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Bridging the Dry Season Dairy Feeding Gap using Quality Rice Residue based Total Mixed Rations in Northern Uganda

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Abstract: ***Urban small holder dairy production is challenged by non-sustainable supply of good quality forage especially in the dry seasons. This study aimed at establishing the economic potential benefit of rice straw based Total Mixed Rations (TMRs) based small holder dairy production. Four dietary treatments prepared using Maize bran (MB), rice straw (RS), molasses (MO), soymeal (SY), sunflower cake (SF) and mineral premix (MIN); TMR1 (MB 5, SY 5, SF10, RB 10, RS 65, MO 10, and MIN 1%), TMR2 (MB 5, SY 10, SF4, RB 10, RS 50 MO 10, and MIN 1%), TMR3(MB 4, SY 15, SF5, RB 25, RS 40, MO 10, and MIN 1%) and TMR4 (MB 10, SY 15, SF10, RB 24, RS 30, MO 10, and MIN 1%) were compared with a control treatment (Panicum hay diet). Each dietary treatment was fed to each of the five Friesian Ankole crosses in a 5x5 Latin square design. Data were collected on dry matter intake (DMI) and milk yield, crude protein intake, total digestible nutrient intake and milk yield per unit crude protein intake determined. The TMR parameters determined included dry matter, crude protein, organic matter digestibility and total digestible nutrient (TDN). Highest DMI, milk yield, CPI, TDN of was obtained in TMR1(15.191 kg cow^{-1} d^{-1}, 562.1 g cow^{-1} d^{-1}15.54 g cow^{-1} d^{-1}, 1538 g cow^{-1} d^{-1}) and least in the control diet (7.98 kg cow^{-1} d^{-1},7.89 L cow^{-1} d^{-1},383.5,1412.3 g cow^{-1} d^{-1}) respectively. Compared with the control, milk yield increased by 96.95, 88.34,67.8 and 37.90% for TMR1, TMR2, TMR3, TMR4, respectively; while the net milk benefits increased by 215.62, 242., 225.99 and 212.93% for TMR1, TMR2, TMR3, TMR4, respectively for the period of 70 days. TMR3 gave the highest net benefits, implying the nutrient profile of the diet met the minimum requirements to exploit the production potential of the Friesian crosses used in the study. Any additional increase in feeding costs through feed quality beyond that of TMR3 gives no economically valid improvement in milk production. This implied that the production potential of the dairy breeds used is maximized by feeding with TMR3. TMR-based small holder dairy production is observed to be an economically viable intervention.***

Keywords: Crude protein, digestible, economic benefits

1. Introduction

Dairy cattle is one of the livestock commodities whose potential has not been fully utilized, with its potential to liberate small holder farmers from poverty and nutrition related challenges, efforts must be made to improve its contribution to farming community livelihood. For the case of northern Uganda, achieving the expended dairy output necessary to meet prospective demand is still a grave challenge (Nviiri *et al.*, 2014), this is due to the multitude of production related challenges ranging from limited access to stress tolerant breeds to feeding. Although attempts have been made to improve on the feeding quality, through promotion of pasture farming based dairy production, the level of adoption is still low a consequence of the knowledge gap (Nviiri *et al*., 2016). According to ILRI (1995), nutrition is by far the greatest challenge as regards ruminant livestock production and to a greater extent dairy production, typical of northern Ugandan case. It's well-known that optimum nutrition of dairy cattle is one of the basic prerequisite for sustainable milk production and full use of their milk production potential of the respective dairy breeds (Kabirizi, 1996). Since the function of the ruminant digestive tract and fibre utilization in feeds is influenced by the feeding technique, efforts must be made to develop feeding techniques which improve on the palatability and utilization of the poor quality dry season feed resources. The form of offer of the fibre rich feeds can be further improved through total mixed rationing aiming at improving the rumen environment to facilitate fibre digestion. During the dry seasons, the naturally available feed resources like crop residues and standing hays are challenged by the anti-nutrient factor lignin which complexes with then cellulose and hemicellulose which makes these digestible fibre fractions un available in the diets (Nviiri *et al.*, 2014). Among the many crop residues properly treated rice straws have shown promising results while fed to dairy cows. However, the economic relevance of using rice straw is not yet established especially when there is need for supplementation as technique to improve on the straw fibre utilization. Besides that, also the acceptability of the straws needs to be improved for maximum intake which can be best done through total mixed ration. This study therefore aimed at establishing the economic potential benefit of rice straw based Total Mixed Rations (TMRs) utilization for small holder dairy production systems in Northern Uganda, hence developing cost effective rations from rice straws which can be used for dairy cows at different levels of production.

2. Methods and Materials

2.1 Site of experiment

This study was conducted at the Ngetta Zonal Agricultural Research and Development Institute (ZARDI). The institute is located at a latitude of 02°17.657'N, longitude of 032°55.171'E and altitude of 1090 m above sea level. The area has a bimodal rainfall pattern, with April to May and August to November as the first and second rainy seasons, respectively. The average annual rainfall ranges between 1300 and 1660 mm. The mean daily maximum temperatures of the area may exceed 33°C, while the minimum temperatures range between 10°C and 15°C.

2.2 Experimental animals and their management

Five lactating Friesian-cross cows in early lactation were selected from the milking herd at Ngetta ZARDI. The cows were fed separately five dietary treatments, and were milked twice a day (07:00 and 17:00 hours) during the feeding trial with adjustment and collection periods lasting for two weeks and one week, respectively. The five dietary treatments were compared using the five milking cows in a 5 x 5 Latin square design. The experimental TMRs and water for drinking were given to the experimental cows *ad-libitum*, and milking was done twice a day. Feed samples were collected for laboratory analysis on every third day of feeding to be analyzed for crude protein total digestible nutrient, and organic matter digestibility.

2.3 Data collection

To determine the intake of the TMR by each cow, the amounts of the TMR offered to each cow and refused were recorded daily and the dry matter left was determined. The milk yield of each cow was recorded daily at each milking.

2.4 Chemical analysis

During the feeding trial, representative feed samples were taken per batch for DM determination. Thereafter, the samples were ground through a 1 mm screen before taken for further laboratory analysis. The samples were analyzed for Crude protein (CP), Total digestible nutrient (TDN) and Organic matter digestibility (OM dig).

2.5 Statistical analysis

Effects of dietary treatments on milk yield and daily feed intake were analyzed as a 5x5 Latin square design using the PROC GLM procedure of SAS (2003), with the model: $Y_{ijkl} = \mu + C_i + P_j + D_k + e_{ijkl}$ where Y_{ijkl} is the milk yield, μ is the overall mean effect, C_i is the cow effect, P_j is the experimental period effect, D_k is the dietary treatment effect and e_{ijkl} is the random error.

2.6 Economic analysis

The associated net benefits with the different TMRs investigated in the northern agro ecological zone were also determined to guide farmers in decision making while choosing between the alternative total mixed rations. The costs that varied with treatments included costs incurred (per day) in purchasing the ingredients used in preparing the TMRs, transportation and application of different quantities of feeds to the feeding stalls. The total costs that vary for each TMRs were calculated by adding up the cost as described by CIMMYT (1989).

3. Results and discussions

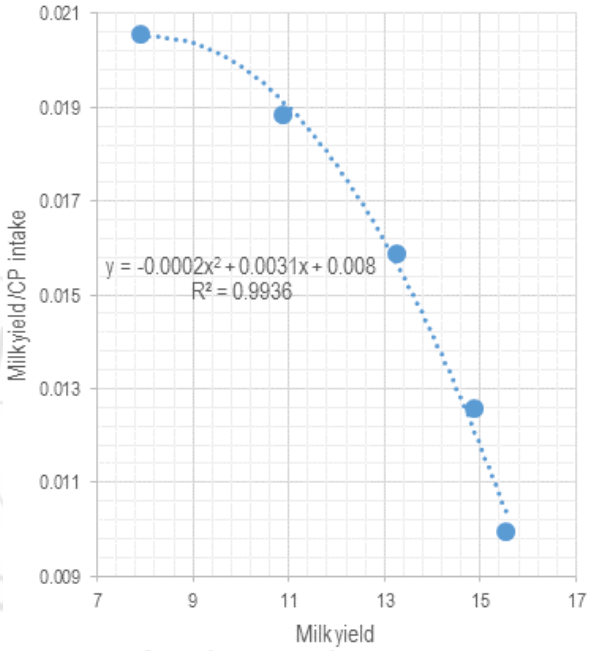

Figure 1: variation of daily milk yield and milk yield per unit crude protein (CP) intake

The milk yield per unit protein intake shows an inverse relationship following a quadratic trend with daily crude protein intake, implying that the utilization efficiency of the crude proteins can be improved through adding less proteins to the fibrous crop residue based diet to improve on the utilization of the digestible fiber in the total mixed rations.

Table 1: Dry matter intake (DMI), TDN intake and milk yield of Friesian-crosses on the five TMR dietary treatments

Dietary treatments	DMI (kg/cow/d)	Milk yield (Lts/cow/d)	CP intake g/cow/day	TDN intake (g/cow/d)
TMR 1	15.19^{a}	15.54^{a}	1562.1^{a}	1538.7^{bc}
TMR 2	13.42^{b}	14.86^{a}	1180.5^{b}	1858.8^{a}
TMR 3	12.16^{c}	13.24^{b}	834.4^{c}	1801.2^{b}
TMR 4	8.29^{d}	10.88^{c}	577.7^{d}	1719.1^{ab}
Control	7.98^{d}	7.89^{d}	383.5^{e}	1412.3^{c}
LSD	0.8003	0.5631	83.82	72.92
P - value	<0.0001	<0.0001	<0.004	<0.0015

^{ab}*Means within the same column with different superscripts are significantly different (P<0.05)*

The milk yields were maximum for TMR1which registered the highest crude protein and dry matter intake. The milk yield is a function the quantities of nutrient especially crude protein that can be ingested by the cow. The assimilated nutrients are dependent on the extent to which microbial fermentation can break down the structural carbohydrates to

the volatile fatty acids. This implied that crude protein was the first limiting nutrient as regards the utilization of the fibre from the low quality crop residue based feed resources. However the total digestible nutrient intake however was still lower as compared with that of TMR2 and TMR3. Implying that three was still room to improve the TMR2 and TMR3. A farmer therefore can sustainably maintain a medium yielding dairy cow using TMR1. For the case of the scavenged pasture forages, the botanical fractions were composed basically of highly lignified stems from mixed plant species. The species are of low nutritive quality and have a high composition of lignin which complexes with the cellulose and hemicellulose which greatly inhibit their utilization.

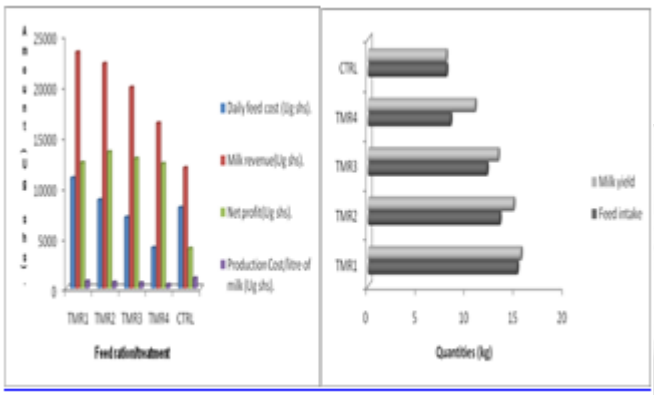

Figure 2a **Figure 2b**

Figure 1: Ration utilization efficiency in relation to feed quantities and associated costs.

The daily feed cost is maximized in TMR1 and minimized in TMR4, the milk revenue is maximized when TMR1 is used and minimized in the control diet. The net profit is maxinmized when TMR2 is used and minimum with control diet. This implies that the control diet comprizing of natural standing hays and non supplimeted crop residues is poorly utilized by the dairy cows yet the cost of obtainig these feed resources is relatily high, *fig 1(a).* The milk yield was minimum for minimum dry matter intake in the control diet and maximum for TMR. However TMR4 was better utilized with the highest milk yield to feed intake ratio. This implies that it had the minimum protein requirement for effective fiber utilization for the fibrous crop residues. The crude protein utilization efficiency for the diets was there for maximum for the minimum crude protein composition which corresponds to TMR4, *Fig 1(b).*

3.1 Economic Analysis

Table 2: Cost-benefit analysis table for the different feeding regimes

	Feeding treatments				
Parameters	*TMR1*	*TMR 2*	*TMR3*	*TMR4*	*Control*
TTCV (Ugx)	10,924.6	8,748.6	7,029.3	4,013.6	7,982
DFC (Ugx)	702.9	590.4	530.8	371.2	1005.3
DGB (Ugx)	23,370	22,248	19,884	16,353	11,925
DFR(kg)	15.4	13.4	12.1	8.3	7.9
DND (Ugx)	12,445	13,499	12,854	12,339	3,943

1 US$=2,800 Uganda shillings

TTCV: Total costs that vary in feeding experimental diet (Ugx), DFC: Daily feeding cost (Ugx), DGB: Daily gross milk benefits (Ugx). DFR: Daily feed requirement (kg), DND: Daily net benefits (Ugx).

The results indicated that the marginal rates of returns; 215.62% 242.35% 225.99%, 212.93% for TMR1, TMR2, TMR3, TMR4 respectively. According to CIMMYT (1989), the minimum MRR for acceptable to farmers before making a decision to change from old practice to a new practice is 50%, holding other factors constant, the MRR for using the total mixed rations instead of using the conventional methods is more than four times the 50% threshold. This result justifies the potential of the total mixed rations as a dry season feeding strategy in northern Uganda.

4. Conclusion and Recommendations

The total mixed ration based dairy production is a profitable feeding strategy especially for small holder peri-urban farmers were there is ready market for milk and as long as the price of milk doesn't fall below 800 per liter. However, the intervention is still challenged by the lack of machinery required to crush the crop residue in the form that can facilitate the mixing of the total mixed rations. The adoption of total mixed ration feeding technologies can be accelerated through improving on the availability of the motorized crop residue pulverizers followed by bridging the information gaps.

5. Acknowledgements

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References

[1] **AOAC, 1990**. Association of Official Analytical Chemists official methods of Analysis, 15th Ed. AOAC Inc. Arlington, Virginia USA.

[2] **CIMMYT. 1988.** from agronomic data to farmer recommendations: An economic training manual. Completely revised edition. Mexico. D.F.

[3] **Geofrey Nviiri, H. Okello, P. Nakyewa and G. A. Maiteki. 2014** Extent of availability of major nutrients from selected Cereal Crop Residues to dairy ruminants as an alternative Dry Season Forage in Northern Uganda. Journal of Advances in Agriculture **161**,158-161

[4] **ILRI. 1995**. Livestock policy analysis. ILRI Training Manual 2. International Livestock Research Institute (ILRI), Nairobi, Kenya. pp. 264.

[5] **Kabirizi, J.M.L. 1996**. Productivity of Lablab purpreus [L.Sweet] cv Rongai and its feeding value as supplement for lactating dairy cow. MSc. Thesis Makerere University, Uganda.

[6] Livestock Systems Research Programme (LSRP), 1999. Masaka District Diagnostic Survey Report. Masaka, Uganda.

[7] **Pacovsky RS, Bethlenfalvay GJ, Paul EA. 1986.** Comparisons between P-fertilized and mycorrhizal plants. Crop Sci. **26**, 151—156.
[8] **Tilley, J.M.A**. and **Terry**, **R.A. 1963**. A two-stage technique for in vitro digestion of forage crops. Journal of British Grassland Society 18: 104-111
[9] **Van Soest, P.J., 1963.** Use of detergents in the analysis of fibrous feeds. 11. A rapid method for the determination of fibre and lignin. J. Assoc. Off. Anal. Chem. 46, 829 - 835.