

Increasing milk yields through reallocation of concentrates by smallholder dairy farmers in Kenya

D Romney¹, M Wambugu³, R Kaitho^{1,2}, J Biwott³, L Chege³, A Omoro^{1,2}, S Staal¹, P Wanjohi¹, D Njubi, and W Thorpe¹

1. International Livestock Research Institute, PO Box 30709, Nairobi, Kenya

2. Kenya Agricultural Research Institute, PO Box 57811, Nairobi, Kenya

3. Ministry of Livestock and Fisheries Development, PO Box 30028, Nairobi, Kenya

Background

This case study describes work carried out by a consortium of partners from national extension and national and international research institutions under the Smallholder Dairy Project (SDP) in Kiambu District in the Central Highlands of Kenya. SDP is an integrated research and development initiative to support the sustainable development of Kenya's dairy sub-sector through small-scale production and marketing. The project is supported by bilateral funds from the UK's Department for International Development (DFID) and is led by the Ministry of Agriculture and Livestock Development (MoALD), which implements the project jointly with the Kenya Agricultural Research Institute (KARI) and the International Livestock Research Institute (ILRI). The project addresses a range of issues relevant to the dairy sub-sector in Kenya. Following identification of key constraints and on-station experiments to develop strategies, field studies to adapt and evaluate options are tested in the field.

Constraint identification:

It has been estimated that in Kiambu District alone 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 Nairobi and its environs. Milk yields reported by smallholders were low (Staal *et al.* 1998), and the smallholders stated that inadequate feed supplies were the major cause.

A survey, using participatory rural appraisal (PRA) methods, found that use of feeds was generally opportunistic, with farmers using small quantities of whatever was available or could be purchased from outside the farm. Commonly used concentrates included dairy meal, maize germ, wheat pollard and maize bran, ranked in that order of preference by the farmers. Farmers said they compensated for fodder shortages in the dry season by increasing quantities of concentrates, principally brans. A study by SDP observed an increase in the amount of concentrate from 0.9 in wet months to 1.58 kg DM TLU⁻¹ in dry months. In contrast, farmers do not alter amounts fed according to stage of lactation, preferring a low, flat rate of concentrate, typical quantities being 2 kg/day (Wambugu, 2000; Romney *et al.* 1998; Staal *et al.* 1998). The general practice of low flat rate concentrate feeding is despite extension recommendations to increase the amount of dairy meal by 0.5-1 kg per day until no further response in milk yield is observed (NDDP extension booklet). One reason given by smallholder respondents for the low levels of concentrate offered was high cost of concentrate feeds. Farmers favoured maize germ rather than the more expensive dairy meal, whose quality was known to be variable, even though it is considered as having higher nutritive value. Generally, farmers with access to a cooperative said they preferred to purchase concentrates at the cooperative, despite lower prices in local shops, in order to take advantage of the credit facilities offered.

On-station development of intervention

In order to explore how to improve the productivity and profitability of concentrate use, an option tested by SDP was to exploit the increased efficiency of concentrate conversion into milk during the early stages of lactation. An on-station trial carried out by the project showed that milk production was significantly higher for dairy cows offered 8 kg/day for the first 12 weeks after calving, compared to animals offered 2 kg/day over 48 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 (Kaitho et al. 2002).

This led to initiation of a field study to determine if the reallocation of concentrates was feasible under on-farm conditions, and to observe how farmers implemented and modified the strategy. Livestock researchers, and government extension staff carried out the trial jointly in collaboration with Limuru dairy cooperative in Kiambu and members of the cooperative delivering to the Ngecha milk collection centre, the largest of the 16 Limuru collection centres.

Methodology to adapt and evaluate intervention in the field

Selection of farmers: A meeting was held with 450 of the 520 active members. The intervention was presented to them and volunteers requested to test it on their farms. Of 90 volunteers with cows due to calve between April and July 1999, 60 were selected at random. Thirty non-volunteer farmers who originally said they did not wish to alter their feeding practices also agreed to be monitored during the experimental period. However, treating the farmers as discrete groups of treatment and control turned out to be invalid 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

Provision of concentrates: The project provided no inputs to any of the farmers. However, an agreement was reached with the co-operative that each volunteer farmer would be allowed to take four bags (280 kg in total)/cow of concentrate at calving, and three bags per month/cow for the subsequent two months. The payments would be spread through the whole lactation if a farmer was unable to clear the debt within the three months. This contrasted with the official credit rules by which farmers were only allowed to take concentrate to the value of the milk delivered to the co-operative in the previous month. This practice meant that during the critical first month of lactation farmers found it difficult to obtain concentrate because of lack of credit at the coop. In the Ngecha area, the most common farmer practice was to feed purchased 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 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, i.e. to reallocate the concentrate bought to the first 3 months of lactation by feeding 8kg/day rather than the standard 2 kg. There was no attempt to insist that the farmers follow any instructions from the researchers, since the primary objective was to monitor the farmers' modifications and to understand why they were made. Quantitative data were collected using formal questionnaires as well as qualitative feedback through informal interviews.

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), and current feeding practices. Cows calving between March and October 1999 were monitored over a period of at least 200 days post-partum, with monitoring ending in May 2000. Quantities of concentrates and forage offered and milk yield were recorded using a formal questionnaire. Frequency of monitoring varied, but was generally weekly to the 12th week of lactation and fortnightly thereafter. Monitoring was carried out by field extension staff, supervised by MoALD, KARI and ILRI staff attached to SDP. Qualitative information was collected during the survey and recorded by the extension officer leading the trials.

Information on credit used between July 1998 (approximately 8 months before the farmers were introduced to the research team) to July 2000 was extracted directly from the co-operative records. Records were initially collected for 60 of the study farmers, and later, an additional group of 30 'control' farmers was selected at random. These controls delivered to the same collection centre but did not participate in the study. Expenditure at the coop was recorded and categorised as dairy feeds (including dairy meal, maize germ and bran) and other items which included 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.

Throughout the study regular visits by enumerators and their supervisors allowed collation of farmer views, observations and comments. At the end of the survey farmers were invited to a feedback meeting where preliminary results were presented and their observations recorded. A follow-up survey using a formal questionnaire based on farmer recall was carried out 12 months after the end of the monitoring to allow comparison of feeding practices before during and after the study; to collect information on calving intervals following the study; and to collect information on sources of purchased feed during and after the study.

Data analysis: The data were used to draw conclusions on the potential for the intervention to be implemented in the field by farmers and to improve milk production. They were analysed as follows:

- Information from the baseline survey was used to determine whether farmers in the study were representative of farmers in the study area.
- Lactation curves (Wood, 1979) were fitted to the data collected (a) in the baseline survey, (b) during frequent monitoring of animals in the actual trial and (c) in the follow-up survey, to determine if there had been changes in milk production as a result of the study.
- Lactation curves were also fitted to production data from individual animals, and yields over 1-30 weeks estimated. Mean milk yield for each animal was regressed against mean quantity of concentrate offered.
- Calving interval was estimated from calving dates recorded in the baseline survey, during the study and in the feedback survey. Pre and post intervals were compared using a t-test.
- Mean milk revenue, dairying-related expenditure and expenditure/revenue in the two periods before (July 1998 – March 1999) and during the study (April 1999 – May 2000) were compared for study farmers and the 'control' group, using simple t-tests. Trends in expenditure at the cooperative were plotted against month to show underlying trends.
- In the follow-up survey farmers were asked to recall concentrate offer rates before, during and after the study period. Average rates in the first 3 months after lactation, as well as

the relative change, were estimated. These data were regressed against household and farm characteristics in order to identify important factors likely to influence the likelihood of farmers changing their practices and of feeding higher amounts of concentrate.

Results

Farmer characteristics: Study farmers were self-selected. The mean area of land farmed (c. 3 acres), number of dairy cattle owned (about 2) and income category were quite similar to average values for the district as whole, but the areas of land allocated to Napier grass and maize (which acts as both a food and forage crop) were at least twice as high (Staal *et al.* 1998). This was interpreted as an indication of high relative importance of dairy to the study farmers.

Implementation of intervention: None of the farmers fed concentrates according to initial recommendations. 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. Nevertheless, data from the follow-up survey indicated large differences between concentrate feeding before and after the study. Before the study, on average a flat rate of approximately 3 kg of concentrate was offered per day, decreasing the amount by about 15% over a 10-month period. During the study, farmers offered approximately twice as much in the first months after calving decreasing by more than 30% over a 10-month period. In the period following the trial farmers offered slightly less than during the study period but maintained high levels (Figure 1). Mean values for the observed data during the monitoring exercise show the close correlation with farmer recall values.

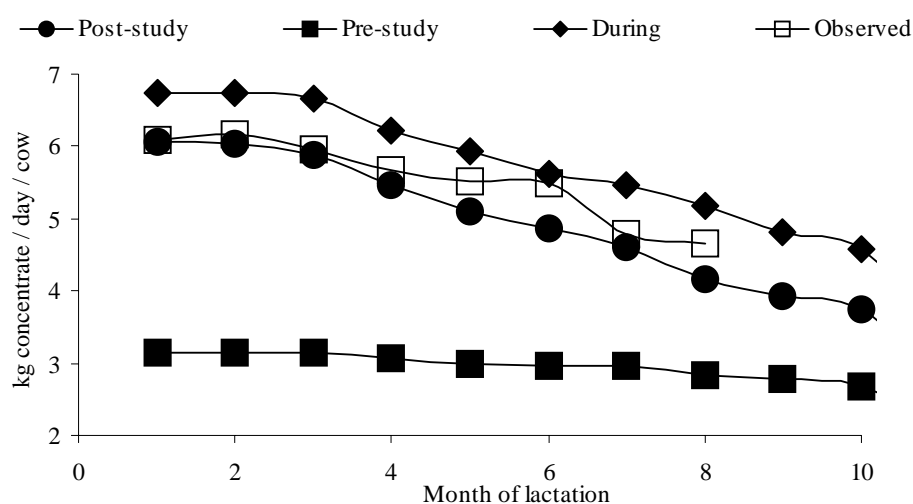


Figure 1: Farmer Recall of Mean concentrate offered (kg/day) 1-10 months post calving pre, post and during the study. Observed values are actual mean values recorded during the study monitoring period included for cross-referencing with the farmer recall information.

Determinants of feeding patterns and changes in the feeding pattern: One of the main reasons given in the pre-trial PRA for using low levels of concentrate was their high cost and a lack of available cash. Nevertheless, before the study neither greater wealth nor the presence of off-farm income appeared to contribute to higher offer rates, whereas years of

education and farming experience had a positive effect, suggesting a knowledge based decision (Table 1). In contrast, level of education had no effect on the degree to which farmers were likely to increase concentrate use following the study. It appeared that once farmers had received relevant information and had observed the effects of higher rates of concentrate use the main factor influencing uptake became the presence of off-farm income, which was taken as a proxy for the availability of ready cash. Those with more cows, considered as an indicator of greater market orientation, were also more likely to increase offer rates by greater amounts. The negative effect of age of the farmer may have reflected an unwillingness to change in older people.

Table 1: Effect of household characteristics on concentrate use and changes in feeding practices. + = positive effect; - = negative effect. NS = no effect.

	Increase following the study	Amount (kg/day/cow) before the study	Amount (kg/day/cow) after the study
Age of household head (years)	- -	NS	- -
Number of Dairy cows	+	NS	+
Years of Education	NS	+++	NS
Years of Farming Experience	+	+	+
Off-farm income (Yes/No)	+	NS	+
Concentrate offered before study (kg/day/cow)	- - -	Not tested	Not tested

Milk yield: Farmers reported higher milk yields during the study, which was supported by the observed data (Figure 2).

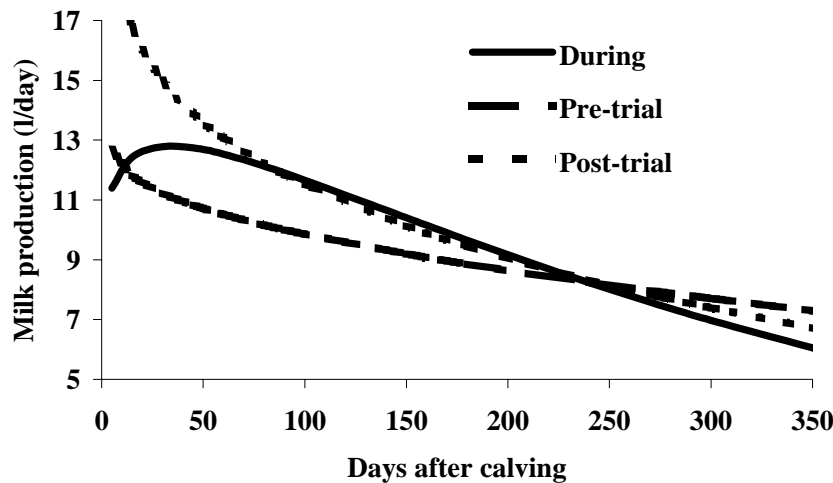


Figure 2: Milk curves fitted to all the data collected in the baseline survey (pre-trial), during the actual trial (during) and in the follow-up survey (post-trial).

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. During the period for which credit data were collected cooperative prices for concentrates varied from 8-15 KSh/kg

and for milk from 14.5 to 18 KSh. Hence even at the highest prices for concentrates and lowest milk prices farmers should still expect to make a profit over the range of concentrate rates observed. Some of the variability will have resulted from individual animal variation, cow parity, cow genotype, and other environmental factors, including month of calving and of sampling.

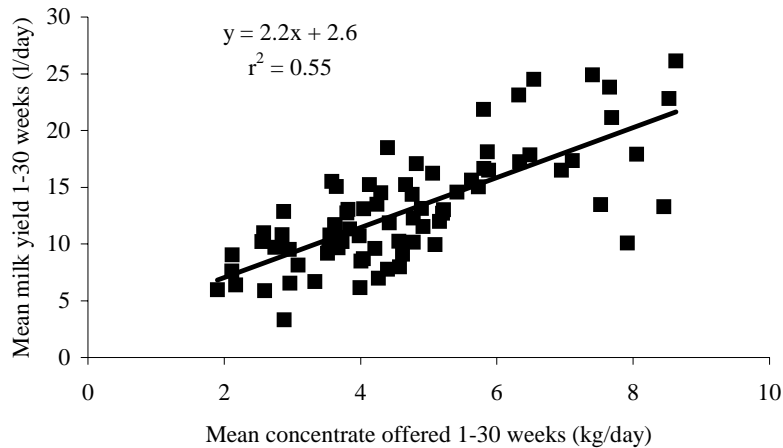


Figure 3: Effect of increasing concentrate offered on milk yield.

Calving interval: Calving intervals following the trial were significantly shorter than pre-trial values (445 cf 542 days), which supports farmers' observations in the feed-back exercises that body condition was maintained and that the animals came into heat faster.

Concentrate purchase and credit: 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 expected from the outset and the study was 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. Despite agreement with the coop, during the course of the trial a number of problems with the system were observed. Farmers reported refusal of credit in early lactation and refusal to spread the credit over subsequent months. In contrast the coop complained that farmers continued to purchase high levels of concentrate so that there was no period in which to recover the money owed.

Examination of the cooperative credit data suggested that credit patterns were not altered greatly during the trial. Nevertheless, the percentage of concentrates represented by dairy meal changed from 20 to over 60% during the study period. Data from the feedback survey indicated that following the study purchase of feed from private sources became more

important, rising from 46% to 76% of total expenditure on concentrates, and suggesting that in fact spending practices were altered during the study.

Conclusions

Technical implications: It appeared that the increased performance resulting from increases in concentrate feeding was financially viable under the observed price ratios. For many smallholder dairy farmers one of the key constraints to making technological changes expected to improve production is the lack of cash or credit to allow them to make investments. The results from the study showed that, although farmers did not implement the intervention according to initial recommendations, increases in concentrate offer rate were sustained following the study period. The pre-study observation that the level of concentrate feeding did not appear to be related to the income category or the presence of off-farm income, but to level of education and years of experience, suggested that knowledge rather than economic factors was a constraint. Once farmers had received relevant information and support from extension staff and scientists, presence of off-farm income became an important factor influencing extent of adoption. Results related to the provision of credit were not conclusive, but the fact that farmers purchased less concentrate from the cooperative following the study while maintaining high offer rate, and the minimal changes in spending patterns during the study, suggest that credit was not the primary constraint. Promotion of increased concentrate feeding in areas where markets are reliable appears to be justified from this study.

Methodological critique: 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, farmers were not forced to adhere strictly to a treatment and their modifications to the recommended practices were recorded. The analytical tools used allowed us to interpret the information collected despite there being no formal control group. Thirdly, rather than control for underlying variability, the study attempted instead to record the variability and use this to explain results. Data gathered in this way are more likely to be translatable into information useful to farmers since it allows farmer circumstances to be taken into account. Data were collected in a variety of ways and the analytical methods used varied depending on the form of the data. The cooperative itself was considered part of the implementation team and although feedback was collected, a more systematic collection of feedback from staff may have provided additional insights to the work. Problems arose from the complexity of the situation. It was realised during the course of the study that additional information was required in order to understand the recorded information. The heavy data handling requirements resulted in long intervals between feeding back results to farmers, making it more difficult for productive interactions between them and the extension and research staff.

Participation: The majority of the data was not collected in a participatory manner. The research scientists defined parameters and formal questionnaires were used to collect the

information. Long delays in data handling meant that it was difficult to feed back information rapidly to farmers and the cooperative and to gather their opinions on it. \when gaps were identified some data were collected in retrospect (e.g. credit information from the non-study farmers). Nevertheless, qualitative information was collected using informal methods and was invaluable in terms of interpretation of the data. The success of this component of the data collection was largely because of one dynamic member of the team who took the time to record observations made by farmers. A more structured method to collect informal feedback from members of the team may have been valuable. Farmers, based on the information provided to them, determined implementation of the technology. One can speculate that facilitation and support of farmers to test an intervention in the way they saw fit gave them enough confidence in the intervention to maintain the altered patterns of feeding suggesting that farmers were convinced by the benefits of change. Collection of data from the cooperative records was valuable in that it allowed quantitative evaluation of assumptions made by the research team and feedback from farmers and the coop.

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