_6 used the mixture of NPSZn and Urea which are considered to be the best fertilizers for the Rhodes grass production.

4 Conclusion

The findings of this study showed positive NPVs for T_3 and T_6, while T_1, T_2, T_4 and T_5 showed negative NPV (Appendix 3). In order to make a good decision and to see if the investment was viable, it was necessary to check on BCR and IRR. Similarly, the results indicated that for T_3 and T_6 the BCR was greater than one and IRR was greater than 11 percent. These findings implies that when hay is sold as totally dried at 233.33 TZS/kg within two seasons, smallholder farmers and ASAS farms will reap more benefits.

Findings from the six experiemental plots show that dairy companies may produce enough fodder for themselves and extra fodder to sell to other livestock keepers. The experimental plots at ASAS Farm can be used 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 through on-farm trials at ASAS Farm) to minimise shortage of fodder during dry seasons in the country. Fertilizer applications such as NPSZn, CFYM and Urea should be promoted to improve the quantity of Rhodes grass production.

Acknowledgements

This article is part of the thesis submitted to SUA for an award of MSc. Agricultural and Applied Economics. Authors are grateful to anonymous reviewers' valuable comments that improved the manuscript. Our acknowledgements are also due to the African Economic Research Consortium (AERC) for their financial support and ASAS Dairies company for allowing us

to undertake an experiment at Matembo Farm.

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 (2020). Monthly Economic Review.https://www.bot.go.tz/Publications/Regular/Monthly%20Economic%20Review/en/2021020412091680.pdf

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

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. [Research Gate " 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). The Tanzania Dairy Industry: Status, Opportunities and Prospects. A Conference paper presented at the 7th African Dairy Conference and Exhibition. Moven Pick 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 (2017). Tanzania Livestock Analysis (2016/2017-2031/2032). Ministry of livestock and fisheries. 58pp.

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

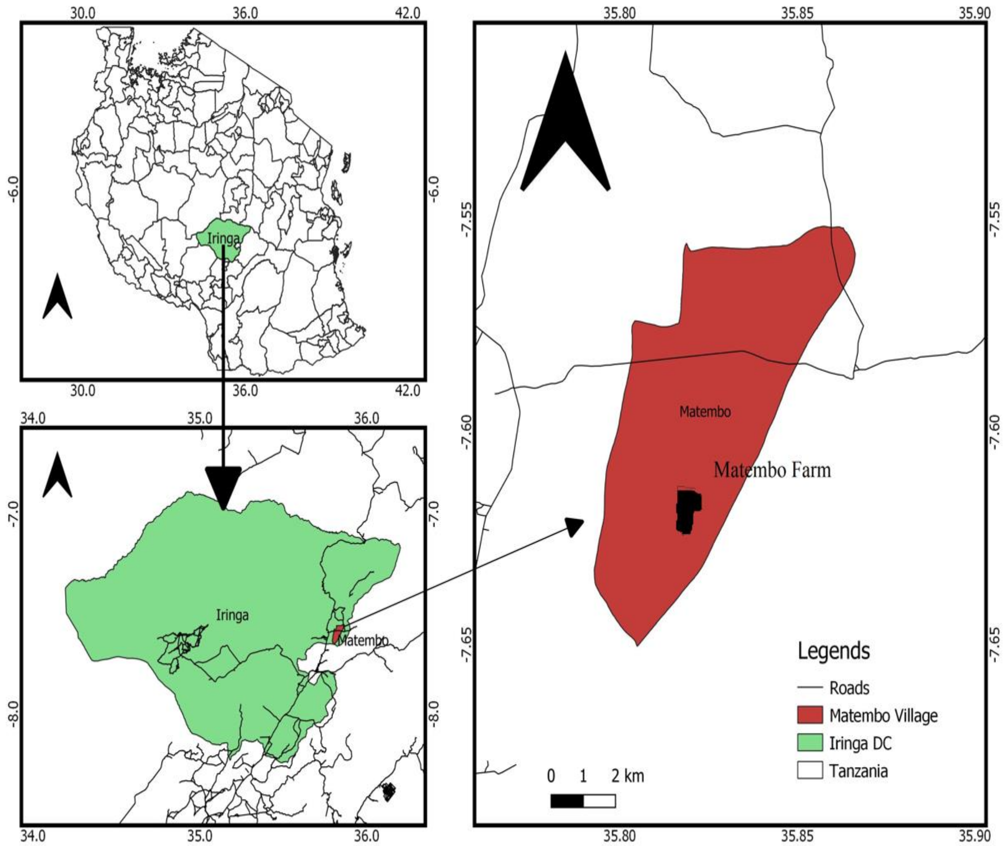
United Republic of Tanzania (2016). Agricultural Sector Development Strategy -II Republic of Tanzania. 97pp.

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

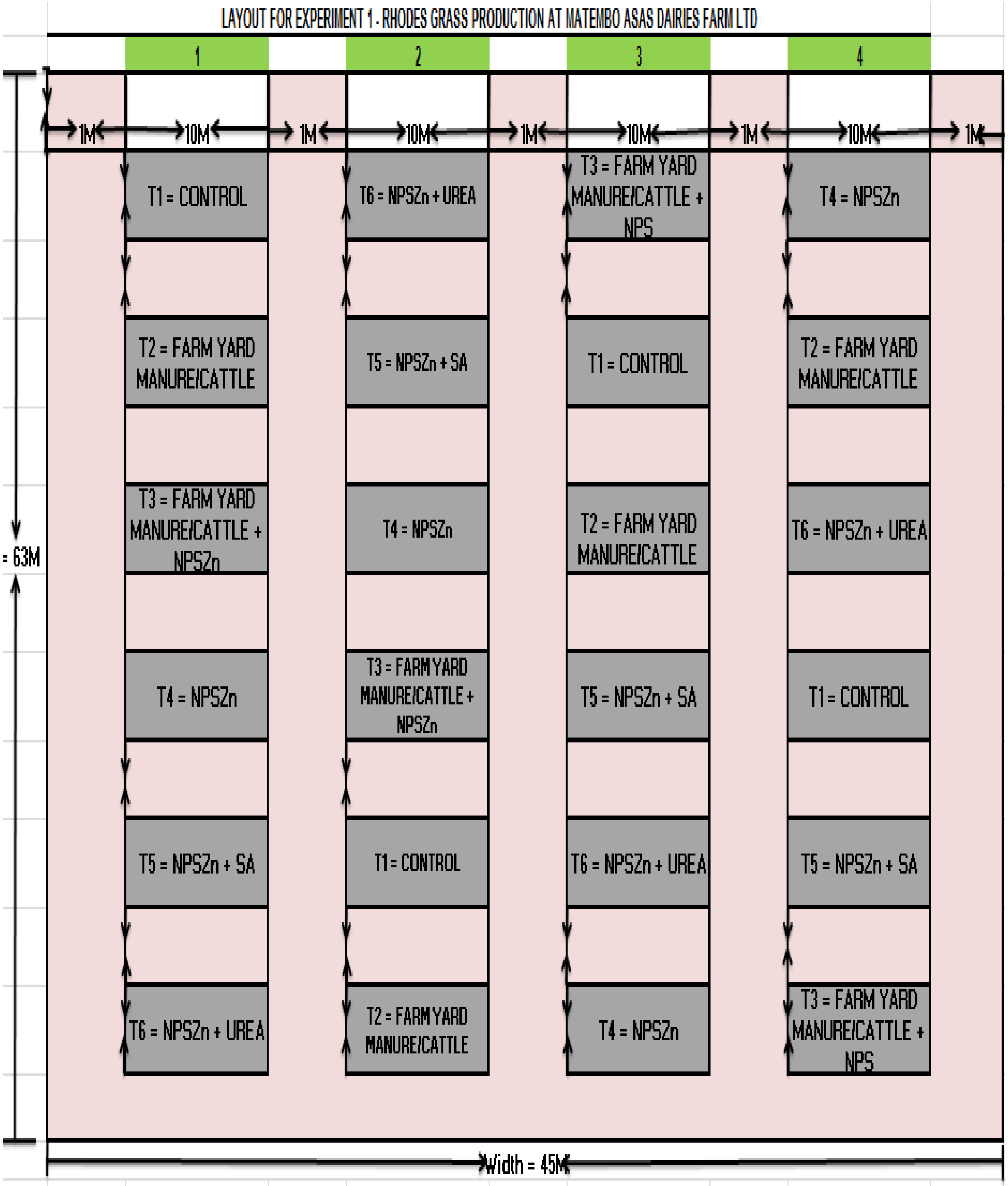
Waziri, M.D. and Uliwa, P. (2020). Supply and Commercial Viability of Forage in Tanzania. American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS), 66(1): 145-156.

Appendices

Appendix 1: Map of Tanzania showing Iringa region-Matembo Farm



Appendix 2: Layout of the experiment



Each replicate/Plot =	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: Comparison of Economic Viability between treatments (Totally Dried-sensitivity analysis)

Treatment 1

	Discount rate						
	3.2%	5%	8%	9%	10%	11%	12%
PVB	535120.1	395750.6	203870.1	155769.6	116586.9	85623.2	61780.9
PVC	1173843	1034727.5	338134.7	7178243	247456.7	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						
	3.2%	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

	Discount rate						
	3.2%	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 4: Results from The Laboratory for Dry Matter Determination

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	4.95	8.63