ENHANCING THE PERFORMANCE OF CUT-AND-CARRY BASED DAIRY PRODUCTION IN SELECTED PERI-URBAN AREAS OF THE UNITED REPUBLIC OF TANZANIA THROUGH STRATEGIC FEED SUPPLEMENTATION

R. NKYA, B.M. KESSY, M.N. SHEM, I.E. MWANGA
Sokoine University of Agriculture,
Morogoro, United Republic of Tanzania

Abstract

ENHANCING THE PERFORMANCE OF CUT-AND-CARRY BASED DAIRY PRODUCTION IN SELECTED PERI-URBAN AREAS OF THE UNITED REPUBLIC OF TANZANIA THROUGH STRATEGIC FEED SUPPLEMENTATION.

A survey was conducted in 81 smallholder farms in the peri-urban areas of Morogoro (Site I: n=52) and Dar es Salaam (Site II: n=29). The results showed that food supply was insufficient and of poor quality resulting in the poor performance of cows. In order to investigate the effect of farm-formulated concentrate (FC) or urea-molasses multinutrient-blocks (UMMB) in improving the productive and reproductive performance of dairy cattle, two feeding trials were carried out in 56 farms, 48 at Site I and 8 at Site II. The cost:benefit analysis determined their suitability for incorporation in dry season feeding. The FC was given to 14 farms at Site I (n=37 cows) to be incorporated in the diet of cows at the rate of 0.8 kg per litre of milk produced. The UMMB was tested in 18 farms (14 at Site I and 4 at Site II), fed to 27 cows (18 in Site I and 9 in Site II) at approximately 0.7 –1.0 kg per cow per day. The Control group comprised of 14 farms (10 at Site I and 4 at Site II) with 28 cows (20 at Site I and 8 at Site II). The supplements were introduced to the farms after successful on-station trials for acceptability by dairy cows. Chemical composition and *in sacco* rumen degradability of the major feeds showed low CP content and degradability. Supplementation of forage with FC and UMMB was associated with increased milk production of 1.26 and 1.5 litres per cow/day and BCS and body weight changes of 0.2 and 4 kg and 0.25 and 8 kg, respectively. The improvement in milk yield, BCS and body weight change were significantly different in the UMMB supplemented cows ($P < 0.05$), but were similar in the FC supplemented cows ($P > 0.05$), and the control groups. Both supplementation strategies had no significant effect on reproductive performance. However, there was a slight reduction in the number of days postpartum (DPP) to first progesterone rise (65.3 vs 77.6), DPP to conception oestrus (120.2 vs 128.7), and calving interval (400 vs 414.5 days) in the UMMB supplemented cows compared to non-supplemented control animals. Conception rate improved from 48% in the control cows to 68% in the supplemented cows. Supplementation of dairy cows with FC and UMMB was cost effective when milk production increased by 0.93 and 0.66 litres/cow/day (break even increase) in the respective groups. The increase milk production gave a profit of US$ 0.11–0.29 per cow/day, which was a considerable increase in income in the case of small-holder farmers.

1. INTRODUCTION

Dairy production is an enterprise for smallholder farmers in many parts of the United Republic of Tanzania. Milk production in The United Republic of Tanzania relies partly upon the smallholder dairy sector, which comprises of rural and peri-urban farms. The peri-urban dairying, which is on the increase in recent years, is based on crosses of Zebu and exotic breeds of dairy cattle sustained on zero grazing, on local grasses with limited supplementation. The major forage for the animals during the dry season with all farmers is dry grass and/or maize stover or rice straw. The quality of the feed in dry season is insufficient to support satisfactory milk production and reproductive performance. The poor quality of the feeds render the dairy cows deficient in protein, and therefore do not meet maintenance and production requirements [1, 2].

Farm made concentrates (FC) have been shown to improve smallholder dairy cattle performance [3]. However, farmers rarely supplement their cows with protein concentrates because of the high cost of supplements. The use of UMMB as a supplement during the dry season has shown to increase milk production [4, 5] and improve growth rate in yearling heifers [6].

Milk progesterone determination by radio-immunoassay (RIA), in conjunction with rectal palpation and other relevant farm management records [7] has widespread application in monitoring of the reproduction function and disorders: identifying non-pregnant animals, silent heat, ovarian cyclicity, cystic follicles, retained corpora lutea (CL) and irregular cycles, in different species.

This paper discusses the effects of supplementation using FC and UMMB during the dry season on productivity and reproductive performance of dairy cows in Morogoro and Dar es Salaam municipalities. The cost:benefit analysis of the supplementation was carried out with the aim to determine their suitability for incorporation in dry season feeding of dairy cows.

2. MATERIALS AND METHODS

The study was conducted in two phases (survey and intervention) at two sites (Site I and Site II) during the dry seasons of years 1998 to 2000.

2.1. Survey

Before the beginning of the intervention phase, a brief survey was conducted in 52 farms in Site I and 29 farms in site II, with a major focus on farm management practices, using a structured questionnaire and interviews. At the end of the survey, willing farmers were selected randomly for the next phase.

2.2. Study sites

The two project sites I and II are municipal areas with high concentration of dairy cows managed at a smallholder level typical of peri-urban areas. Site I, Morogoro, is located 200 km west of Site II, Dar es Salaam. Both sites are located in the typically hot and humid semi-arid eastern United Republic of Tanzania with minimum and maximum temperatures ranging from 15–23°C and 32–34°C respectively, and relative humidity of 65–85%. Site I is situated at an altitude of 528 metres above mean sea level (msl) and Site II at 14 msl. The annual rainfall is between 800–1400 mm. Both sites have two seasons: a rainy season (March to May) and a dry season (June to February) interrupted by short rains in October to December.

2.3. Animals and Management

Smallholder farmers (48 at Site I and 8 at Site II), who were willing to participate in the study owned on average 4 milking cows and 1–2 ha of land for cultivation of food crops, with no land specifically allocated for pasture production. The animals, normally crosses of Zebu and exotic dairy breeds were in their second to fourth parity, with a daily milk production of 4–10 L and a BCS ranging from 2–4. The animals were kept indoors throughout and were zero grazed with the grasses, *Panicum maximum, Hyperrhenia rufa, Neonotonia, Wightii, Penisetum* and *Cynodon spp.* The major forage for animals during the dry season for almost all farmers was dry grass and/or maize stover.

Early weaning is the normal practice amongst the farmers. Cows are milked twice a day. Breeding is by artificial insemination (AI), natural service or both. Oestrus detection is done by the owner or herdsman at the time of milking, feeding or cleaning the barn.

2.4. Measurements and analyses

2.4.1. Milk production and body condition

Milk yields were recorded daily on data entry forms. The body weights of the cows were estimated by heart girth measurement using a measuring tape and that of calves using a spring balance. The body condition score was determined using the 1–5 scale with manual palpation of the lumbar spines.

2.4.2. Feeds

The amounts of forage and supplements given to cows were estimated and recorded and samples taken from representative farms for analysis for dry matter (DM), crude protein (CP) and ash content using methods described by AOAC [9]. Feed digestibility was estimated by the nylon bag technique on surgically rumen-cannulated steers [10].

2.4.3. Milk samples for progesterone RIA

Whole milk samples were collected by farmers or technicians during routine visits, processed according to the recommendations for collection and processing of samples and were analysed using the FAO/IAEA self-coating milk progesterone RIA kits supplied by the International Atomic Energy Agency [11].

2.4.4. Reproductive parameters

Dates of calving, occurrence of postpartum oestrus, inseminations and number of services per conception were recorded. Postpartum anoestrus intervals were determined from progesterone concentrations less than 1 nmol/L and the interval from calving to first oestrus when progesterone concentrations were above 1 nmol/L. The interval to first detected oestrus was determined from oestrus observations by the farmers and technicians/researchers during bi-weekly visits. Conception date was determined based on the elevated and sustained progesterone concentrations three weeks after insemination and was confirmed by rectal palpation. Calving interval was calculated from the actual dates of two successive calvings.

2.5. Supplementation trials

Two Trials were conducted to determine the effect of FC and UMMB as feed supplements on the performance of dairy cows during the dry season. Both supplements were taken to the smallholder farms after they were successfully tested on-station for acceptability by cows.

2.5.1 Supplementation with FC (Feeding trial I)

The FC, consisting of cotton seed cake, maize bran, mineral mix (brand Maclicke) and common salt (NaCl) (Table I), was fed to 37 cows at the rate of 0.8 kg per litre of milk produced. The components were mixed using shovels. This trial was carried out at Site I and a total of 24 farms participated; 14 farms (37 cows) being in the treatment group and 10 farms (28 cows) in the Control group. The animals in the Control group received 0.6 kg of maize bran per litre of milk produced.

2.5.2. Supplementation with UMMB (Feeding trial II)

The UMMB (see Table I for composition) was tested on 18 farms (14 at Site I and 4 at Site II), and was fed to a total of 27 cows (18 at Site I and 9 at Site II). The level of UMMB intake ranged from 0.7–1.0 kg per animal/day. The Control group of 28 cows (20 from Site 1 and 8 from Site II) were from 14 farms (10 at Site Site I and 4 at Site II). Each cow in the Control group received 0.6 kg of MB.

For the preparation of the UMMB, a modified cold process described by Sansoucy et al. [12] was used where the content of maize bran was increased and that of molasses decreased in order to obtain sufficient hardness of the blocks. Fertiliser grade urea, limestone, salt, and bone meal were also included. Cement was used as a binder to solidify the blocks. All solid components were mixed by hand. The salt was ground to a powder and mixed with water and added to the molasses. The liquid component was added to the solid component and mixed thoroughly by hand. The resulting mixture was transferred into wooden moulds (0.25 m × 0.2 m × 0.2 m) and pounded with wooden poles until satisfactory consistency was obtained. Following this, the blocks were removed from the moulds and air dried for at least two days.

In all trials farms were randomly assigned to treatment and control groups. The supplement FC was given postpartum and UMMB 1–2 months both pre- and postpartum. The trials lasted for 90–120 days.

TABLE I. COMPOSITION OF THE SUPPLEMENTS (% INCLUSION BY WEIGHT)

Component	FC	UMMB
Cotton seed cake	28	0
Mineral mix	1	0
Maize bran	70	33.5
Salt (NaCl)	1	2.3
Molasses	0	23.0
Urea	0	9.3
Limestone	0	4.6
Cement	0	13.0
Bone meal	0	2.3
Water	0	7.0
Total	100	100

2.6. Data analysis

Analysis of data was carried out using ANOVA to test differences in means using the linear model procedure with milk yield, BCS and reproductive parameters as dependent variables. The Student's t-test was used to compare differences in mean values of production and reproduction parameters, in treatment and control groups.

3. RESULTS

3.1. Survey phase

3.1.1. The availability and quality of feed

The survey conducted at the two Sites I and II showed that farmers rarely supplemented their animals with protein concentrates. At milking time, animals in all farms received a supplement of maize bran on very rare occasions the maize bran mixed with cotton seed cake, brewers waste or some mineral mix/lick. The supplement was given at an average rate of 0.6 kg/L of milk produced. Feed was scarce during the dry season and therefore animals received insufficient amounts of forage (<8.0 kg/day) most of the time. Feed analysis indicated low CP content and rumen degradability (Table II) in the dry season feeds as compared to the supplements (FC and UMMB).

TABLE II. CHEMICAL COMPOSITION AND *IN SACCO* DRY MATTER DEGRADABILITY OF DRY SEASON FEEDS AND SUPPLEMENTS (DATA ARE ON DRY MATTER BASIS)

Component (%)	Grass	Maize bran	UMMB	FC
DM	88.3	90.9	89.3	94.3
N	0.8	1.8	5.8	2.6
ADF	39.8	7.2	3.6	55.8
NDF	73.4	30.1	19.5	48.6
Ca	0.27	0.01	5.3	1.28
P	0.18	0.63	0.82	0.22
In sacco DM degradability (%)				
24 h	32.6	75.8	nd	nd
48 h	41.4	87.4	nd	nd

nd, not determined

3.2. Intervention phase

The mean values of each production and reproductive parameter for the UMMB supplemented cows at the two sites were pooled since no significant differences between the two sites were observed.

3.2.1. Production parameters

Milk yield of cows supplemented with FC (Feeding trial I) and UMMB (Feeding trial II) increased from 6.75 L/d to 8.0 L/d and 5.5 L/d to 7.0 L/d, respectively, an increase of 1.25 and 1.5 L/cow/day for the two supplements. The increase in milk yield was non-significant in the FC group but was significantly different ($P < 0.05$) from the control in the UMMB supplemented cows. The respective changes in body weight and BCS in the treatment group as compared to the control group were 4 kg and 0.2 for FC and 8 kg and 0.25 for UMMB groups. The observed changes in body weight and BCS in the UMMB supplemented group were significantly different ($P < 0.05$) from the control group (Table III).

TABLE III. THE EFFECT OF SUPPLEMENTATION WITH FARM FORMULATED CONCENTRATE (FC) AND UREA MOLASSES MULTINUTRIENT BLOCKS (UMMB) ON MILK YIELD AND CHANGES IN BODY WEIGHT AND BODY CONDITION SCORE (MEAN ± SE)

	Feeding trial 1		Feeding trial II	
Parameter	FC	Control	UMMB	Control
Milk yield (L)	8.0 ± 0.3	6.7 ± 0.27	7.0 ± 0.3 [b]	5.5 ± 0.2 [a]
Body weight (kg)	319.0 ± 13	315.0 ± 11	369.0 ± 24 [b]	361.0 ± 17 [a]
Body condition score	2.7 ± 0.1	2.5 ± 0.1	2.9 ± 0.1 [b]	2.6 ± 0.1 [a]

[ab] within rows, values with different superscripts are significantly different (P <0.05)

3.2.2. Reproductive parameters

The reproductive parameters measured included days post-partum (DPP) to first rise in milk progesterone concentration, DPP to first observed oestrus, DPP to conception oestrus, conception rate, inseminations/conception and calving interval, as shown in Table IV. These parameters in supplemented cows were not significantly different from those in the Control groups (P >0.05).

3.2.3. Cost : benefit analysis

The supplementation was cost effective if milk production in the respective treatments increased by 0.93 and 0.66 L/cow/day (break even increases). Supplementation of the dairy cow's diet with either FC or UMMB increased milk production by 1.26 or 1.5 L/cow/day, respectively (Table V). In terms of money this was equal to Tsh 346 and 413, giving a profit of 90 and 231 Tsh/cow/day (US$ 0.11 and 0.29), respectively.

4. DISCUSSION

Similar to the observations made by by Shem [1] and Msangi et al. [13], animals in the present study were unable to maintain a satisfactory level of milk production and reproductive performance, presumably due to inadequate intake coupled with the poor quality of the forages. These observations were also supported by the results of feed analysis, which showed low CP content in the feeds routinely used by farmers during the dry season. In a study conducted by Shem [1] in western United Republic of Tanzania it was shown that nitrogen content of grazing pasture and cut-and-carry grass differed significantly between wet and dry seasons (P <0.05). Similar findings of low nitrogen were reported by Kidunda [14] in a study of nutritive value of some tropical grasses and legumes at different stages of growth. The *in sacco* rumen degradability of the grass was very low (41.4%) which was lower than the potential degradability for Tanzanian forages reported by Shem et al. [15] and was in the range of rumen DM degradability reported for straws [16].

TABLE IV. EFFECTS OF SUPPLEMENTATION OF DAIRY COWS WITH FORMULATED CONCENTRATE (FC) OR UREA MOLASSES MULTINUTRIENT BLOCKS (UMMB) ON SOME REPRODUCTION PARAMETERS (MEAN ± SE)

	Feeding trial 1		Feeding trial II	
Parameter	FC	Control	UMMB	Control
Number of cows	37	28	27	28
DPP to:				
first progesterone rise	66.1 ± 4.8	81.3 ± 6.4	65.3 ± 7.9	77.6 ± 9
first oestrus	71.2 ± 5.3	86.3 ± 6.6	99.7 ± 12.0	111.9 ±11.0
conception oestrus	90.4 ± 5.0	102.4 ± 5.	120.2 ± 10	128.7 ± 13
Conception rate (%)	68	50.7	66.7	48.9
Inseminations/conception	1.3 ± 0.1	1.94 ± 0.2	1.5 ± 0.1	2.1 ± 0.2
Calving interval (days)	412 ± 13.0 417 ± 12	400 ± 13.7	414.5 ±15.6	

The improvements recorded in all measured production and reproduction parameters between the animals supplemented with the FC and those in the control group were non significant and similar to reports by Jingura and Sibanda [3]. There was an increase of forage digestibility, feed intake and absorption of total nutrients but the improvement was not significant probably because farmers withdrew other routine supplements in favour of the experimental supplement in order to reduce costs, although they were urged to feed their animals at the established rate. This probably happened because the experimental supplement was distributed at no cost. Similarly, control farms were supplied with some maize bran at no cost, as an incentive for participating in the project.

TABLE V. COST: BENEFIT OF SUPPLEMENTATION WITH FORMULATED CONCENTRATE (FC) OR UREA MOLASSES MULTINUTRIENT BLOCKS

Source	FC	UMMB
Cost of supplement (Tsh/kg)	100	101
Cost of feeding (Tsh)	256	182
Price of milk (Tsh/L)	275	275
Break even milk increase (L/d)	0.93	0.66
Observed increase (L/d)	1.26	1.5
Profit margin (Tsh)	90	231

However, supplementation with the UMMB significantly improved milk production ($P < 0.05$) and body condition of dairy cows ($P < 0.05$). But it had no effect on reproduction parameters. The improvement in milk yield may be explained by the fact that the E:P ratio was balanced in the rations and lead to the subsequent maintenance of ammonia content in the rumen leading to an improved rumen environment for micro-organisms. Therefore, digestibility and dry matter intake of feed stuffs increased [17, 18]. In similar experiments in Tanga, Msangi [4] demonstrated an increase of 1.1 L in milk yield when the ration was supplemented with UMMB. The increase in milk production due to the provision of UMMB was much lower than that observed in the on-station study [19], but close to that reported by Habib et al. [20], Hendratno et al. [21] and Msangi [4].

The parameters used to indicate reproductive performance were DPP to first rise in milk progesterone concentration, DPP to first observed oestrus, DPP to conception oestrus, conception rate and calving interval. A more accurate way of measuring reproductive performance in dairy cows would be to record the number of open days, provided it is calculated from calving to conception [22]. In the UMMB supplemented group the interval from calving to resumption of ovarian cyclicity based on milk progesterone concentration was 65.3 days and DPP to first observed oestrus was 99.7 days, both of which were better than that of the control group. However, this improvement was not statistically significant ($P > 0.05$). These values were high probably due to the fact that the animals in the present study were stressed by under nutrition, poor management, high temperature and humidity. However these findings are close to those reported by Orellana et al. [23] for dairy herds in Chile.

The majority of the cows experienced cycles of short duration prior to cycles of normal duration. This observation is in agreement with that of Tegegne et al. [24]. The mean length of short cycles was 13 days. Short cycles arise due to weak corpora lutea and peak progesterone levels which create weak endocrine function. The progesterone amplitude of short oestrus cycles was low implying sub-functional corpora lutea. This phenomenon is considered beneficial in that the progesterone production act as a primer for resumption of normal cycles [25, 26].

The interval to first observed oestrus in both supplemented groups was greater than those reported by other researchers, and was most likely due to poor oestrus detection and 'silent heats'. Heat was not properly detected as it was either too brief or sometimes not observed at all. The non-observation of heats lead to many animals remaining open for a long time, thus the prolonged calving interval of 400–412 days in the supplemented animals. Enough time should be given to heat detection in order to observe individual cows for at least 10–20 minutes and preferably three times a day; morning, afternoon and evening [22]. The interval to conception oestrus of 120 days is in agreement with findings of Msangi et al. [13] and Katyega [27].

The cost:benefit analysis indicated that supplementation with the FC and UM was cost effective since it allowed a marginal profit of Tsh 90 and 231 ($ 0.11 and 0.29), respectively. UMMB was more acceptable by farmers as it was less costly to feed and gave a better profit margin.

5. CONCLUSIONS

The widespread application of UMMB is only possible following large scale production of the blocks. Many farmers in Morogoro and few in Dar es Salaam have shown an interest in the use of the blocks during the dry period if the blocks could be made available in the animal feed markets. This could be undertaken either by the Ministry of Agriculture and Co-operatives, the Sokoine University of Agriculture (on cost recovery basis, as a productive venture) or by individual farmers/farmers' organizations on private business basis. To transfer this technology to other areas of the country, demonstrations of the possible benefits of the blocks under their own conditions would be necessary.

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