PJN

ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet

308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

Pakistan Journal of Nutrition 5 (2): 130-134, 2006
ISSN 1680-5194

Performance of Dairy Cows in Different Livestock Production Systems on Smallholder Farms in Bahati Division, Nakuru District, Kenya

T.P. Lanyasunya[1], Wang, H. Rong[4], E.A. Mukisira[2] and S.A. Abdulrazak[3]
[1]National Animal Husbandry Research Centre, P. O. Box 25, Naivasha, Kenya
[2]KARI-Hq, P. O. Box 57811, Nairobi, Kenya
[3]Egerton University, P. O. Box 536, Njoro, Kenya
[4]Animal Science Department, Yangzhou University, P.R. China

Abstract: Kenyan dairy industry is a smallholder activity in terms of both milk production and volume of sales. The challenge, however, is how to sustain it amid myriad of constraints. The current study was carried out in Bahati division of Nakuru District over a period of 3 years. The objective was to quantify performance of dairy cows on smallholder farms. Out of the 120 smallholder households interviewed during the preceding feed survey, 60 of them were selected to participate in the trial. They were all trained on data collection. Dam weights and milk yields were monitored on monthly and daily basis respectively over 2 to 3 consecutive lactations. The collected data was stratified according to zero, semi-zero and free grazing systems and stored in MS Excel. SAS (ANOVA and proc. GLM) models were used to compare the differences between systems. Scatter plots were developed using Lotus. The study revealed that, of the many constraints facing smallholders, lack of sufficient land for forage production, is the most critical. Majority of farmers owned between 0.5 to 5 acres out of which over 80% was committed to food crop production. Established acreage of Napier grass, which is the most popular fodder crop among smallholder resource-poor farm was low (ranged: 0.125 to 0.5 acres). This was further complicated by farmers' inability to conserve feeds (silage or hay). Consequently dairy cows' performance was observed to be low across the 3 production systems. Body weights and milk yields showed a wide variation both within and between systems. Dairy cows in zero grazing systems recorded higher body weights (480±75; range: 345-601 kg) compared to those in free (338±39; range: 275-410) and semi-zero (397±59; range: 280-490 kg) grazing systems respectively ($P<0.0001$; r^2 = 59%). A similar trend was observed with milk yield (free: 5-12; semi-zero: 6-16 and zero grazing system: 8-24 kg/cow/d) ($P<0.0001$). Cases of dairy stock morbidity and mortality due to diseases (tickborne, worms) exacerbated by malnutrition were also recorded. It was therefore concluded that, since little can be done on land scarcity, building farmers capacity on feed production, conservation and utilization would be the way forward. Development of suitable fodder crops, cost effective methods of feed production and ration formulation is therefore critical.

Key words: Dairy, milk yield, body weight, resource-poor farmers

Introduction

Kenya has one of the largest dairy sector industry in the Sub Sahara Africa based mostly on smallholder milk production. The sector is a significant part of the national economy and it comprises of a variety of production systems. These systems are predominantly, run by an estimated 660,000 force of smallholder rural households who are generally resource-poor. They own over 80% of the 3 million heads of dairy cattle, producing about 56% of the total milk production and contributing 80% of the marketed milk (Peeler and Omore, 1997; Staal *et al.*, 1999; Conelly, 1998; Thorpe *et al.*, 2000). The production systems evolved from the pressure to maximize on the use of limited households' land resources. They range from stall-fed cut-and-carry system or Zero grazing, semi-stall-fed cut-and-carry system or semi-zero to a non-stall-fed cut-and-carry system or free grazing. In response to the declining farm size, farmers generally attempt to intensify their farming systems by integrating livestock with crop production and shifting from free-grazing to semi-zero to zero-grazing where feed, water and minerals are brought to the animal (Baltenweck *et al.* 1998). Smallholder dairy farmers typically keep 2 to 3 dairy cows, with their followers, on approximately 2.5 to 5 acres of land with other livestock. Large portions of these household land parcels are committed to arable agriculture. Cattle on these farms are mostly genetically heterogeneous *Bos taurus* breeds, or cross-breds, containing a high proportion of *Bos taurus* dairy with infusion of *Bos*

Corresponding Author: T.P. Lanyasunya, National Animal Husbandry Research Centre (NAHRC), P. O. Box 25 Naivasha, Kenya. Tel: +254 723 416904

indicus. Most of the dairy herds are crosses of Friesian-Holstein, Ayrshire, Guernsey, Sahiwal and in very few cases local Zebus. High producing exotic dairy breeds tend to be preferred for zero-grazing systems where costs of inputs are comparatively higher. Free-grazing herds are often, dominated by crossbred cattle. Milk production is however constrained by a number of factors. The major ones being the level of dairy cattle feeding (quantity and quality), diseases, lack of replacement stock and farmers' lack of preparedness for feed shortfalls during dry seasons. The current study examined the performance of dairy cows in different production systems on smallholder farms.

Materials and Methods

The current study was conducted in Bahati division of Nakuru District Kenya over a period of 3 years. Bahati division is one of the 10 divisions of Nakuru District. It is situated about 25 km North of Nakuru town. It covers an area of 613 sq km with an altitude of 1800 - 2400 metre above sea level. The climate of the division is highly influenced by the altitude and the surrounding escarpments. It traverses across agro-ecological zone III in the lower part, II in the middle and I in the upper highland. Farming activities are concentrated in zones II and III. It receives two well-defined rainy seasons divided into long (April-July) and short (Aug. - Nov.). About 120 smallholder farms (average 2.0 acres (0.9 ha), mixed farming: crops/livestock) were randomly visited and interviewed and about 60 of them were selected to participate in the trial. They were further stratified according to the existing livestock production systems (zero -, semi - zero, and extensive grazing). The scope of selection covered three, actively dairying and densely populated, locations (Kabazi, Bahati and Dundori) covering over 85% of the Division. The farmers' selection was based primarily on a preset criteria focusing on whether dairy cows (in their early lactation or in-calf) were available. The other important factor considered was individual farmer's willingness to participate in the trial. Through a 2-day workshop, all the participating farm households and frontline extension staff were trained on fodder establishment, data recording (milk yield in kg/cow/d), dairy ration formulation (Pearson square method) using farm based feed resources, feed conservation (silage and hay making), clean milk production, disease control (tick-borne, mastitis) and heat detection. To facilitate data recording, each of the participating farmers was supplied with a standard heart-girth measurement tape, a spring balances (25 kg), a plastic bucket (10 litres for feed weighing) and graduated jug (1 litre for milk measurement), a record book, a daily feeding schedule and a performance chart. They were also supplied with forage planting materials (seeds, canes or vines). Parameters of study were body weight (kg/cow/month) changes and daily milk yield (kg/cow/d). Composite samples of feed resources used by farmers were regularly collected for dry matter (DM) determination according to AOAC (1990) and chemical analyses. Crude protein (CP) was determined by Kjeldahl method (AOAC, 1990). Cell wall fractions were determined as described by Van Soest and Robertson (1985). Ash was determined by igniting 1 g of dried feed materials in weighed porcelain crucibles in a muffle furnace preheated to 550^{o}C for 3 h (Abdulrazak and Fujihara, 1999). The collected data was stored in MS Excel and later subjected to SAS (2002)(ANOVA and proc. GLM) models to compare the statistical differences between the 3 production systems. Animal performance (body weight changes and milk yield) was further illustrated using scatter plots developed using Lotus software.

Results and Discussion

The study showed that, of the many constraints facing smallholder farmers, lack of sufficient land for forage production, is most critical. Majority of farmers own between 0.5 to 5 acres out of which over 80% is committed to food crop production. It is from this that the current problem of feed inadequacy (quantity and quality) on smallholder farms, stems from. This was clearly illustrated by the decreasing acreages of fodder crops on these farms. The study revealed that the established acreage of Napier grass, which most smallholder resource-poor farmers rely upon, ranged between 0.125 to 0.5 acres. This is hardly enough to maintain one livestock unit throughout the year. Table 1 presents the results of the chemical analysis of forage samples collected from both research stations (Snyders *et al*., 1993) and farmers' farms. As indicated (Table 1), the quality of farm grown forages is comparable to those grown at research stations. The slight differences in CP, and CF observed were attributed to difference in stages of growth at harvest. While the cutting age of forages sampled at research stations ranged between 3-6 months those at farm level were harvested more frequently ($\leq$ 3 month interval).

The high frequency of forage harvesting at farm level, is quite understandable since farmers have very small acreages, forcing them to harvest much earlier than the recommended height (90 - 120 cm). This perhaps explains the high CP and CF of farm grown forage (Table 1). Judging from these results, it seems that it is not the quality that is limiting dairy cow productivity on smallholder farms, but the quantity available. Field observations made during the current study strongly supported this assertion. This was further compounded by farmers' inability to apply inorganic fertilizer to boost the yields. Given the small herd sizes, animal manure is insufficient to meet nitrogen (N) requirements of farm grown forages. This has therefore impacted negatively on their overall dry matter yields.

Table 1: Chemical composition of forages commonly used on the trial farms

Forages	CP	CF	EE	Trial Site
Pennisetum purpureum	10.1±2.7	26.2±2.7	2.3±0.3	Karati (Lanyasunya *et al.*, 1998)
	9.5±1.7	32±1.6	2.1±0.4	Naivasha (Snyders *et al.*, 1993)
	11.2±4.8	27.2±3.5	2.1±0.4	Bahati (current study)
	10.6	27.8	-	Kakamega (Snyders *et al.*, 1993)
	9.4	33	-	Kisii (Snyders *et al.*, 1993)
Ipomoea batatas	17.8±2	14.9±1.4	2.3±0.2	Karati (Lanyasunya *et al.*, 1998)
	11.1±1	15.2±1	1.9±0.4	Naivasha (Snyders *et al.*, 1993)
	13.7±5.1	17.2±2.7	3.2±0.5	Bahati (current study)
Desmodium intortum	16.9±4.2	28.8±3.1	2.1±0.6	Bahati (current study)
Sesbania sesban	28.6±3.3	11.7±0.8	3±0.9	Bahati (current study)

Table 2: Daily milk yield (DMY) and live weight change of dams (DmWt) over lactation periods in different production systems

Prod. System	Model	N	R^2	DmWt (kg)
Free	DMY = 11.37 – 0.0224*CAge + 1.41^{-5}CAge^2	30	0.60	350
Semi-zero	DMY = 12.96 – 0.0387*CAge + 1.28^{-5}CAge^2	40	0.71	325
Zero	DMY = 19.90 – 0.0224*CAge + 1.41^{-5}CAge^2	70	0.61	375
Free	DmWt = 341.8 + 0.218*CAge – 1.67^{-4}CAge^2	30	0.65	350
Semi-zero	DmWt = 313.8 + 0.274*CAge – 2.13^{-4}CAge^2	40	0.72	325
Zero	DmWt = 367.1 + 0.217*CAge – 1.81^{-4}CAge^2	70	0.75	375

DMY - Milk yield (kg/cow/d) Cage - Days after calving N - Number of lactating cows (with an average of 302 days per lactation)
DmWt - Average live weight of dams at the onset of the trial

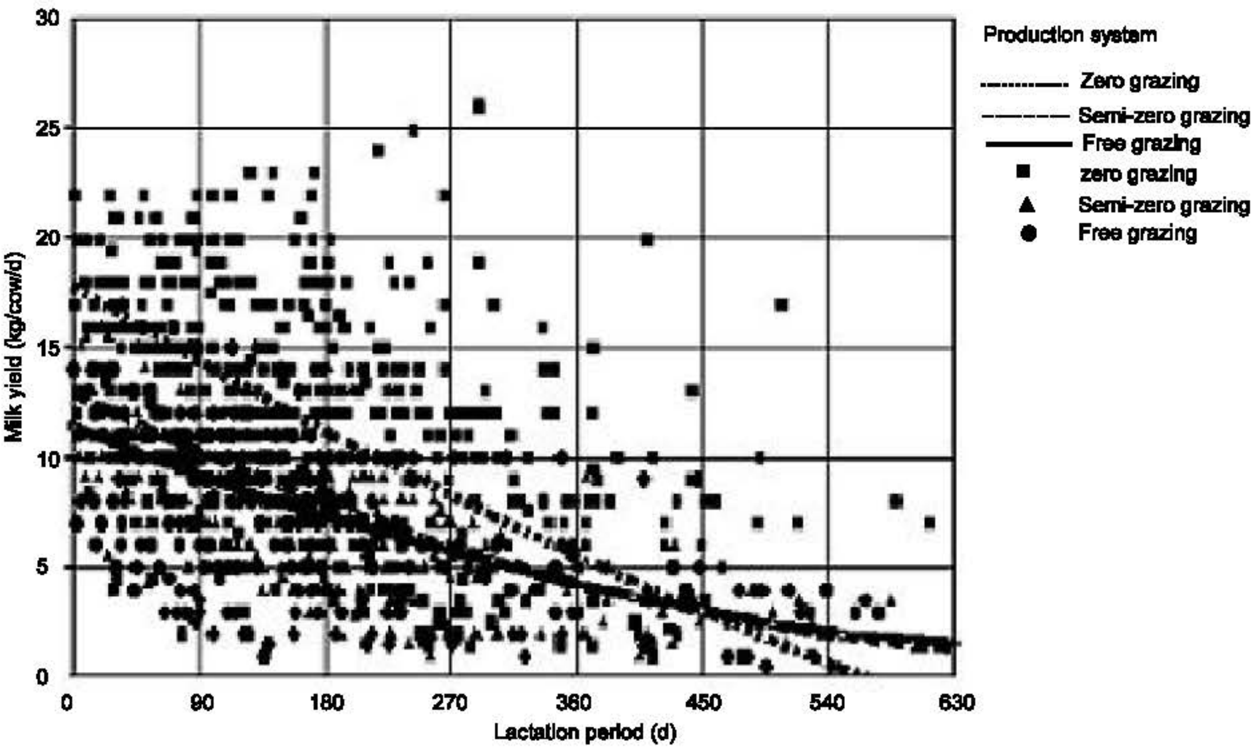

Fig. 1. Milk yield (kg/cow/d) of dairy cows under different production systems

The investigation stratified dam performance according to the 3 production systems. Table 2 presents the statistical models developed to evaluate the trends of daily milk yields and body weight change over dam's lactation period in different production systems.

The models with the days after calving and the dam's weight at onset of the trial (immediately after calving), explained 60-71% of the variation in milk yields and 65-

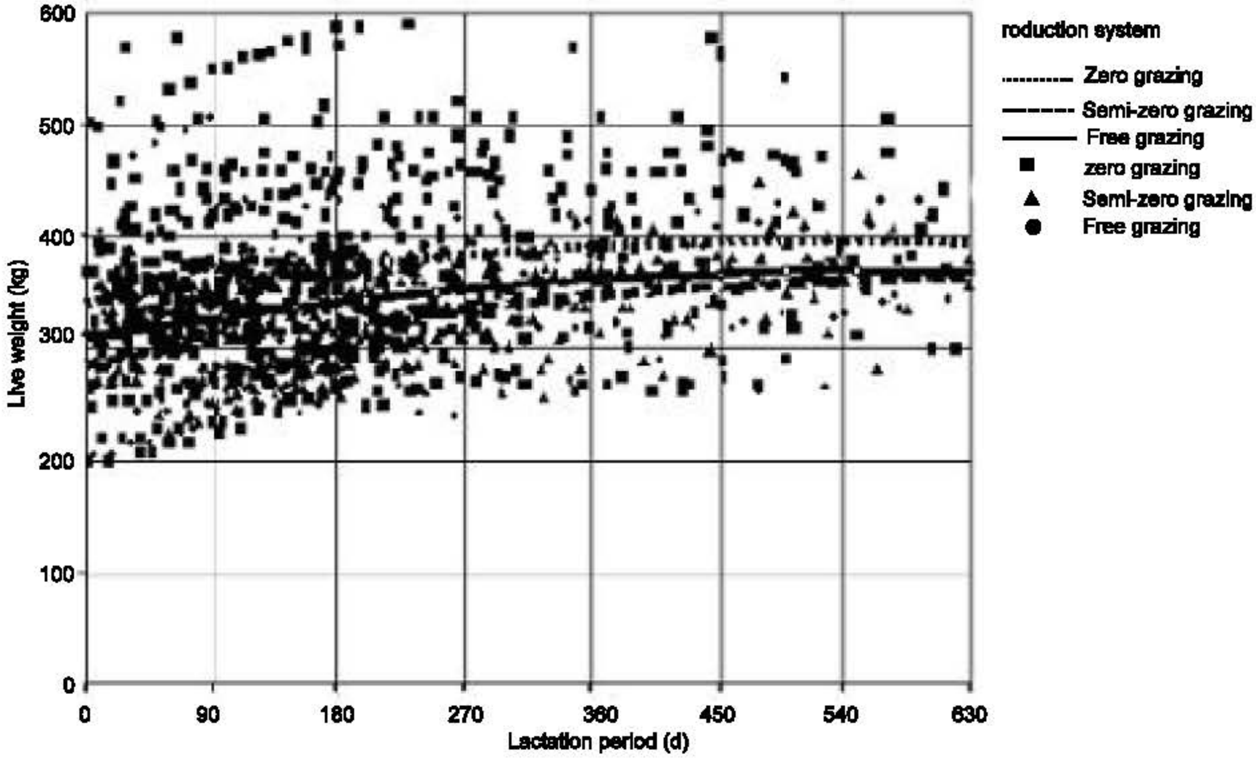

Fig. 2: Live weight changes of dairy cows in different production systems

75% of the measured dam's body weight. The scatter plots of live weight and daily milk yield of the dam over 2 lactation periods are presented in Fig. 1 and 2 respectively. The figures revealed wide variations occurring at farm level in dams' live weight, milk production and lengths of lactation periods. It was observed that some farmers hardly dry their cows. This was further complicated by high cases of dairy cow infertility in Bahati division (65.2%; Lokwaleput *et al.*, 1999). In Kenya, the National Dairy Development Project Fig. 2. Live weight changes of dairy cows in different production systems reported an overall calving interval of 468 days for 2,024 cows on farms in 22 districts (Kiptarus, 1993), while Odima *et al.* (1994) found a calving interval of 600 days on smallholder dairy farms in Kiambu District. Often, this forces farmers to continue milking cows for a long time. Though the observed differences in dam performance are largely attributed to imbalances in their planes of nutrition, impaired fertility leading to long lactation periods may have contributed to the variations observed in milk production between the production systems and consecutive lactations of individual cows. Breed differences may have also contributed to some extent on the variations observed. Body weights (Fig. 2) and milk yields (Fig. 1) showed a wide variation both within and between systems. At the end of the trial, dairy cows in zero grazing systems recorded higher body weights (480±75; range: 345-601 kg) compared to those in free (338±39; range: 275-410) and semi-zero (397±59; range: 280-490 kg) grazing systems respectively ($P<0.0001$; $r^2 = 59\%$). This translated to an improvement in body weight of 28 and 22 % for zero and semi-zero grazed cows respectively. Those in free grazing system showed a slight decrease in average weights (-3.4%). A similar trend was observed with milk yield (free: 5-12; semi-zero: 6-16 and zero grazing system: 8-24 kg/cow/d) ($P<0.0001$). Cases of dairy stock morbidity and mortality due to diseases (tick-borne, worms) were recorded. The observed high morbidity rates (especially that of young stock) on smallholder dairy farms was attributed to tick-borne disease and heavy worm loads exacerbated by malnutrition

Conclusion: The study revealed that lack of sufficient for forage production, is most critical limiting increased fodder production on smallholder dairy farms in Kenya. As a direct consequence, the amount of fodder established on these farms is hardly enough to maintain reasonably high milk production and dairy cows' fertility rate. The current study attributed observed variation in milk yield and body weight changes of dairy cows to the differences in feeding regimes emanating from land scarcity. This was further compounded by farmers' inability to conserve feeds (silage or hay), at least during the rain season when forages are abundant. It was therefore concluded that, since little can be done on land scarcity, building farmers capacity on feed production (application of supplementary N to boost yields), conservation and appropriate utilization of feeds (including crop residues) is a more sustainable way towards enhancement of dairy production on smallholder farms. Development of suitable fodder crops, cost effective methods of feed production and ration formulation is critical in this regard.

References

Abdulrazak, S.A. and T. Fujihara, 1999. Animal Nutrition: A Laboratory manual. Kashiwagi printing Co. Japan, pp: 32-39.

Association of Official analytical chemistry (AOAC), 1990. Official method of analyses 15th Ed. AOAC. Washngton, D.C. USA.

Baltenweck, I., S.J. Staal, M. Owango, H. Muriuki, B. Lukuyu, G. Gichungu, M. Kenyanjui, D. Njubi, J. Tanner and W. Thorpe, 1998. Intensification of dairying in the greater Nairobi Milk-shed: Spatial and housing analysis. Smallholder dairy (Research and Development) Project. MoA/KARI/ILRI. Collaborative Research Report. ILRI (International Livestock Reseach Institute), Nairobi, Kenya.

Conelly, W.T., 1998. Colonial era livestock development policy: Introduction of improved dairy cattle in high-potential farming areas of Kenya. World Development 26: 1733-1748.

Kiptarus, J., 1993. Fertility Report 1992. National Dairy Development Project. Monitoring unit. Ministry of Agriculture, Livestock development and Marketing. Nairobi, Kenya.

Lanyasunya, T.P., F.W. Wekesa, A. Osinga and R. de Jong, 1998. On-farm testing of improved calf rearing technologies in Naivasha, Kenya. Proceedings of the 2nd Intrnational symposium of the African Association of Farming Systems, Research-Extension an Training (AAFSRET), 21-23 August 1996, Ouagadougou, Burkina Faso, pp: 529-541.

Lokwaleput, I.K., D.N. Siamba and R. de Jong, 1999. Improved cow fertility through appropriate management practices on-farm in Koibatek and Nakuru Districts. In: R. de Jong and E. A. Mukisira (Eds). Testing of livestock technologies on smallholder mixed farms in Kenya, pp: 85-103.

Odima, P.A., J.J. McDermott and E.R. Mutiga, 1994. Reproductive performance of dairy cows on smallholder dairy farms in Kiambu District. Design, Methodology and Development constraints. Proceedings of the ISVEE Symposium. 5th-19th August. Nairobi, Kenya. The Kenya veterinarian 18: 47-64.

Peeler, E.J. and A. Omore, 1997. Manual of livestock Production Systems in Kenya. 2nd Edition. KARI (Kenya Agricultural Research Institute), Nairobi, Kenya, pp: 138.

Snyders, P.J.M., R. Schreuder, A.P. Wouters, A. Steg and J.N. Kariuki, 1993. Variation in organic digestibility (*in-vitro*), crude protein yield and ash content of Napier grass (Pennisetum Purpureum) and their prediction from chemical and environmental parameters. KARI - Naivasha. Unpublished report, pp: 75-76.

Staal, S.J., R. Kruska, I. Balteweck, M. Kenyanjui, A. Wokabi, Njubi, P. Thornton and W. Thorpe, 1999. Combined household and GIS analysis of smallholder production systems: An application to intensifying smallholder dairy systems in central Kenya. Paper presented at the 3rd international symposium of Systems Approaches for Agricultural Development (SAAD-III) held in Lima, Peru, 8-10th November 1999, National Agrarian University, La Molina, Lima, Peru.

Statistical Analysis System (SAS), 2002. Guides for personal computers. Version 9.00. (Ed.) SAS Institute Inc., Cary, NC. USA.

Thorpe, W., H.G. Muriuki, A. Omore, M.O. Owango and S. Staal, 2000. Dairy development in Kenya: The past, the present and the future. Paper presented at the annual symposium of the Animal Production Society of Kenya, Nairobi, Kenya, 22-23 March, 2000.

Van Soest, P.J. and J.B. Robertson, 1985. Analysis of forages and fibrous foods. A Laboratory Manual for Animal Science 613, Report.