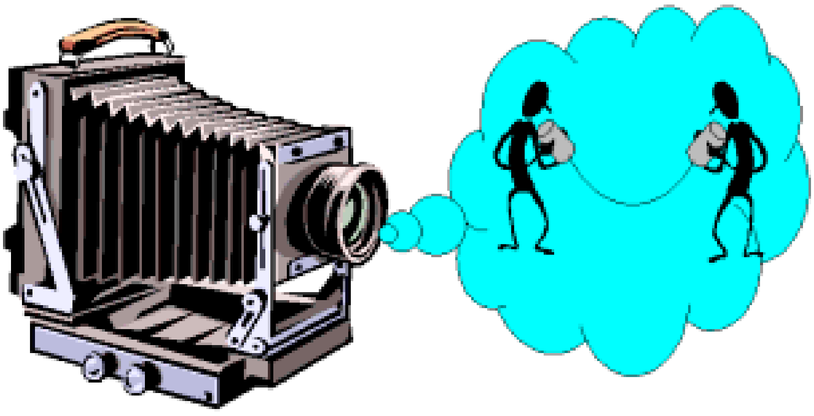
Talking Pictures



Pilot Phase
Final Technical Report
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Executive Summary
The lack of the effective links amongst research, extension and farmers is a global problem. Although much effort has been spent on improving the communication between these stakeholders, most research results are still delivered in a format that is difficult to comprehend and assimilate by extension workers who are frequently not experts in the particular subject area. Without the effective implementation of this link, it is difficult to see how extension services can promote improved feed management amongst their client-farmers in a way that is flexible enough to meet individual needs, and that accounts for the dynamics of feed resource availability in smallholder systems. The Talking Pictures project proposed to develop a simple pictorial system for disseminating extension information. Because this system is based on the DRASTIC software, developed by an earlier LPP-funded project (R6282), it will be unique in being able to support *dynamic* decision making *for a wide range of situations*, thereby compensating for contact between farmers and extension staff, that is often infrequent.

The project addressed the following Programme Outputs: i) Develop and promote strategies to improve the seasonal availability of livestock feeds (HPPS 1.2.); ii) Develop and promote strategies for the allocation and management of on-farm and locally available resources in order to optimise livestock production and improve their contribution to the crop/livestock farming system (SAPS 1.2); iii)Validate and promote improved feeding and management strategies (FAPS 1.5)

In close collaboration with client-farmers, extension services, research institutes and the MoAs in Kenya and Tanzania, through a series of participatory research and development activities, the project has developed a prototype, dynamic pictorial analysis, management and decision-making guide (‘Talking Pictures’) that allows smallholder farmers to analyse their dairy enterprise and to make informed management decisions based on their individual resource endowment and production objectives, and a version of DRASTIC, enhanced to produce ‘Talking Pictures’ for a wide range of specific circumstances of the client farmers of local extension services. The prototype is currently undergoing a first round of field-testing. In addition, links and complementary activities between an Indian NGO (BAIF) and the project are being developed, to enable testing and application of the Talking Pictures methodology in South Asia.

Background
All agricultural activities are entered into with a production objective or objectives specified in the mind or business plan of the farmer. In the production systems of the “developed” World, this objective has generally, in the past, been a relatively simple one and based almost exclusively on profit maximisation. The needs of many households in the developing World who practise integrated crop-livestock farming have, more recently, been recognised as more complex than this. Such farmers must balance objectives that relate to a wide range of livelihood issues such as food security, risk aversion and environmental sustainability, in addition to maximising levels of production. In many parts of the World, even the managers of more industrialised production systems must now take on board considerations related to the environmental impact of their activities and the need to limit production levels so as not to exceed quota or market capacity. A range of decision support methodologies, including those based on operations research techniques, have been studied as a means of assisting farmers in more effective objective specification and planning. A number of these have even found widespread practical application in a production context.

Livestock production is no exception in requiring decisions to be made that relate to the generation of specific outputs from available inputs. This background reviews some of the approaches that may be used in different situations to assist livestock managers in planning diets and / or feeding strategies to best meet their production objectives, and clearly identifies the need for the tools and methodologies of which the development was initiated during the currently reported pilot phase of the Talking Pictures project.

Mathematical approaches to feed planning
The widespread application of mathematical techniques to feed planning was made possible *c*. 25 years ago by the advent of powerful micro-computers capable of rapidly conducting the calculations required by the mathematical programming algorithms that are used for this purpose.

The best developed of these methods for ration formulation is based on linear programming (LP) using the simplex method or its derivatives. In general terms, LP has been used for a wide range of applications where it is necessary to identify the combination of values for a set of decision variables that will minimise (or maximise) the value of the objective function that, in combination, they make up. In addition to the objective function a LP model will have a set of constraints which place limits on the acceptable values of the decision variables. Thus a typical LP model for cost minimisation in diet formulation takes the form:

Decision variables:	$i_1 \ldots i_n$ Inclusion levels of n available feeds
Objective function:	$c_1.i_1 + \ldots + c_n.i_n = C$ Total cost of the ration (C) as the sum of the products of the costs (c) and inclusions levels (i) of the n available ingredients
Example constraints:	$p_1.i_1 + \ldots + p_n.i_n > P$ The sum of the products of the protein contents (p) and inclusions levels (i) of the n available ingredients must be greater than the protein requirement (P) specified for the ration
	$i_1 < I_1$ The level of inclusion of ingredient 1 (i.e. the value of decision variable) mast be less than the level (I) specified for the ration.

In a situation where a wide range of raw materials and nutritional supplements are available, LP techniques are very effective in identifying the optimum combination of feeds that will produce a nutritionally adequate diet at least cost. Apart from assigning a concrete value to the variables in the objective function, the algorithm may also be used to generate information for ranging and sensitivity analysis allowing the robustness of the solution to be assessed. For example, if the cost of an individual ingredient increases, the price at which its continued inclusion ceases to represent part of the optimum (i.e. least cost) solution may be recognised.

However, in an unmodified form, simple LP applications suffer from at least two major limitations:

- They are unable to cope with multiple objectives. This is not generally considered to be a problem where profit maximisation may be regarded as an overarching objective. However, if a second or further objectives must also be met, a least cost ration formulation derived by LP will tell us nothing about the impact of this solution on other enterprises on the farm. It would therefore be of little use in instances where livestock are kept by their owners for multiple uses such as the provision of draught power and manure, in addition to meat or milk.
- They cannot identify near-feasible solutions that, in many practical situations may be deemed adequate by the producer. This is a more general limitation and relates to the assumption that the nutritional specifications of diets are absolute and crisply defined. Individual animals of a specified type are highly variable in their responses to nutrients so a diet that is not optimal for one animal may be perfectly adequate for another. In addition, slight under-specifications to an optimised LP solution may reduce ration costs considerably at the expense of an intangible reduction in level of production. Such a solution, however, would be deemed infeasible by a LP algorithm and not identified.

In order to address these difficulties, a number of alternative, mathematical programming techniques have been suggested. Rehman and Romero (1984) considered a number of possible approaches based on a number of multiple criteria decision making models (goal programming, lexicographic goal programming and multiple objective programming). The authors concluded that each of these approaches could offer benefits. These benefits ranged from the opportunity for making a systematic exploration of trade-offs amongst different optimisation criteria offered by the goal programming techniques to the possibility of using multiple objective programming to identify a set of contrasting optimal solutions that can be further evaluated for practicality by the user. The use of goal programming with penalty functions, suggested by Rehman and Romero (1987), revolves around replacing the rigid constraints required by simple LP with goals that are associated with a penalty function. Thus, for example, if the goal related to a minimal value for a nutrient in the formulation is not quite achieved the solution is not rejected as infeasible. Whether or not it is optimal will be determined by the extent of the penalty that has been assigned to not achieving that goal and the extent to which the solution falls short of the goal. The authors claim, with justification, that this approach makes "the specification of minimum nutrient levels more flexible and realistic".

These approaches have not found widespread application, due perhaps in part, to the limitations of computer hardware when they were first suggested. With the considerable enhancement of desktop computing power since the mid-eighties and the availability of programming tools for the rapid development of user-friendly software interfaces, it is, perhaps time for a re-assessment of the practical possibilities of these approaches to ration formulation.

The particular needs of developing countries

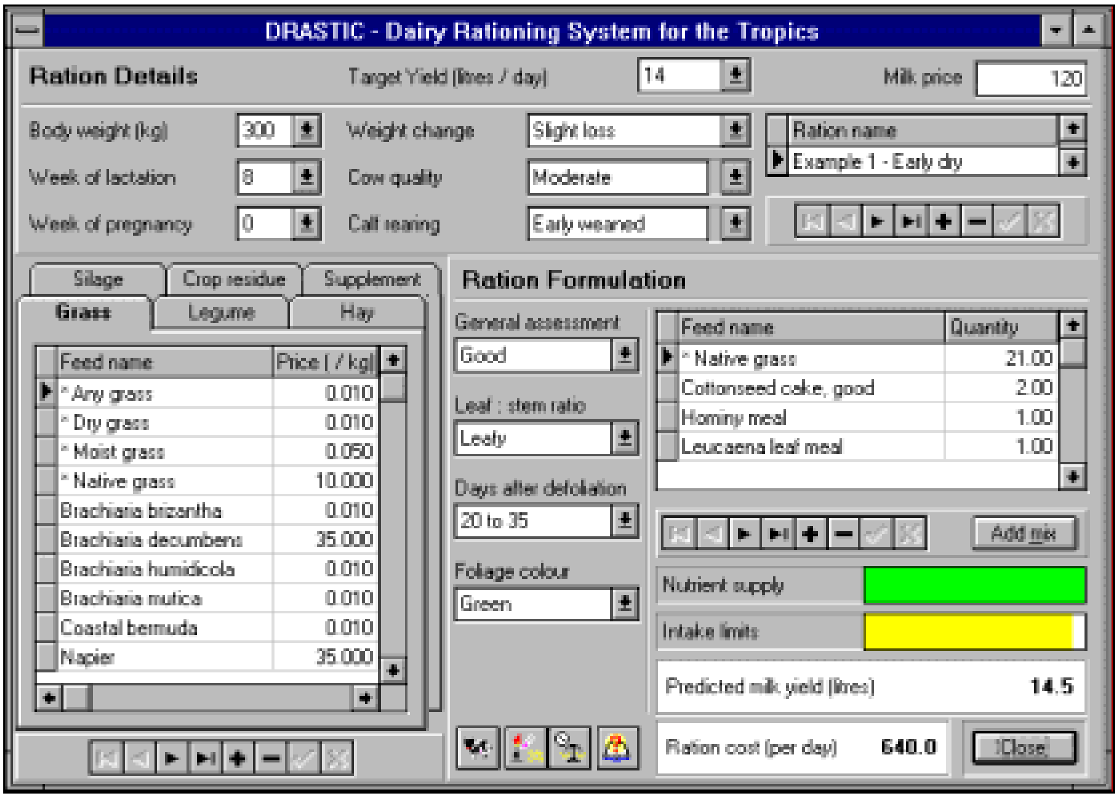
Whilst mathematical programming techniques, in their various guises, offer wide flexibility in feed planning, they do have a further, serious limitation for use in practical feed planning in developing countries. Mathematical programming algorithms are based on a relatively rigid, deterministic statement of the problem addressed – in this case a biological description of the relationships between the nutrient inputs to and productive outputs of farm livestock -. As a result they are not easily adapted to situations where data are few and / or unreliable. This is almost invariable the case in developing countries when one is working close to the farmer in a decision support capacity. Tropical feeds are highly variable in quality and the need for the specific, quantitative information required to run these algorithms is unlikely to be met by under-resourced extension services. In addition, practical decision support tools for developing countries must be simple to apply and flexible enough to account for multiple, varied and frequently changing objectives. The computer-based applications of mathematical programming techniques that are available currently require an availability of data and a degree of sophistication on the part of the user that it is unlikely to qualify them for field use.

DRASTIC

DRASTIC (Thorne, 1999) was developed with the objective of producing a genuinely useable, decision support tool for planning dairy feeding under tropical conditions. A major problem of rationing cows under these conditions is the lack of information on the nutritional quality of available feeds - particularly in the basal ration. This is compounded by a high degree of variation in feed quality that makes routine chemical analysis or reliance on "book values" for composition of little practical use.
Thus, the following key requirements were addressed during the development of DRASTIC:

- It has a user-friendly design (Figure 1);

Figure 1: *The DRASTIC user interface has been designed to be intuitive and simple to use.*



No expert knowledge of nutrition is needed to use it;

- Nutritional variables in the underlying model are assessed from simple indicators of feed quality (Table 1) allowing DRASTIC to cope with variable feed compositions in the absence of quantitative data

In order to address these difficulties, DRASTIC formulations access the whole range of variability observed in tropical feeds. The software is supplied to the user with the nutritional data that are required to run the core model for a range of commonly used tropical feeds, including supplements. For basal feeds, both maximum and minimum values are provided for each variable. The user, in conjunction with the farmer who will use the formulation, must then apply the set of qualitative indicators (summarised in Table 1) to the feeds that are currently available. These indicators are used to prime an artificial intelligence algorithm (essentially a fuzzy model adopting the approach described by Thorne *et al.*, 1997). This then generates data to run a biological simulation of protein and energy nutrition – modified from the standard approaches proposed by AFRC (1993) – that predicts the outcome, in terms of milk production achieved, of using a particular mix of feeds.

Table 1: *Qualitative indicators used by DRASTIC for assessing the nutritive value of basal diets.*

Indicator	Allowable values	Used for
General, subjective quality assessment by the farmer or extension officer	Very poor, poor, moderate, good, very good	Grasses, legumes, silages, hays, crop residues
Leaf : stem ratio	Very stemmy, stemmy, stem = leaf, leafy, very leafy	Grasses, legumes, silages, hays, crop residues
Days after previous defoliation by grazing or cutting	More than 45, 35 to 45, 20 to 35, 7 to 20, less than 7	Grasses, legumes
Colour of foliage	Yellow, greenish yellow, yellowish green, green, deep green	Grasses
Pest damage	More than 70%, 35 to 70%, 10 to 35%, less than 10%, no damage	Legumes
Odour	Nauseating, very acrid, slightly acrid, musty, sweet	Silages
Apparent moisture content	Very moist, moist, normal, dry, very dry	Silages, hays, crop residues
Length of chop	Not chopped, long chop, medium chop, short chop, fragmented	Hays, crop residues

Use of DRASTIC in the field, in an interactive mode with farmers, has shown that it can be very effective in predicting outcomes and then in designing modified feeding strategies for more cost effective production or increased yield. In particular, trial use in Bolivia (Table 2) was effective in illustrating the outcomes of increased supplementation in feeding systems based on native pastures.

(DRASTIC may be downloaded, free of charge, from: http://www.stirlingthorne.co.uk/drastic.html)

Table 2: *Examples of the use of DRASTIC with a group of cattle farmers in Bolivia. The DRASTIC predictions were used as a basis for identifying improved supplementation strategies for enhancing the actual milk yields on these trial farms.*

Farmer	Actual milk yield (litres day^{-1})	Yield predicted by DRASTIC (litres day^{-1})
Eduardo	20	19.1
Fidel	15	15.4
Fito	8	8.2
Juan	12	9.9
Miguel	8	7.9
Oscar	8	7.9
Rosendo	15	14.5
Toto	8	7.4
Yapacani	8	7.3

The Talking Pictures pilot-project

The previously mentioned lack of effective linkages between research, extension and farmers is a global problem. Particularly in recent years, when climatic changes combined with a reduction in access to natural resources due to significant population increases have called for significant changes to the traditional methods of animal management, neither indigenous knowledge systems nor existing advisory mechanisms have been able to keep pace with the rate of change required.

Although much effort has been spent on improving the communication between stakeholders, most research results are still delivered in a format that is difficult to comprehend and assimilate by extension workers, who are, generally, not experts in the particular subject area (Greenland *et al*. 1994; Moris 1991; Østergaard 1994). Without the effective implementation of this link, it is difficult to see how extension services can promote improved feed management amongst their client-farmers in a way that is flexible enough to meet individual needs, and that accounts for the dynamics of feed resource availability in smallholder systems.

Paper-based extension literature - in tabular or other formats - is not easily assimilated by extension staff who are not generally experts in nutrition. The development of DRASTIC, described above, directly addressed these problems. However, DRASTIC still relies heavily on frequent contact between extension systems, which are often poorly functioning, and farmers. Deficiencies in this process may mean that the outputs produced by tools such as DRASTIC will not always be sufficiently responsive to changing seasons, resource endowments, local markets and production objectives, compromising the extent to which farmers can base their management decisions on these and other factors.

There is, therefore, an additional need to generate information in a form that reduces the complexity of the interaction between extension services and farmers, and that allows farmers to take a more active part in the evaluation of alternative strategies. This is particularly important for enterprises such as dairying, in which changes in activities on a daily basis can influence production in the short-term. Static recommendations prevent farmers from adapting effectively to short-term changes in resource availability and production levels. In response to this need, the development of Talking Pictures has taken the scientific information on dairy nutrition packaged by DRASTIC and used it to generate a methodology for presenting it dynamically to farmers in an easily-understood pictorial format.

Project Purpose

- Develop and promote strategies to improve the seasonal availability of livestock feeds (HPPS 1.2.)

- Develop and promote strategies for the allocation and management of on-farm and locally available resources in order to optimise livestock production and improve their contribution to the crop/livestock farming system (SAPS 1.2).

- Validate and promote improved feeding and management strategies (FAPS 1.5)

The Talking Pictures project proposed to develop, in close consultation with all stakeholders, a dynamic pictorial system for representing the nutritional management of dairy cows in smallholder farming systems. This computer-based tool would built on the principles used in the development of DRASTIC, using this software to generate pictorial guides in hard copy. These hard copy guides consist of several separate pictorial layers that incorporate genotype, condition, stage of lactation and physiological status, quantity and quality of feed inputs (basal and supplements), estimated costs, expected production outputs and income, differentially linked through colour coding, to pictorially represent expected outcomes for each specific situation. The proposed methodology was envisaged to provide a truly dynamic analysis and management guide that would allow farmers to make informed management decisions for their dairy enterprise based on their own specific social and economic circumstances. Additional modification of DRASTIC would be undertaken to enable it to produce the required pictorial outputs for a wide range of specific localities and market situations.

Identified constraint to development

The lack of the effective links between research, extension and farmers is a global problem. Although much effort has been spent on improving the communication between stakeholders, most research results are still delivered in a format that is difficult to comprehend and assimilate by extension workers who are frequently not experts in the particular subject area. In addition, the delivery of such messages often relies heavily on frequent contact between extension systems that are often poorly functioning, and farmers. Moreover, extension messages are generally not sufficiently responsive to changing seasons, resource endowments, local markets and production objectives, compromising the extent to which farmers can base their management decisions on these and other factors. The development of a methodology which would reduce the complexity of these interactions and that would allow farmers to evaluate alternative strategies could hence have a significant impact on household food security, income generation and poverty alleviation.

This pilot project proposed to develop and evaluate the Talking Picture methodology to address the priority problem of nutritional management of dairy cattle in smallholder dairy production systems. It was hypothesised, however, that once developed, this methodology could be adapted and used in a wide range of smallholder production enterprises on a global scale.

Research Activities

To develop the prototype Talking Pictures, a stratified random sample of 40 households involved in smallholder dairy farming, based on the results of prior research (Msangi *et al*. 1998), were taken in Tanga, Tanzania. From October 1999 till September 2000, these farmers participated in the component activities described below.

Establishment of unit sizes/weights for roughage, supplements and milk

Monthly observations were made on all participating farms to establish what units are used and recognised by farmers for the measurement of forage, concentrate and milk and the actual weights of the used units, to enable the linking of the appropriate pictures with an actual unit size. During this activity, farmers were asked to estimate the quantity of fodder, concentrate, milk, they thought the units represented, after which the actual quantities were established with a Salter™ spring-balance. Farmers were also asked to convert between units (i.e. 1 bicycle load of forage equals X donkey carts of forage, 1 bucket of concentrate equals X cups of concentrate) if different units are in common use in the area for the measurement of the same commodity.

During the same exercise, observations were made about the types of concentrate or straights mixtures as well as the types and mixtures of fodder used.

Pictorial representation of calf feeding systems, stage of lactation/physiological status and condition

To ensure that some of the more ambiguous pictorial input variables would be recognisable by the users, twenty farmers were asked to draw the calf rearing (feeding) system they use, the stage of lactation/physiological status of their animals, and an animal loosing, gaining and maintaining weight, during individual farm visits. Following this exercise, farmers were asked to explain why they drew as they did. The 20 sample farmers that did not make the sketches were asked to interpret the other farmers' drawings to ensure that the visual indicators used are based on a common understanding. This exercise was carried out four times over the experimental period with farmers alternating between the 'artist' and 'interpreter' roles, and to check for continuity in pictorial representation and interpretation.

Farmers' perceptions of fodder quality

To enable the appropriate pictorial representation of fodder of different quality, farmers were asked, during the monthly visits, to score the fodder they were feeding on a scale from 1 to 5 (1 being the poorest, 5 being the best). If farmers were feeding fodder mixtures, they were asked to score within fodder species and the mixture as a whole (for the purpose of this exercise 'roadside grass' was assumed to be one species). Farmers were also asked if s/he would rank the fodder in the same way if this was a different season. During these scoring exercises farmers were asked to enumerate what indicators they use/what comparisons they make to score the fodder.

Participatory testing of the 'Talking Pictures' prototype

Following the development of the 'prototype' guide described above, 100 copies of the guide were produced and extension workers and farmers were trained on its use and the instructions required for presentation to other end-users. Six weeks after delivery of the guides to farmers, an impact assessment of the 'prototype' guide would be carried out on all farms, to assess its user-friendliness and effectiveness on-farm. Unfortunately, the start of this specific activity was delayed slightly as a result of internal TDDP management problems. In addition, based on the experience gained during the project, it was decided that it would be better to carry out the impact assessment of the guide after a longer period of on-farm testing. The results of this activity are expected to be available in December 2000.

Outputs

i. A prototype, dynamic pictorial analysis, management and decision-making guide ('Talking Pictures') that will allow smallholder farmers to analyse their dairy enterprise and to make informed management decisions based on their individual resource endowment and production objectives, developed and field tested.

ii. A version of DRASTIC, enhanced to produce 'Talking Pictures' for a wide range of specific circumstances of the client farmers of local extension services.

Project publications

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THORNE, P. J. AND DIJKMAN, J. T. (2000) Simple decision support for feed planning. FAO FEEDback review paper series. Food and Agriculture Organization of the United Nations, Rome, Italy.

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DIJKMAN, J. T. AND THORNE, P. J. (2000) Analysis, management, and decision support for farmers' feeding strategies: Talking Pictures. 20 pp. (RD1)

Additional Dissemination of Results

i. Training workshops for extensionists and farmers in Tanzania and Kenya;
ii. Participatory evaluation and field testing of Talking Pictures prototypes;
iii. Collaboration agreement with Heifer Project International (Global and Tanzania);

iv. DRASTIC workshop held in collaboration with BAIF in India;
v. Global DRASTIC dissemination network

The Talking Pictures concept

The current prototype Talking Pictures hard-copy guides are produced in such a way that users can choose one of three options, appropriate to each specific animal, for each of five pictorial input layers, i.e. lactational and physiological status; condition; calf-rearing system; quality of the basal diet; quantity of the basal diet. Each option is either colour- or pattern–coded, depending on whether colour or black and white printers are used to generate the hard-copy guides. The pattern or colour for each of the chosen input layer options is transferred with dry-wipe markers to a re-usable laminated 'credit card', leading to a unique sequence of five colours or patterns. This sequence is matched to the appropriate sequence out of 243 possibilities, supplied on three pages and linked to a pictorial representation of the expected production level for the animal in question. Based on this, users turn to the appropriate supplementation page, indicated by the picture of the expected production level. On these pages, users can select from different pictorial representations of supplementary feeds and different levels of supplementation, which are connected to a picture of the total milk production expected. Each of the supplementation choices will in the future also supplies pictorial data on the ratio between milk and concentrate prices at which supplementation of the chosen quantity becomes profitable (see Annex 1).

Participatory development and use of Talking Pictures

The guides can be prepared for specific areas and situations as prior to the generation of the hard-copies (as booklets or posters), pictures of the appropriate cow genotype, calf rearing systems, recognisable quantities of feed and milk, types of concentrates etc., can be selected from a thumbnail library which is linked to the appropriate biological data in the DRASTIC software. To enable this development of area specific Talking Pictures an appropriate thumbnail library will have to be collected. This requires the determination and testing of unit sizes/weights for basal diets, supplements and milk, universally recognisable pictorial representations of calf feeding systems, stage of lactation/physiological status and conditions, and farmers' perception of fodder quality.

The methodology is currently undergoing further refinement, and a standard protocol for the rapid collection of these pictorial indicators under development. Nevertheless, our experiences during the elaboration of the prototype in Tanzania and Kenya show that these variables are collected easily and rapidly through a number of participatory exercises and that identical unit sizes to measure concentrates and milk are used over large areas. In addition, pictorial representations of calf rearing systems, stage of lactation, condition, fodder quality etc. collected in Tanzania were readily interpreted by farmers in Kenya, indicating that many visual indicators that farmers use may be based on a widely-held common understanding. Moreover, although farmers had difficulty in estimating the actual weight in kg of recognisable units of forage (for example, bicycle load, head load, wheel barrow etc.), they demonstrated great aptitude in the conversion between units and the comparison of pictures of different quantities of forage with the amount of fodder they provide to their animals.

As mentioned before Talking Pictures prototype is currently undergoing field evaluation and initial results have indicated that the guides are accurate and user-friendly, for farmers and extensionists alike.

Contribution of Outputs

The project has achieved its outputs and has contributed to the research goal (*Improve the performance livestock (including draught animals) in various crop/livestock and livestock production systems*) as follows:

i. Initiation of the development and testing of new pictorial dissemination methodology;

ii. Initiation of the development and testing of a dissemination methodology that will ensure that previous DFID-funded strategic research, as well as research funded by other donors, has increased uptake and impact;

iii. Initiation of the development of a decision support system that not only provides extension services with a practical and user-friendly tool, but, more importantly, that gives farmers a science-based, **but useable**, decision support system, to analyse and manage their livestock enterprise based on their own social and economic reality.

The project leaders submitted a RD1 in June (Annex 2) in which they requested funds for the further development of the Talking Pictures methodology. The Talking Pictures phase II project continues to address the difficulty that has been experienced in the past in presenting scientific information to farmers in a form that is not static. This is particularly important for enterprises such as dairying in which changes in activities on a daily basis can influence production in the short-term. Static recommendations prevent farmers from adapting effectively to short-term changes in resource availability and production levels. The project will take the scientific information on dairy nutrition that is packaged by DRASTIC and generate a system for presenting it dynamically to farmers in an easily-understood pictorial format.

In addition, the phase II project addresses the optimisation of the effectiveness of existing and newly identified dissemination pathways, through the development of a generic dissemination methodology / tool.

The project will contribute to solution of the constraints enumerated above, through (a) the development of the dynamic, pictorial decision support tool, which will allow small producers to make science-based decisions on the nutritional management of their dairy enterprise. In addition, it will (b) provide a methodology that will contribute to a more effective contact between extension services and their client-farmers and effective linkages across the producer-extension-research pathway. Although the contribution to the solution of these constraints may be restricted to the areas of work in the collaborating countries for the duration of the project, the flexibility of the system under development allows for quick and easy adaptation to different situations and countries. Moreover, the methodology developed (i.e. dynamic pictorial dissemination) could, potentially, make a significant contribution to resolving a number of livelihood constraints in many lesser-developed nations within the next 15 years.

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