Development of Endiisa Decision Support Tool for Improved Feeding of Dairy Cattle in Uganda

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Abstract

Efforts to improve livestock feeding in Uganda have made great strides in identifying nutritious feed resources for cattle. These feed resources include pasture grasses and legumes, leguminous shrubs and multi-purpose trees, crop residues and agro-industrial by-products. Despite this knowledge and, in some cases, use of the appropriate feed resources, milk production on dairy farms has remained low, in the range of 2–5 L per cow per day. This poor performance indicates a gap in the knowledge disseminated to farmers with regard to cattle feeding. One major knowledge gap in Uganda was that farmers did not know the quantities of feeds that would adequately meet the nutritional requirements of their animals. As a result, the farmers only provided 59 and 36% of the required metabolisable energy and crude protein, respectively, to their animals. Thus it was necessary to develop a mechanism by which farmers could establish adequate nutritional feed quantities for their cattle even when they combine a variety of feeds. One practical means of achieving this was through the use of a decision-support tool (DST), which was one of the major outputs of this research. In conclusion, the study provided information on the low status of dairy cattle feeding in the central zone. The DST that was developed and tested led to improved cattle feeding status, and increased milk production by 24%. The tool, available on the website of the National Agricultural Research Organisation (NARO-Uganda), should be recommended for use by farmers, researchers, trainers and policy-makers. A mechanism should be established for regular updating of the DST to include new feed resources and incorporate emerging information.

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INTRODUCTION

Dairy production makes a significant contribution to incomes, nutrition and general livelihoods for a large number of households in Uganda. It contributes 54–98% of household incomes for mixed crop–dairy farms in the Lake Victoria crescent (Mubiru *et al.*, 2007). However, milk production was found to be very low – averaging about 2,400 kg per cow per lactation from cross-bred (Holstein Friesian × Small East African Zebu) cows, which is approximately 50% of their milk production potential. Previous studies showed that farmers provided only 59 and 36% of the minimum required metabolisable energy (ME) and crude protein (CP), respectively, to their dairy cattle (Mubiru *et al.*, 2003). Poor cattle nutrition resulting from inadequate feeding was a major contributor to the low levels of milk production. A stakeholder meeting with farmer participation identified the major source of the under-feeding problem as a lack of clear information on how to feed dairy cattle. Farmers indicated knowledge of the high-value cattle feed resources; however, they had no knowledge of the quantities to feed. The major intervention deemed appropriate to respond to this was the development of a mechanism that would assist farmers in knowing the appropriate quantities of feeds to offer to their cattle in order to, at least, meet their minimum nutritional requirements.

MATERIALS AND METHODS

Through a brainstorming process, a team of scientists (four female and four male) from the National Livestock Resources Research Institute (NaLIRRI), Makerere University, Kulika Charitable Trust–Uganda, Mukono Zonal Agricultural Research and Development Centre (MuZARDI) and the National Agricultural Advisory Services (NAADS) agreed that the prudent solution would be to develop a computer-based decision-support tool (DST). The team also agreed that the DST should have the capacity to generate least-cost feed combinations for farmers on the basis of available feed resources to enable profit maximisation. The DST would benefit dairy farmers through three main channels:

- farmers who had access to computers and were computer-literate would, using the DST, carry out proper planning of the feeding of their dairy cattle – this would be an option not only for farmers with personal computers, but also for those living in close proximity to farmers' resource centres, numbers of which are growing in Uganda;
- extension advisors (government and NGO) would receive information from farmers on their cattle types and available feed resources, and use this information in the DST to generate cattle-feeding schedules for the farmers;
- researchers could incorporate all new feed resources and strategies into the DST to evaluate mechanisms for their use.

The team embarked on a process in two dairying districts of Uganda: Kayunga and Luwero. The four-stage process involved: (i) a baseline study; (ii) DST development; (iii) DST testing; and (iv) uploading the DST onto the NARO website and collecting stakeholder feedback. The baseline study covered 106 representative dairy farms, and used a structured questionnaire to collect data on household characteristics and production inputs and outputs, with major focus on dairy. Of the study households, 84% were male-headed with a husband and wife, the rest were female-headed households. Data collected from the baseline study were analysed using GenStat (Discovery Edition, version 3) to establish the proportion of farmers providing less than the required ME and CP to their dairy cows. In addition, *t*-tests were used to study differences in milk production where feeding was adequate compared with situations where feeding was inadequate. Simple linear regression was used to study the effects of ME and CP,

separately, on milk production. In this case, milk production (L per cow per day) was the dependent variable, and the proportions (%) of the daily requirement of ME and CP provided were the independent variables.

Data from the baseline survey were also partly used in developing the DST. This incorporated information on feed resources used in the study area. Cattle feed requirements and feed nutritional values in terms of ME and CP were obtained from information generated from previous research in Uganda. The DST was uploaded on the NARO-Uganda website prior to the testing phase. This was done to obtain ideas for improvement of the DST before its release to the general public. Testing of the DST was carried out on six farms selected from those where data were collected during the baseline study. This was done to evaluate selected feed combinations generated from the DST: the ability of the cows to consume all the feed, and the effect on milk production. Data on milk production were collected before and after implementation of the feeding regime developed from the DST, and tested using paired *t*-tests in Genstat. After the testing phase, the DST was revised and two stakeholder feedback workshops were held, one in each of the districts of Kayunga and Luwero. The workshops – which were largely attended by farmers, extension advisors and policy-makers – aimed at dissemination of the DST, explaining its mode of use, describing the benefits that could be realised through its use, and obtaining stakeholders' views on it.

RESULTS

Survey

The baseline survey showed that only 24 and 28% of farms in the study area were providing dairy cows with their daily minimum ME and CP requirement, respectively. Where the nutrition was inadequate, on average only 49% of the minimum ME and 52% of the minimum CP requirement was being provided to the dairy cattle. Milk production was 26% higher where feed offered provided the minimum nutritional requirement compared with farms where it did not. The regression analysis showed that the effects of both ME and CP on milk production were positive, with closely related levels (Table 1). Metabolisable energy and CP each accounted for about 14% ($P < 0.1$) of the variation in milk production on the farms.

Table 1 Effects of quantities of ME and CP provided to dairy cattle on milk production in Kayunga and Luwero districts, Uganda*

Variable	Regression coefficient	R^2	*F*
Proportion of daily requirement of ME	0.51	14.0	0.07
Proportion of daily requirement of CP	0.54	14.3	0.07

*ME, metabolisable energy; CP, crude protein.

Decision-support tool

A DST was developed with the capacity to generate feed combinations from 22 types of feed resources commonly used by dairy farmers. Feed combinations and their costs could be generated for lactating cows of weight 350 kg and above. The DST, which was named 'Endiisa' by the research team, generates feed combinations based on the specific cow CP and ME requirements and the CP and ME contents of the feed resources. The word '*endiisa*' means 'feeding' in Luganda, which is the most widely spoken local language in Uganda. The DST can be accessed and used via the internet (Mubiru *et al.*, nd).

Two of the feed combinations generated from the DST and fed to the test cows are shown in Table 2. These were developed for a daily ration for a lactating cow of 4–6 lactations in its early stage of lactation (1–3 months) and weighing 450 kg.

Table 2 Feed combinations generated from the decision-support tool for cows of four to six lactations weighing 450 kg and in the early stage (1–3 months) of the lactation cycle

Sample feed option 1	Quantity of feed component	Sample feed option 2	Quantity of feed component
Elephant grass (kg)	53.3	Elephant grass (kg)	53.5
Maize bran (kg)	2.5	Banana peel (kg)	23.5
Lablab (kg)	23	Lablab (kg)	23
Total (kg)	79	Total (kg)	100
Cost of formulation (UShs)	1,515	Cost of formulation (UShs)	1,000

Overall feeding of the DST-calculated feed combination to cross-bred (Zebu × Friesian) cows in the early lactation period (1–3 months) of four to six lactations increased daily milk production by 3.6 L per cow (24% increase; $P < 0.05$).

Stakeholder workshops

The stakeholder feedback workshops in the two districts were attended by 120 participants. These included farmers, extension advisors, NGOs, researchers and policy-makers. During these workshops, presentations were made on the research findings and description of the Endiisa DST, and comments and questions from participants were received and, where possible, addressed.

Dissemination

For further dissemination of the DST, the following activities were carried out:

- an article was published in the Ugandan print media – *The New Vision* daily (Nyapendi, 2009);
- a leaflet on Endiisa was produced;
- a booklet summarising the research was produced and the results, including the use of Endiisa, were also circulated;
- the DST was put on computer storage media (USB drives), which were circulated in the major dairying districts where internet access is still a challenge.

DISCUSSION AND CONCLUSIONS

Much of the dairy cattle feeding in the Central zone of Uganda is inappropriate, with most farmers offering feed providing less than the minimum nutritional requirement for dairy cows; as a result, milk production is low. Metabolisable energy is a critical source of energy for maintenance and production, and CP contributes greatly to milk production. Metabolisable energy and CP each account for about 14% of the variation observed in milk production. It is expected that the rest of the variation is caused by other factors, such as cattle breed, age, lactation stage and other nutritional components. If available feed resources are acquired and fed in the appropriate quantities, the required CP and ME can be provided to dairy cattle, and this will lead to an increase in milk production.

The Endiisa DST, developed as one of the outputs of this project, is a tool for the development of feed formulations/mixtures that provide the required nutrition for dairy cows at least cost in Uganda and similar agro-ecological zones, particularly in parts of eastern and central Africa. Endiisa is a valuable tool for policy-making with regard to feeding dairy cattle. Currently, Endiisa can be used only for milking cows weighing 350 kg and above. The tool will be improved over time to handle more applications, using inputs provided by users who take the time to post their comments on the website.

The tool will also:

- reduce time wastage through uncertainty about the quantities of feeds to prepare for dairy cows;
- enable conservation of feed when feed resources are in excess, for use in the dry season;
- enable development of long-term feeding plans and programmes;
- control feeding disorders, such as bloat, that result from feeding excess protein.

Endiisa, being computer based, will be particularly attractive to the younger generation of farmers, and will provide an incentive for older farmers to develop computer skills. In addition, the tool has prospects for incorporation into a mobile (cell) phone mechanism whereby farmers can receive feedback regarding least-cost feeding options based on information they send to farmers' resource centres or extension staff on their available feed types and cattle characteristics. This system, using short messaging service (SMS), would increase access to the DST, as most farmers have mobile phones.

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