Proc. 3rd All Africa Conf. Anim. Agric. & 11th Conf. Egyptian Soc. Anim. Prod., Alexandria, Egypt, 6-9 November 2000: 133-139

TECHNOLOGY DEVELOPMENT AND FIELD TESTING: ACCESS TO CREDIT TO ALLOW SMALLHOLDER DAIRY FARMERS IN CENTRAL KENYA TO REALLOCATE CONCENTRATES DURING LACTATION

D. Romney[1], R. Kaitho[1,2], J. Biwott[3], M. Wambugu[3], L. Chege[3], A. Omore[1,2], S. Staal[1], P. Wanjohi[1] and W. Thorpe[1]

1- International Livestock Research Institute, PO Box 30709, Nairobi, Kenya, 2. Kenya Agricultural Research Institute, PO Box 57811, Nairobi, Kenya, 3- Ministry of Agriculture and Rural Development, PO Box 30028, Nairobi, Kenya

SUMMARY

A field trial with smallholder dairy farmers in central Kenya was carried out to study the feasibility of reallocating concentrates as a means of increasing the profitability of milk production. Researchers designed the trial with extension officers, dairy co-operative and feed company staff to ensure that all stakeholders and key players were involved. Central to the design was the provision of feed on credit from the dairy co-operative to its members, the volunteer farmers involved in the study. The role of the research team was to present the technology to the farmers and monitor the implementation and impact. Farmers were not constrained in the way they chose to implement the recommendations, but the research team monitored any modifications as well as recording production parameters and characteristics of the farm and feed management systems likely to explain underlying variation.

The recommendation was to feed 8 kg/day in early lactation, withdrawing concentrates completely after twelve weeks so that during the course of lactation the amount fed would be equivalent to the most frequent farmer practice, a flat rate of 2 kg/day. Actual quantities offered by most farmers were reported to be higher than in previous lactations, but varied from 2-10 kg/day. Although some decreased the amount offered between 8-12 weeks post lactation most continued with the higher levels until a drop in milk yield was observed. Milk production increased as a result of the intervention with a large part of the variation in milk yield (r^2 = 0.55) reflecting the amount of concentrate offered. Month of calving and sampling also influenced the production response

For many smallholder dairy farmers one of the key constraints to making technological changes expected to improve production is the lack of credit to allow them to make investments. The results so far available from our study showed that farmers were able to increase their milk yield as a result of the intervention, and that, as expected, the response depended on the level of concentrate offered.

INTRODUCTION

In the highlands of East Africa, and particularly in central Kenya, dairy production is an important source of income for many smallholder households. For example, in a cross-sectional characterisation survey of a random sample of 365 households in Kiambu District, Central Province, Kenya, 93% of households were agricultural and of those 77% kept dairy cattle (Staal *et al.* 1998). In Kiambu District alone, therefore, it is estimated that there are more than 80,000 smallholder households (of Kenya's estimated 600,000 smallholder dairy farms) involved in dairy production to supply the ready market within the Nairobi milk shed. However, the milk yields reported to the survey by smallholders were low, an average of 5.6 l/day of calving interval (Staal *et al.* 1998) and the smallholders stated that inadequate feed supplies were the major factor causing the low milk yields. In a subsequent participatory rural appraisal (PRA) with a small sample of the characterisation study farmers, they observed that fodder shortages occurred all year round, although the scarcity was most severe in the dry season (Romney *et al.* 1998). Farmers compensated for some of the shortages by purchasing concentrate feeds, however evidence from a number of studies indicates that the large majority of farmers feed a low, flat rate of concentrate throughout lactation, typical quantities being 2 kg/day (Wambugu, 2000; Romney *et al.* 1998; Staal *et al.* 1998).

It is well documented that under-nutrition in the early part of lactation can have a negative effect on milk production later in lactation (Broster and Strickland, 1977; Johnson, 1984). To confirm this under the production conditions of central Kenya, and to test the responses to re-allocating the total concentrate fed on average to a smallholder cow during her lactation, an on-station experiment was carried out. Dairy cows were fed 2 or 8 kg/day dairy meal for 48 and 12 weeks respectively in an on-station study. Milk production was significantly higher for dairy cows offered 8 kg/day for 12 weeks, despite the fact that over the 48 weeks all animals received the same amount of concentrate. Milk

yields were calculated in 4 periods (1-75, 76-150, 151-225 and 226-305 days) and yields were 45, 24, 6 and 8% lower for animals receiving the flat rate in the 4 periods respectively (Biwott, 2000).
The present paper presents the preliminary findings of a study carried out with smallholder farmers and their cows to test the feasibility of changing farmers' concentrate allocation practice by shifting the concentrates fed to early lactation. Livestock researchers, and dairy co-operative and government extension staff carried out the trial jointly.

Materials and Methods

Study area and selection of farmers: The study was carried out in Ngecha Location, Limuru Division Kiambu District in collaboration with farmers delivering milk to the Ngecha milk collection centre, the largest of 16 centres in the division supplying milk to the Limuru Dairy Co-operative. Farmers volunteered for the study during meetings where results from the on-station trial (Biwott, 2000) were presented and the proposed intervention introduced. The intervention was the feeding of 8 kg concentrates/day for the first 12 weeks of lactation rather than the general practice of feeding a flat rate of 2 kg/day. To ensure that the volunteers could afford the increased level of concentrate feeding, the Limuru Dairy Co-operative agreed to extend increased credit facilities to those members participating in the study. Sixty volunteer farmers were chosen, all of whom had animals due to calve between April and July, 1999. In addition, a further 30 farmers offered to serve as controls by making no changes to their normal feeding practices.
Concentrate supply: The project provided no inputs to any of the farmers. However, as mentioned above, an agreement was reached with the co-operative to increase the availability of credit to facilitate the purchase of the concentrate feed. Normally, farmers were allowed to purchase items from the co-op, including animal feed, other dairy and agricultural inputs and human food, up to an amount equivalent to the value of expected milk deliveries during that month, based on previous delivery records. For the study it was agreed that each participant would be allowed to take 4 bags (280 kg in total)/cow at calving and 3 bags (210 kg in total)/month/cow for the subsequent 2 months, whatever the actual value of that farmer's milk deliveries. If farmers were unable to clear this debt through milk delivered to the co-op during the first 3 months of the cow's lactation, repayments would be spread throughout the whole lactation.
In the Ngecha area, the most common farmer practice was to feed maize germ rather than dairy meal, due to the unreliable quality and the perceived high cost of the dairy meal. However, during the initial meetings the research team undertook to monitor the quality of the feed and as a result most farmers chose to use dairy meal for the study.
Monitoring: The concentrate feeding management recommended to the farmers was based on the experimental findings described above. There was no attempt to persuade the farmers to follow the recommended practices, since an objective of the study was to monitor the farmers' modifications to the recommended practices and to understand why they were made
In a baseline questionnaire, information was collected to characterise the farm (including area of land farmed, herd size and household composition) as well as the animals themselves (including milk production and date since calving on the day of the visit) and current feeding practices. Cows calving between March and October 1999 were monitored for at least 200 days post-partum. Quantities of concentrates and forage offered were recorded together with milk yield. Frequency of monitoring varied, but was generally weekly to the 12th week of lactation and fortnightly thereafter.
Information on credit use was extracted directly from the co-operative records. Expenditure was recorded and categorised as dairy feeds (including dairy meal, maize germ and bran), other dairy items (such as udder salve and veterinary products or services) and non-dairy items (fertiliser, human food etc.). Milk delivery records were also extracted. The data from July 1998, approximately 8 months before the farmers were introduced to the research team, until December 1999, are presented in this paper. Recording for the complete study continued up to July 2000.
Data analysis: Preliminary analyses are presented to allow some discussion and interpretation of the data; the analyses include:

- Lactation curves (Wood, 1979) were fitted to the data collected in the baseline survey and to the data collected during frequent monitoring of animals in the actual trial
- Mean milk yield for each animal was regressed against mean quantity of concentrate offered as a preliminary step in data analysis. Values used were means for the days monitored for each animal.
- A log transformation (Rowlands *et al.* 1982) of the Woods curve (Wood, 1980) (equation 1) was fitted to milk yield data from each animal involved in the monitoring. In addition to the Woods equation variables, coefficients were estimated to describe the effect of month of calving and the month of data collection (equation 2). Using these coefficients, the effects of month of calving and sampling on mean milk yields were estimated.

$Y_n = an^b e^{-cn}$ equation (1)

$Log_e Y = log_e a + b log_e n - cn + log_e s_i + log_e m_j$ equation (2)

Where Y = milk yield; n = days after calving; a, b and c are coefficients which define the lactation curve and; $log_e s$ and $log_e m$ are coefficients describing the effect of month i of sampling and month j of calving ;

- Mean expenditure on dairy feeds, other dairy items and non-dairy items were plotted against month to show underlying trends in the patterns of expenditure before and after the farmers were first introduced to the research team and the proposed intervention. Mean values for milk revenue were also plotted.

Results

Sampling: Farmers in the survey were self-selected. Table 1 shows that the mean area of land farmed, TLU owned and income category were similar to average values for the district as whole, but that the area of land allocated to Napier and maize (which acts as both a food and forage crop) were higher (Staal *et al.* 1998). This may reflect the importance of dairy to these volunteer farmers.

Table 1: *Farm characteristics. Values are means for all farmers involved in the study together with standard deviation, minimum and maximum values. Mean values for Kiambu district from Staal et al. 1998 are included for comparison.*

Parameter	Mean	s.d.	Min	Max	Kiambu average Staal *et al.* 1998
Total land farmed	3.4	2.80	0.3	12	2.9
Total animals owned	1.9	1.29	0.2	11.6	1.7
Income category*	2.9	1.10	1	6	2.8
Area of Napier	1.0	1.00	0.13	5	0.5
Area of maize	0.9	0.80	0.13	4	0.4

*Income categories were defined as 1 = <2500 2 = 2500-5000 3 = 5000-10000 4 = 10000-20000 5 = 20000-30000 6 = >30000 KSh/month income estimated by the farmer

Implementation of intervention: None of the farmers fed concentrates according to initial recommendations and although some decreased quantities after 8-12 weeks none withdrew concentrates completely, many stating that they did not wish to make such changes while milk yields remained higher than observed in previous lactations. Overall, concentrate offered reduced gradually, as shown by the mean weekly values presented in figure 1. Treating the farmers as discrete groups of treatment and control was not valid since some volunteers fed lower amounts than planned and some control farmers opted to feed higher levels of concentrate after observing positive results on other farms. Overall, mean amount of concentrates offered over 1-30 weeks varied from 2 – 10 kg/day, with a mean value of 4.8 (s.d. 1.8) kg.

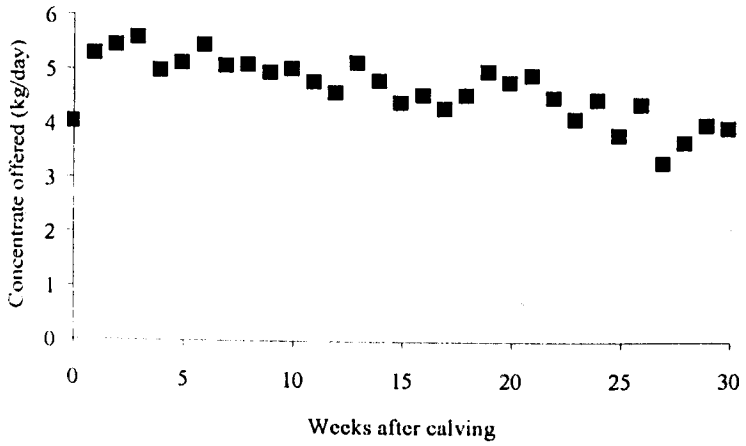

Figure 1: Mean concentrate offered (kg/day) 1-30 weeks post calving for all cows for which complete datasets were achieved

Milk yield: Figure 2 suggests a positive effect on milk yield as a result of the study activities. Although the data should be treated with caution, since very low r^2 values were observed for the baseline data, the baseline curve is similar to that reported by Tanner *et al.* (1998) for exotic dairy cows on smallholder farms in East Africa.

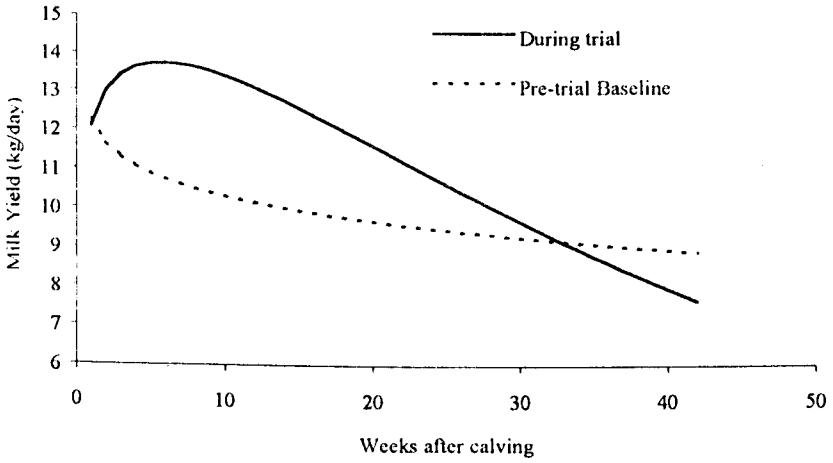

Figure 2: Milk curves fitted to all the data collected in the baseline survey (pre-trial) and during the actual trial. R^2 values = 0.57 and 0.06 for the curves fitted to trial and baseline data respectively

Figure 3 presents the relationship between concentrate intake and milk yield showing that the level of concentrate explained 55% of the variability in milk yield. The results indicate a 2.2 l/day increase in milk yield for every extra kilo of concentrate offered, a value that might be expected given typical ME values of local concentrates (12 MJ/kg DM) and requirements for production (5.1 MJ/litre for milk with a fat content of 40g/kg for animals consuming a diet with a metabolisability of 0.55 (AFRC, 1993)).

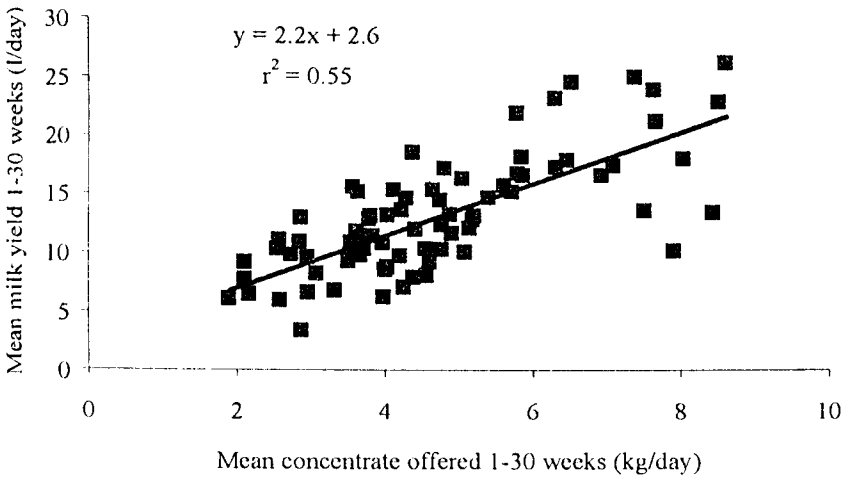

Figure 3: Effect of increasing concentrate offered on milk yield.

Some of the variability will have resulted from individual animal variation, cow parity, cow genotype, and other environmental factors. These include month of calving and of sampling. Estimation of coefficients for month of calving and month of sampling showed that both factors had a significant effect. Figure 4 shows that maximum yield occurred in April, early in the long rains, at which time fodder supply was good. Quantitative estimations of fodder supply from the monitoring will be tested as a factor once this part of the data is available. Lowest yields occurred in September/October at the end of the short dry season. Effect of month of calving showed a similar pattern, with mean lactation yields being higher if the animal calved just before or during the rainy season. This may reflect the availability of a relatively good fodder supply in the early part of lactation, and its positive effect on overall yield.

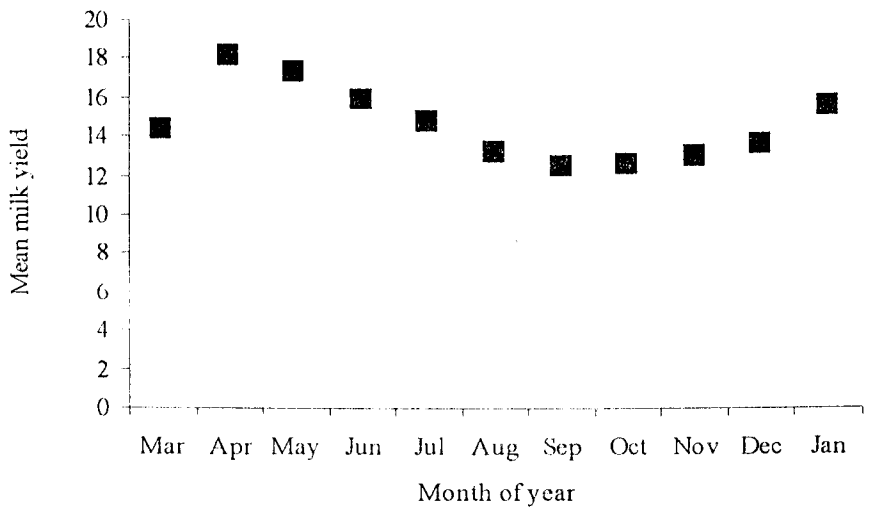

Figure 4: Effect of month of sampling on mean milk yield

Credit – An exclusive focus on production aspects of interventions on-farm is to misunderstand the factors that influence farmers' decisions when deciding whether or not to try a technology. in this case to purchase and use more concentrate in early lactation. In a study in Tanzania where feed options to increase milk production were presented to farmers, the most important criteria stated for adoption were money required for implementation, compatibility with the existing farming system and the knowledge required for implementation (Ashley *et al.* 2000). The Tanzanian farmers also observed

that some options that seemed economically viable on paper were not appropriate since the farmers did not have the cash available for initial investment.

In the present study the likely influence of other factors on farmer behaviour, such as availability of credit, was recognised from the outset and the study carried out in collaboration with the managers of the dairy cooperative, who agreed to increase the credit facilities available to the farmers involved in the study. Figure 5 shows that during the course of the experiment, total expenditure at the cooperative as well as milk revenues appeared to increase following the first introduction of farmers to the study although it should be noted that trend appeared to have commenced before the start of the study. The expenditure increase mainly appeared to be due to the amount spent on feeds, which coincided with a small drop in expenditure on non-dairy items.

Milk revenue is not necessarily an indicator of production, since households often split milk sales between the formal (the co-operative) and informal (e.g. neighbours and traders) markets as well as being consumers themselves. Consequently the increase may reflect changes in farmers' decisions on how to dispose of their milk. It should also be noted that expenditure was only recorded at the cooperative. During the course of the study it became clear that farmers also purchased concentrate feed and other goods from private stockiest. These purchases were not recorded systematically which means that the influence of the co-operative credit on farmer behaviour cannot be analysed definitively.

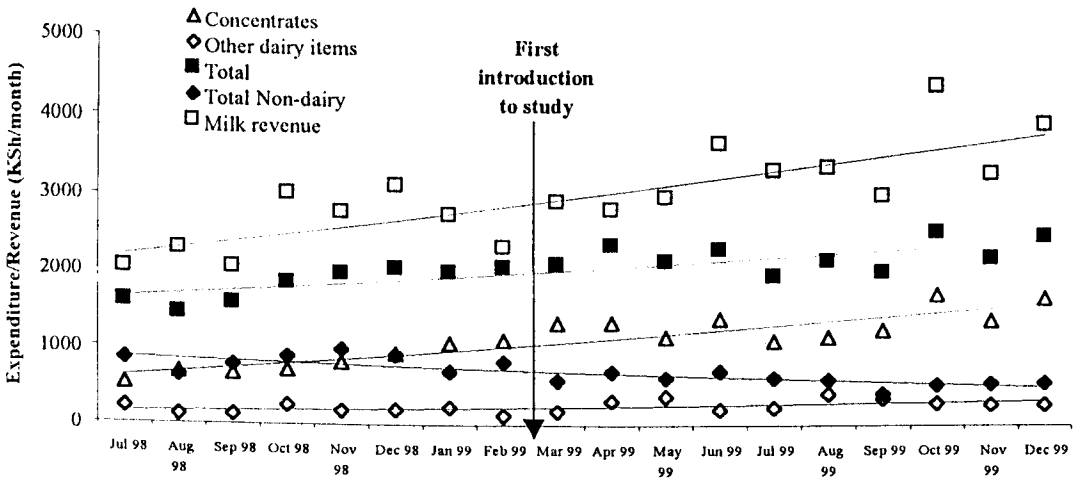

Figure 5: Expenditure through the dairy co-operative on concentrate feeds, other dairy items, non-dairy items and total, plus revenue from milk. Values are monthly means for farmers involved in the study. Regression lines fitted are given below

Milk revenue: $y = 93x + 2107$ $r^2 = 0.64$
Total: $y = 44x + 1608$ $r^2 = 0.65$
Concentrates: $y = 56x + 568$ $r^2 = 0.81$
Total Non-dairy: $y = -22x + 894$ $r^2 = 0.57$
Other dairy items: $y = 9x + 147$ $r^2 = 0.37$

Data for a random sample of farmers delivering milk to the Ngecha collection centre but not involved in the study, are being extracted from the co-operative records. This will allow the researchers to determine to what degree changes in expenditure at the co-operative were influenced by the study. These outcomes will be discussed using participatory techniques during feed-back sessions with the farmers and the co-operative and extension staff.

Conclusions:

On-farm experimental studies generally conform to the conventional approach of testing well defined biological treatments under conditions where underlying variation is either minimised or taken account of e.g. in blocking procedures. Changes in application of the 'treatments' by farmers are often strongly discouraged and results discounted when they occur. The present study differed from that approach in a number of ways. Firstly there was only a single 'treatment' which was not only biological, but also

attempted to address the working capital constraint faced by smallholders by making credit available for the timely application of the biological intervention, the feeding of concentrate in early lactation. Secondly, rather than control for underlying variability, the study attempted instead to record the variability and use this to explain results. Thirdly farmers were not forced to strictly adhere to a treatment, but again, their modifications to the recommended practices were recorded to help the technicians (researchers, extension agents and co-operative managers) to better interpret the data collected in the study and to better understand the farmers' responses and needs. For example, the fact that, as the study progressed, some control farmers chose to increase their level of concentrate feeding was taken as a positive indication that farmers were seeing the benefits of the intervention and were adopting it.

For many smallholder dairy farmers one of the key constraints to making technological changes expected to improve production is the lack of credit to allow them to make investments. The results so far available from our study showed that farmers were able to increase their milk yield as a result of the intervention, and that, as expected, the response depended on the level of concentrate offered. The data analysed so far do not allow us to state that farmers would not have increased concentrate use if the credit had not been available. However, the indications are that farmers appeared to make use of the increased credit availability to purchase more concentrate feeds and to feed them in early lactation resulting in higher milk yields than with their previous feeding management practice.

ACKNOWLEDGEMENTS

This research was carried out through the Smallholder Dairy (R&D) Project (SDP) of the Kenya Ministry of Agriculture and Rural Development, the Kenya Agricultural Research Institute and the International Livestock Research Institute. SDP is funded by the UK Department for International Development (DFID). The views expressed are those of the authors and not necessarily those of DFID or SDP.

REFERENCES

AFRC, 1993. Energy and Protein Requirements of Ruminants. An advisory manual prepared by the AFRC Technical Committee on Responses to Nutrients. CAB International, Wallingford, UK, University Press, Cambridge

Ashley S.D., Holden S.J., Massawe N.F., Owen E., Mtenga L. and Romney D.L. ,2000. Evaluation of farmer participatory approaches livestock production research. Compromise and callenges: the process of participatory livestock research in Tanzania.

Biwott J. 2000. Effect of different levels of concentrate at different phases of lactation on milk production of lactating dairy cows. *MSc thesis, Nairobi University*

Broster W.H., and Strickland M.J., 1977. Feeding the dairy cow in early lactation ADAS Quarterly Review No. 26, pp 87-105.

CBS (Central Bureau of Statistics), Kenya., 1994. *Kenya population census, 1989 Vol. I.* Office of the Vice-President and Ministry of Planning and National Development. Nairobi, Kenya.

Johnson C.L., 1984. The effect of feeding in early lactation on feed intake, yields of milk, fat and protein and on live-weight change over one lactation in dairy cows. *Journal of Agricultural Science, Cambridge* 103: 629-635.

Romney D L, Tanner J, Chui J, Kenyanjui M, Morton J, Ndegwa P, Kimari A, and Thorne P. 1998. Feed utilisation options for smallholder dairy farmers. In: *BSAS/KARI Proceedings of an International Conference on Foods Lands and Livelihoods, Setting Research Agendas for Animal Science, 27-30 January, 1998, Nairobi, Kenya,* BSAS, Edinburgh p 43

Rowlands G.J., Lucey, S. and Russell, A.M., 1982. A comparison of different models of the lactation curve of dairy cattle. *Animal Production* 35: 135-144

Staal S.J., Chege L., Kenyanjui M., Kimari A., Lukuyu B., Njubi D., Owango M., Tanner J., Thorpe W. and Wambugu M., 1998. Characterisation of dairy systems supplying the Nairobi milk market : A pilot survey in Kiambu district for the identification of target producers. *KARI/MoA/ILRI Collaborative Research Project Report*

Tanner J.C., McCarthy N.A. and Omore A., 1998. Why shorten calving intervals on smallholder dairy farms in East Africa? In: *BSAS/KARI Proceedings of an International Conference on Foods Lands and Livelihoods, Setting Research Agendas for Animal Science, 27-30 January, 1998, Nairobi, Kenya,* BSAS, Edinburgh pp 190-91

Wambugu, M., 2000. Extension and its effect on dairy cattle nutrition and productivity in smallholder dairy enterprises in Kiambu district. *MSc thesis, Nairobi University*

Wood P.D.P., 1979. A simple model of lactation curves for milk yield, food requirement and body weight. *Animal Production* 28: 55-63.